Emotion Recognition Ability in Older Adults

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I Nicola Dimelow certify that this thesis is my own work and confirm that the work undertaken towards the above named Thesis has been conducted in accordance with the SHU Principles of Integrity in Research and the SHU Research Ethics Policy
(tick box opposite)

Signed…N.Dimelow………..

Date 06/12/2018

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Abstract

This thesis investigated the extent of age-related emotion recognition deficits across several emotions, presentations, and stimuli types. Evidence suggests that older adults (OAs) are less able than younger adults (YAs) to recognise emotions (Ruffman et al., 2008). However, clarity regarding the breadth of these age-related emotion recognition deficits may be thwarted by difficulties in comparing findings due to methodological variations and sample differences. The current research sought to address some of these issues by comparing the emotion recognition ability of OAs (59 to 84 years) to those of YAs (18 to 29 years). Phase 1 of the research used a series of tightly controlled experiments to measure emotion recognition (for happiness, sadness, fear, anger, disgust) and non-emotion processing from static faces, non-verbal vocalisations, and single words. Phase 2 employed unimodal and cross-modal presentations of dynamic faces and prosodic sentences to measure recognition of the same basic emotions as well as a different set of discrete emotions (joy, amusement, pride, anger, and surprise). In terms of *deficits* the only emotion for which OAs showed a consistent impairment was anger as seen when static faces were used, when all presentation types were compared in Phase 1 and in one experiment in Phase 2. Moreover there is evidence to suggest that this deficit for anger is a specific function of the older-older (70 years+) adults' performance. OAs were also impaired in recognising joy from prosodic sentences and older-older adults in recognising sad from faces. More generally OAs had a deficit in processing auditory information and older-old adults in processing static faces irrespective of the emotion content. In contrast, OAs showed a *superior* ability than YAs to recognise emotion from words (particularly sad) and disgust when all presentation types were compared in Phase 1. It is concluded, therefore, that OAs' emotion recognition deficits are not as widespread as previously reported and in many cases performance is maintained and even improves in later years.

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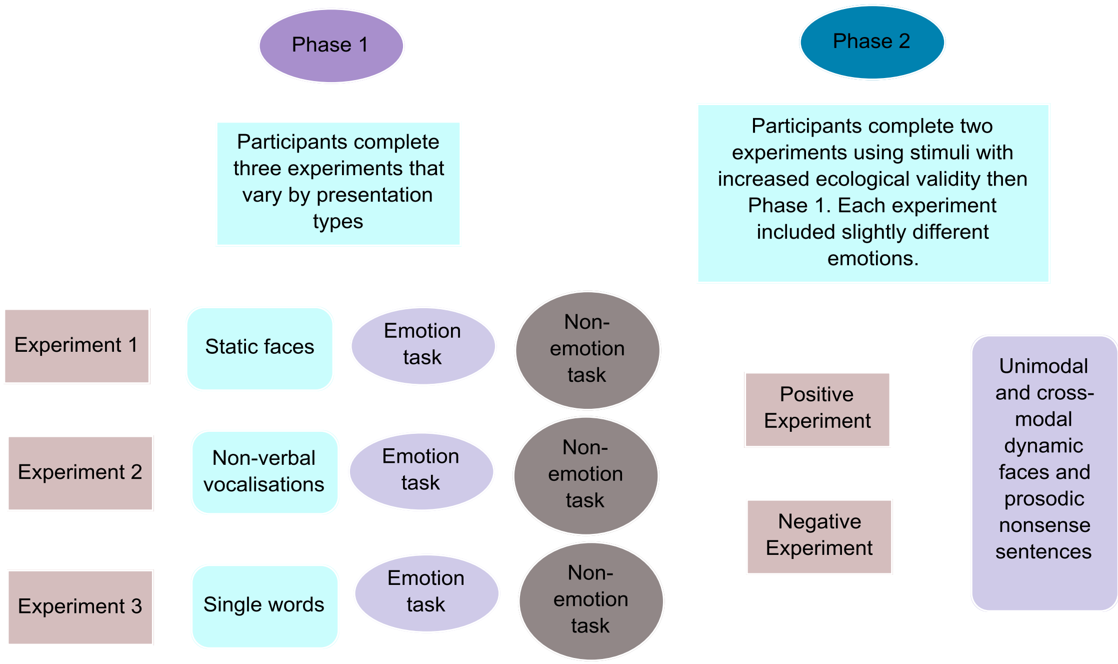
Introduction

Research suggests that older adults (OAs) are less able than younger adults (YAs) to recognise emotions from faces, vocalisations, and words. However, methodological disparities often make between study comparisons difficult; thus the extent of age-related impairments in OAs is unclear. The overarching aim of the current theses is to understand the extent of age-related emotion recognition deficits in OAs by tightening the methods used; thus, enabling meaningful comparisons to be made across several emotion and presentation types.

There are eight chapters within the theses. Chapter 1 provides a critical review of the research in the area and an introduction to the concepts of basic emotions and emotion recognition. Furthermore, four themes are introduced that are used to provide a rationale for the current research. The chapter concludes with the aims of the research programme and introduces the two phases of the programme. Chapter 2 details the general method for the experiments in Phase 1 of the research programme. Chapters 3, 4, and 5 give specific details of the three experiments within Phase 1 namely, emotion recognition from facial expressions, non-verbal vocalisations, and single words. To the researcher's knowledge this is the first study to investigate emotion recognition ability across these three presentation types whilst discerning between emotion types. Importantly these experiments included novel non-emotion tasks to measure participants' ability to meet the task demands and to process the stimuli. The advantage of the tight methodological controls allows for meaningful comparison across the experiments in Phase 1 and this is detailed in Chapter 6. This chapter underscores OAs' difficulties in recognising anger alongside an age-related improvement for recognising disgust. Then two experiments in Phase 2 that use stimuli with higher ecological validity than the stimuli in Phase 1 are discussed in Chapter 7. To the researcher's knowledge this is the first study to measure emotion recognition ability in

OAs using unimodal and cross-modal presentations of dynamic faces and prosodic nonsense sentences whilst discerning between emotion types. In addition a novel experiment was designed to tease apart a positivity effect from task design as explanations for the pattern of emotion recognition in OAs typically observed in the field. Finally, a concluding discussion (Chapter 8) underscores that OAs generally have comparable emotion recognition ability to YAs with only a few age-related emotion recognition impairments including anger and emotion from auditory information. Both Phases of the research programme received ethical approval from Sheffield Hallam's Ethics Committee (see Appendix a and b)

Figure 1. An Overview of the Experiments in Phase 1 and Phase 2 of the Research Programme.



Chapter 1-Literature Review

1.1 Overview

The current research programme takes a lifespan developmental approach. Such research is important due to the increase in the proportion of older adults (OAs) in Western populations. OAs are generally considered to be over the age of 65 years and currently account for 18% of the UK population, a figure that is expected to increase to 20% by 2020 (Office for National Statistics, 2017). A similar pattern is reported for other Western nations, as between 2014-2015 the OA population in the Unites States of America increased by 1.6 million (United States Census Bureau, 2017). Given the rise in the proportion of OAs and the potential economic and social impact of this population shift it is important to understand development into older age.

One area worthy of empirical investigation is emotion recognition ability in OAs. To date valuable insights have been made regarding this skill yet there are several ways to advance our knowledge and understanding in the area. Most of the research in the field uses the traditional forced-choice emotion recognition task (Isaacowitz & Stanley, 2011). In this task an emotion stimuli is presented and participants are required to select from the given emotion labels, usually one positive emotion (e.g., happy) and several negative emotions (sad, anger, fear, and disgust), which label they believe best represents the emotion in the stimuli. However, there are several inconsistencies in the methods used across studies and these will be discussed in detail throughout the theses. Importantly, these methodological differences make it difficult to compare findings across studies. The central aim of the current research programme, therefore, is to extend and tighten the method that is typically used in the field. To achieve this the aim is for each experiment to have a consistent method to enable comparisons across presentation and emotion types, and between emotion and non-emotion tasks. Furthermore, in line with most of the research in the area the findings of the current research will be explained within the concepts of cognitive, neurological, and motivational changes in OAs (e.g., Ruffman, Henry, Livingstone, & Phillips, 2008). Before introducing the literature in the field several concepts need to be understood including basic emotions and development of emotion recognition. Due to the nature of these concepts and the availability of research in the field these are often discussed using evidence from developmental stages preceding older age.

1.2 Basic Emotions

According to evolutionary theory emotion expression and emotion recognition are such vital behaviours for survival that they are innate (Darwin, 1872/1965), at least for some emotions. These innate emotions are often termed as the basic emotions, or primary emotions, and typically refer to a defined set of emotions including happy, sad, fear, anger, disgust, and sometimes surprise (Ekman & Cordaro, 2011; Johnson-Laird & Oatley, 1992). Essentially basic emotions are believed to be automatic, innate, pancultural, and have differential physiological responses that serve to direct behaviour in response to an event (Ekman & Cordaro, 2011). Thus, the characteristics of the basic emotions distinguish them from other affective phenomena including enduring mental states, such as love; and secondary or non-basic emotions, such as pride (Ekman & Cordaro, 2011).

Evidence in young infants appear to support the claim that the basic emotions are innate, as three-month-old infants can discern between facial expressions of anger (frowning faces) and happiness (smiling faces) (Barrera & Maurer, 1981), seven-month-old infants can distinguish between fear and happiness (Kotsoni, de Haan, & Johnson, 2001), and five-month-old infants can discriminate between affective vocalisations in the presence of facial expressions (Walker-Andrews & Lennon, 1991). However, the categorical discrimination observed in these studies is likely to be based on the ability to observe differences between the physical properties of the face, rather than attributing affective meaning to the expression (Walker-Andrews, 1997). Nevertheless, the evidence generally supports the idea that young infants are able to distinguish between some affective expressions. In contrast to these basic emotions, the recognition and experience of other secondary or non-basic emotions, such as guilt and embarrassment, are not thought to be innate and develop from the second year of life after cognitive advancement allows for self-representation to emerge (Izard, 1994).

1.3 Emotion Recognition

It is important for individuals to master the ability to recognise emotions as they notify of emotion states in others, which in turn can be used to predict behaviour and inform of appropriate responses (Ekman, 1999). For instance, affective facial expressions serve to transmit signals of an emotion experience to others and act as prompts for action; thus, emotion expressions often reflect emotion experience (Gross & John, 1997).

However, according to the Brunswik lens model (Brunswik, 1956) the ability to recognise emotion is complex. The premise of the model is that emotion recognition results from the ability of the expression producer, the encoder, to convey an emotion and the accuracy in which the receiver, the decoder, perceives it. Accurate encoding and decoding depends on how closely the expression fits with the display and decoding rules. For example, emotions can be read directly from the face through specific facial muscular movements or via pitch and tempo in vocal prosody (Belin, Fillion-Bilodeau, & Gosselin, 2008; Dougherty, Abe, & Izard, 1996; Ekman & Friesen, 1978). There are approximately 40 different facial muscle movements that are measured as Action Units, such as Upper Lid Raiser; Nose Wrinkler; and Lip Stretcher, and specific configurations of these action units are believed to form a particular emotion expression (Ekman & Friesen, 1978). Moreover, portraying the vocal pitch and tempo or facial muscular movements close to the display rules should result in accurate emotion recognition.

Thus emotion recognition ability relies on the skill of the encoder to portray the emotion and the decoder to perceive the target emotion; as such errors may arise if these skills are deficient. There are several factors, however, that can affect emotion recognition proficiency including the age of the encoder (as wrinkles in older faces can make them more difficult to read), a lack of contextual information, the proficiency of the encoder to mask a true emotion or modulate emotion expression, and the prior knowledge and experiences of the decoder (Barrett, Mesquita, & Gendron, 2011; Elfenbein & Luckman, 2016; Hess, Adams, Simard, Stevenson, & Kleck, 2012; Malatesta & Izard, 1984; Riediger, Voelke, Ebner, & Lindenberger, 2011). Thus successful emotion recognition can depend on many factors.

Given the many aspects that are involved in accurate emotion recognition it is not surprising that, despite the signs of this ability in infants, the skill takes time to refine. There is evidence that one important influence on emotion recognition ability from the decoder's perspective is emotion experience. For example, evidence suggests that physically abused children have a response bias for anger, whereas physically neglected children find it difficult to distinguish between emotions compared to non-abused children (Pollack, Cicchetti, Hornung, & Reed, 2000). Further evidence suggests that the relationship between emotion experience and recognition is also applicable to adults, as YAs with rich emotion experience have better emotion recognition ability than those with restricted emotion experience (Zhang, Song, Liu, & Liu, 2016). It is apparent, therefore, that environmental emotion experiences can influence the development of emotion recognition abilities. This may have implications for OAs' emotion recognition ability given the accumulated effects of life experience; therefore, this ability may differ to that of YAs. There is little evidence, however, that directly investigates emotion experience and emotion recognition ability in OAs.

In relation to experience, natural aging brings cognitive maturity that enables emotion regulation and this may influence emotion recognition ability. Adults are able to regulate emotions by supressing or reappraising emotion expressions and experience (John & Gross, 2004). Therefore, by adulthood individuals are generally able to mask their internal emotions, display expressions in line with cultural expectations, and crucially emotion experiences are more complex than those in childhood (Fischer, Shaver & Carnochan, 1990). Specifically, experience and cognitive maturation in OAs means they are often more proficient in emotion regulation than YAs (Blanchard-Fields, 2007). Thus emotion regulation may lead to differential emotion experience between YAs and OAs and given the documented link between emotion experience and emotion recognition this may influence emotion recognition ability.

In summary, evidence suggests that emotion recognition is a complex ability with basic skills being evident in young infants and refined with maturation. However, mastery of emotion recognition may be influenced by emotion experience and emotion regulation and this may change across the lifespan.

1.4 Socio-emotional Selectivity Theory

More complex emotion experience and positive wellbeing are two potential benefits of greater competency in emotion regulation in OAs than YAs, and have been explained by changes in motivations in older age (Carstensen, 2006; Carstensen, Mayr, Pasupathi, & Nesselroade, 2000; Charles & Carstensen, 2004). According to Socioemotional Selectivity Theory (SST; Carstensen, Fung, & Charles, 2003) individuals set goals along two trajectories: a pursuit of knowledge and the enhancement of emotion experience. The balance between these goals can depend on age as YAs tend to focus more on long-term knowledge driven goals, whereas OAs pursue short-term goals related to positive emotion experience (Carstensen, 2006). Specifically, SST suggests that in the face of reduced time horizons OAs tend to be motivated by short-term emotion led goals and these activities or behaviours are aimed to enhance positive life experiences (Carstensen, Fung, & Charles, 2003).

Fundamental to SST is the belief that OAs' focus on affect enhancing goals makes them more sensitive to processing positively valenced stimuli (e.g., happiness or positive surprise) than negatively valenced stimuli (e.g., anger or fear) and this is termed the positivity effect (Charles, Mather, & Carstensen, 2003; Carstensen & Mikels, 2005). A positivity effect, where the ratio for positive information over negative information is greater for OAs than YAs (Reed & Carstensen, 2012), has been observed across several domains including memory (Kan, Garrison, Drummey, Emmert, & Rogers, 2018; Mather & Carstensen, 2005). This processing effect may have implications for emotion recognition ability (Isaacowitz & Stanley, 2011). Indeed, evidence suggests that OAs rate surprised faces, an emotion expression that can be interpreted as either positive or negative, more positively than YAs (Shuster, Mikels, & Camras, 2017). A positivity effect using the traditional emotion recognition task would be revealed if recognition accuracy was higher for positive emotions than negative emotions in OAs and the ratio for this difference was greater for OAs than YAs. Thus, a positivity effect would reflect a pattern of emotion recognition ability in OAs as reflecting maintenance (or improved) recognition of positive emotions alongside impairments for recognising negative emotions compared to YAs. This possibility is evaluated later in the chapter (see Theme 1, Subtheme 1b).

1.5 Cognitive and Neurological Change

In contrast to a seemingly positive development of emotion functioning in older age OAs are susceptible to cognitive and neurological decline. It is well established that some cognitive abilities change in adulthood and the direction of the change depends upon the function (Baltes, 1987). For example, fluid intelligence (aptitude for problem solving that is not necessarily taught [Cattell, 1963]), memory, and processing speed tend to decline, whereas verbal abilities generally improve or are maintained with age (Benjamin, 2016; Salthouse, 1982; Salthouse, 2010). Furthermore, the age at which specific cognitive abilities start to decline varies (Hartshorne & Germine, 2015). For example, processing speed starts to decline at around 20 years of age and crystallised intelligence (learnt knowledge), such as vocabulary, peaks between 60 and 70 years of age (Hartshorne & Germine, 2015).

It is possible that age-related declines in some cognitive abilities may impact on emotion recognition ability in OAs. Emotion recognition relies on several cognitive processes including attention to and perception of the stimuli, knowledge from experience of the stimuli, memory of similar stimuli, the application of concepts, and categorising and labelling the emotion (Adolphs, 2002). Given that emotion recognition ability potentially relies on different cognitive processes that maybe susceptible to decline in older age, it is conceivable that the ability to recognise emotions also declines with advancing age. This possible association between cognitive abilities and emotion recognition abilities is discussed throughout the thesis.

Similar to cognitive changes with age many neurological areas are believed to undergo reductions in volume or activity in older age. This is an important consideration as several brain areas are recruited during emotion recognition tasks including the occipito-temporal cortices, amygdala, orbitofrontal cortex (OFC), and the basal ganglia and the level of activation may differ in these areas depending upon the emotion in the stimuli (Adolphs, 2002). Importantly, certain brain regions and neurotransmitters believed to be involved in emotion processing are prone to age-related decline including reduced volume in the frontal lobes and reduction in dopamine levels (Bartzokis et al., 2001; Cacioppo, Bernston, Bechara, Tranel, & Hawkley, 2011; Lawrence, Calder, McGowen, & Grasby, 2002; Raz, 2000). Specifically, the OFC is thought to have a rapid decline with age (Raz et al., 1997), the Prefrontal Cortex (PFC) may have reduced volume (Resnick, Pham, Kraut, Zonderman, & Davatzikos, 2003), and activity in the amygdala in response to affective faces is thought to reduce in older age (Gunning-Dixon et al., 2003).

Furthermore, neurological changes with age may influence emotion recognition ability depending upon how the emotion information is presented. For example, the volume of white matter in the visual cortices appears to be stable with age, grey matter volume in many language areas are also largely preserved with declines occurring in later older age, whereas reduced asymmetrical activation may lead to changes in the central auditory processing system and the latter is related to OAs' lesser ability in processing temporal information from sounds (gap detection) and may reduce their ability to distinguish between sounds (Martin & Jerger, 2005; Raz, Ghisletta, Rodrigue, Kennedy, & Lindenberger, 2005; Sowell et al., 2003; Zendel & Alain, 2011). Given the disparate rate of change in areas thought to be responsible for processing visual, lexical, and auditory information, then age-related impairments in OAs may differ across modality and presentation types. Taken together, the cognitive and neurological differences between YAs and OAs may reduce emotion recognition ability with age.

1.6 Emotion Recognition and Social Competence

Lower emotion recognition ability in older age may reflect a broader age-related deficit in social functioning (Phillips & Slessor, 2011). The ability to accurately interpret emotion cues is important as emotion signals act to inform our behavioural responses (Fiske et al., 2007; Potthoff & Seitz, 2015). In turn appropriate behavioural responses are related to our social interaction competence (Sze, Goodkind, Gyurak, & Levenson, 2012). For example, if emotion recognition ability is impaired and a person is unable to determine the emotion state of others then emotion cues may be misinterpreted. These emotion recognition errors may result in an inappropriate behavioural response and this in turn may negatively impact on social relationships (Isaacowitz et al., 2007).

Indeed the ability for young children to recognise affective facial expressions has been related to the ability to form positive friendships (Denham, 1998). Research highlights that children diagnosed with disorders partially characterised as having reduced social competence, such as ADHD and autism, have impaired emotion recognition ability compared to typically developing children (Fonesca, Seguier, Santos, Poinso, & Deruelle, 2009; Wong, Biedel, Sarver, & Sims, 2012). Further, emotion recognition ability from vocal expressions has also been related to social behaviour in children on the autistic spectrum (Demopoulos, Hopkins, & Lewine, 2016). It appears from these clinical studies that emotion recognition ability is associated with social competence, at least in children.

Likewise, emotion recognition aptitude maybe related to social functioning in OAs but there is little research that directly investigates this possible relationship (Phillips & Slessor, 2011). Importantly, poor social functioning may lead to feelings of social isolation and loneliness (Hawkley & Kocherginsky, 2018); therefore, if OAs have reduced social competence then it might be expected that older age would be characterised by high levels of loneliness. However, despite a reduction in the quantity of social interactions and networks, through death of friends and family members; reduced natural contact with others when work life has finished; and increased restrictions in mobility, loneliness is not widespread in OAs with few self-reporting as experiencing severe loneliness (Dahlberg & McKee, 2014). This finding may reflect the importance of the quality rather than quantity of social relationships in older age in protecting against loneliness (Pinquart & Sörensen, 2000). Given that many OAs are able to maintain quality friendships it could be expected that OAs would have maintained emotion recognition ability, as this skill is supposedly fundamental to social relationships.

From the limited research in the field age-related declines in emotion recognition ability in OAs appear to be related to lower levels of social activity and reduced social networks (Antonucci, 2001; Bailey, Henry, & Von Hippel, 2008). Importantly, what is omitted from most of the research in the field is how emotion recognition ability in OAs is related to social competence and not simply the size of social networks, as the latter may decline naturally due to changes in life circumstances rather than a result of emotion recognition skills. Phase 2 of the current research programme fills this gap in the literature by investigating the relationship between emotion recognition ability and social activity and quality of friendships.

1.7 Age-related Emotion Recognition Research in Older Adults

Given that emotion recognition ability may change in older age, it is important, to assess how this change is measured. The traditional emotion recognition tasks typically use forced-choice response formats (e.g., Horning, Cornwell, & Davis, 2012; Suzuki, Hoshino, Shigemasu, & Kawamura, 2007). Of note, however, forced-choice formats have been criticised for limiting choice and the perceived emotion may not be represented in the options; thus, responses may not reflect the observer's true emotion recognition judgement (Barrett, 2013; Gendron, Roberson, & Barrett, 2015; Russell, 1994). Nevertheless, forced-choice tasks do provide a useful and controlled method of assessing the ability to label emotionally salient stimuli.

Table 1.1 (Appendix 1.1) reports findings from forced-choice studies assessing emotion recognition ability in OAs using different presentation and stimuli types including faces, vocalisations, prosodic sentences or words, and read texts or words. Of note whilst Table 1.1 aims to convey the results of known papers found via several Internet searches it may not include all published papers in the field. The Internet search terms were: “age-related emotion recognition”, “age-related emotion perception”, “emotion recognition in older adults”, “emotion perception in OAs”, “facial expression recognition in OAs”, “prosodic emotion recognition in OAs”, “emotion recognition from vocalisations in OAs” and “emotion recognition of words in OAs”. Further articles were discovered through citations in other research. To provide an up-to-date view of emotion recognition in OAs an original cut off was set for the year 2000 but research by Grunwald et al. (1999) was considered to be influential so this was extended to include 1999. Further exclusion criteria included studies that measured implicit emotion recognition, intensity of emotion, and studies that used non-human faces such as avatars or computer generated faces, as these were not considered comparable to research in the field that use expressions produced by humans. For ease of comparison the table is organised by presentation type starting with faces, then auditory and finally lexical stimuli. Within each of these presentation types, the stimuli types are grouped together, for instance static faces are separated from dynamic faces. Finally, papers within each stimuli type are presented in alphabetical order by author's surname.

The findings presented in Table 1.1 demonstrate that OAs are often less accurate at recognising the target emotion than YAs (e.g., Isaacowitz et al., 2007; Sullivan & Ruffman, 2004). However, it is also apparent that recognition impairments in OAs compared to YAs are not uniform across emotion types. For example, most studies report an age-related decline in at least one negative emotion; typically anger, fear, or sadness. This is in contrast to several studies that report that OAs are more accurate at recognising disgust than YAs. Finally, the majority of findings indicate that the ability to recognise happiness and surprise appears to be maintained in older age. This summary largely reflects the findings from a meta-analysis of research in the field revealing that the age-related decline in emotion recognition ability in OAs is particularly true for negative emotions (fear, anger, and sadness) and less so for positive emotions (happy and positive surprise), and the ability to detect disgust may improve with age (Ruffman, Henry, Livingstone, & Phillips, 2008). Whilst this pattern of emotion recognition ability is often reported close inspection of the results reveals inconsistencies between studies; thus, the exact pattern of emotion recognition ability in OAs is unclear and this will be discussed throughout the thesis.

To make sense of the findings in Table 1.1 a review of the literature in the area is now presented in the form of four principle themes. The author created the themes and many are represented in several reviews of the emotion recognition literature (i.e., Freund & Isaacowitz, 2014; Isaacowitz & Stanley, 2011; Phillips & Slessor, 2011). The themes reflect recurrent aspects in the field and serve to organise the literature whilst emphasising the central findings and evaluating the research methodologies found in the area. Furthermore, within the themes ideas for advancing knowledge are explored including understanding the influence of task demands on emotion recognition accuracy, investigating the positivity effect in emotion recognition, and increasing ecological validity in the stimuli. The four main themes central to the current thesis are:

- *Theme 1 - Most studies of older adults use the basic emotions as stimuli*. Within this theme the basic emotion and dimensional approach are discussed alongside how these concepts are reflected in the literature in the field. There are two subthemes in Theme 1, the first addresses the evidence that OAs tend to have recognition impairments relative to YAs for negative emotions. Also explanations are proposed for the between-study variations in findings including methodological inconsistencies and confounding intrinsic sample differences. The second subtheme discusses the maintenance for the recognition of positive emotions in older age that is generally reported in the field. Furthermore, two explanations (i.e., the positivity effect and task design) for this trend are explored.

- *Theme 2 - Most studies of older adults use facial expressions as stimuli*. This theme highlights the predominance in the area of measuring emotion recognition from facial expressions. The discussion centres on the evidence for emotion recognition ability in OAs across different modalities and presentation types. Importantly the information in this theme highlights the gaps in knowledge due to the relative neglect of studying emotion recognition in communication channels other than facial expressions.
- *Theme 3 - Studies of emotion recognition in older age participants lack ecological validity*. This theme explains how the traditional forced-choice task provides a good measure of laboratory-based emotion recognition ability but the purposeful control in these tasks makes them low in ecological validity. It is possible that OAs are less able than YAs in these laboratory experiments but are just as able as YAs to recognise emotions in real world scenarios. The information in the theme discusses the research in the field regarding various levels of ecological validity.
- *Theme 4 - It is unclear to what extent older age performance on emotion recognition tasks is attributable to cognitive decline.* This theme discusses the evidence regarding cognitive aging effects on emotion recognition ability in OAs. Specifically, methods to understand any potential influence of age-related cognitive decline on emotion recognition ability in OAs are proposed. These include the need to understand findings within the context of any age-related differences in cognitive ability and the advantages of including non-emotion tasks in emotion recognition experiments.

1.7.1 Theme 1-Most studies of older adults use the basic emotions as stimuli.

In this theme the basic emotion and dimension approach to emotion processing are discussed alongside their prevalence in the emotion recognition tasks used in the field. Basic emotion theory (Ekman, 1976), as previously stated, is essentially based on the documented evolutionary premises that the ability to experience and recognise certain emotions is innate. The select basic emotions are required to meet several criteria to distinguish them from other emotion states (Ekman, 1992). For instance, one criteria of a basic emotion is having a distinctive facial expression that serves to inform others about the internal affective state of the individual (Ekman & Cordaro, 2011). Therefore, the purpose of a basic emotion is to direct appropriate behaviour to the individual experiencing the emotion and social members who receive the emotion information (Johnson-Laird & Oatley, 1992). For instance, fear or anger elicits fitting responses, such as avoidance, to situations that are considered to be threatening (Johnson-Laird & Oatley, 1992). As such facial expressions are important markers for communication as they serve to relay affective messages and act as a prompt to behaviour.

However, facial expressions are only one of the several criteria needed for an emotion state to be considered a basic emotion. Given the extent of the inclusion criteria it is not surprising that only a few emotion types meet the classification principles of a "basic" emotion. There are, however, controversies as to which emotions are basic. For example, pride meets some of the basic emotion criteria as it has high recognition rates (around 80%) but identification relies on body gestures as well as facial expressions so it does not meet the literal definition of a basic emotion being readily recognised from facial expressions (Tracy & Robins, 2004; Tracy & Robins, 2007). Furthermore, some emotions considered basic are contentious in their classification. For instance, contempt is not consistently classed as being universally read (Elfenbein & Ambady, 2002). Also surprise may not be an emotion at all as there are situations in which surprise can be a positive, negative, or neutral experience (Ortony & Turner, 1990). What is considered as a basic emotion is an evolving process as research may provide evidence to warrant classification of some affective states as basic emotions that are not currently considered to meet the inclusion criteria (Ekman & Cordaro, 2011).

Of importance, facial expressions of the basic emotions are accurately recognised above that of chance across various cultures (Ekman et al., 1987). For example, in a study by Ekman et al. (1987) participants from 10 countries (including Turkey, Estonia, Greece, Sumatra, and Scotland) completed an emotion recognition task. Participants were shown photographs of facial expressions and were asked to select from the given labels which emotion they believed was displayed. The participants were then shown the photograph for a second time and were asked to state if they perceived any other emotion. There was agreement across participants as to the perceived emotions and this finding potentially provides evidence that basic emotions are universal.

However, emotion recognition accuracy rates tend to be lower in non-Western cultures than Western cultures (e.g., Wolfgang & Cohen, 1988). Furthermore, it appears that emotion recognition accuracy increases with higher exposure to Western culture (Ducci, Arcuri, Georgis, & Sineshaw, 1982). This may be an artefact of the stimuli used in the emotion recognition task, as most studies in the area use posed expressions of Western individuals taken from the Ekman and Friesen dataset (1976). These images provide facial expressions that may be considered Westernised concepts of a particular emotion (Gendron, Roberson, van der Vyver, & Barrett, 2014). Therefore, familiarity with Western cultures, through direct contact or media, may increase emotion recognition ability when tasks use Westernised expressions of affect. This suggests that emotion recognition ability at least to some extent may be learnt rather than innate.

Indeed when the traditional forced-choice tasks using posed facial expressions have been adapted to use free labelling response formats and spontaneous affective expressions then the results regarding the universality of basic emotion recognition are less conclusive (Russell, 1994). For example, Gendron, Roberson, van der Vyver, and Barrett (2014) report that in a card sorting task participants from the Himba ethnic group in Namibia (with little exposure to Western culture) did not demonstrate universal knowledge of facial expressions of affect, whereas American participants did. When emotion labels were verbally provided, however, then the participants from the Himba tribe did categorise the expression along the expected pattern. Thus the evidence of universality of basic emotions may be exaggerated by the methods used (Haidt & Keltner, 1999). Indeed current definitions of basic emotions have been adapted according to the evidence as Ekman and Cordaro (2011) describe emotion expressions as being universal and having culturally specific responses. Whilst this definition does not dismiss the universal basis of basic emotions it does demonstrate an acceptance of cultural variations.

In addition to being universal, basic emotions are considered as having distinctive, physiological, and neurobiological responses (Ekman, 1992; Izard, 2007). Evidence suggests that dissociable neural networks are activated during the processing of discrete emotions, such as fear and disgust, (Sprengelmeyer, Rausch, Eysel, & Przuntek, 1998) (for a review see Calder, Lawrence, & Young, 2001). Specifically, evidence suggests that exposure to fearful facial expressions (and affective vocalisations) activate the amygdala whilst disgusted facial expressions (but perhaps not affective vocalisations) are shown to be associated with the recruitment of the insula

(Phillips et al., 1998). In line with this, patients with Huntington's disease are often characterised as having smaller volume of the insula than controls and generally have maintained emotion recognition ability with the exception of impaired disgust recognition (Kipps, Duggins, McCusker, & Calder, 2007; Sprengelmeyer et al., 1996). The findings indicate that the insula is important in processing disgust. In contrast, two patients with bilateral amygdala damage made more errors than controls in recognising fear from static facial expressions but no group differences were found for other emotions (Calder et al., 1996); thus, suggesting that the amygdala is supportive in the processing of fear (but see Peelen, Atkinson, & Vuilleumier, 2010; Wright & Liu, 2006). Taken together the evidence suggests that there is a dissociation of the neural pathways for disgust and fear and this supports one of the premises of the basic emotion theory that emotions have distinct neurological pathways.

However, despite the evidence of an apparent dissociation of neural activation for disgust and fear evidence for separate neural networks for other basic emotions is less clear. The limited evidence does suggest that the OFC is associated with the recognition of anger in faces (e.g., Blair & Cipolotti, 2000). Further, there is some indication of disparate neural networks for happiness and sadness in populations with mood disorders. For example, findings from fMRI studies suggest that depressed patients compared to non-depressed controls had lower levels of activation in the front temporal and limbic areas when conducting a lexical decision task using happy words but more activation in the inferior parietal lobule with less activation in the superior temporal gyrus and cerebellum for sad words (Canli et al., 2004). The recruitment of differential brain areas for happiness and sadness on the word task needs further empirical evidence from non-clinical populations and across other presentation types, such as facial expressions, to support these observations. Taken together the findings suggest that whilst there is evidence of separate neurological activation for fear and disgust the basic emotion theory is seemingly weakened by a lack of evidence for distinctive neural mechanisms for other emotion types (Hamann, 2012; Posner, Russell & Peterson, 2005). Further investigation is, therefore, required to establish definitive neural networks across all of the basic emotions.

Taken together, despite the criticisms there is some evidence to support the basic emotion theory as emotion expressions are to some extent innate and are largely recognised across cultures. However, the basic emotions do not capture all affective states and the evidence used to support the basic emotion theory is often based on prototypical facial expressions that do not reflect the complexity of emotion expressions displayed in real world interactions (Russell, Bachorowski, & Fernandez-Dols, 2003). Therefore, the basic emotion theory contrasts with the dimension approach as the latter attempts to account for the nuances of emotion experience and expression. Rather than emotions being seen as distinct entities, as suggested by the basic emotion concept, the dimension approach tries to capture the variation in emotion (i.e., emotion experience) within a few constructs and these are typically valence (positive or negative emotion) and arousal (level of intensity) (Russell & Barrett, 1999). James (1890) first suggested that emotions are experienced as unpleasant or pleasant but the number of feelings is infinite (Johnson-Laird & Oatley, 1992). Akin to James' proposal, researchers have developed their own versions of the dimension model including the positive-negative affect model (Watson & Tellegen, 1985) and the circumplex model (Rubin & Talarico, 2009; Russell, 1980). The circumplex model suggests that emotions are distinguished along dimensions of valence and arousal and each emotion is a product of varying degrees of these two dimensions (Russell & Barrett, 1999). For example, a positive affective state with moderate arousal could be happiness, whereas extreme arousal could be excitement. Conversely, a negative state with low arousal could be boredom, whereas high arousal could be fear. As can be appreciated by the many labels used to describe affective states, the dimension model reflects more nuanced affective states that would not necessarily be considered as emotions according to the basic emotion theory.

Furthermore, the dimension model and the basic emotion theory have different standpoints regarding the neurology of emotion states. According to the dimension model rather than having distinct neurological systems, affective states are a product of only two separate neurophysiological systems, valance and arousal (Posner, Russell, & Peterson, 2005). However, as explained by Lindquist, Siegel, Quigley, and Barrett (2013) the dimensional approach does not necessarily hold that valence and arousal are the only requirements necessary to make sense of emotion experience, expression, and recognition. It is thought that processes including prior knowledge and experience, such as social referencing and attribution, are often effortlessly applied before meaning (i.e., discrete emotion identification) is made (Russell, 2003). Furthermore, unlike the concept of basic emotions, the dimensional approach implies that there is not a hierarchy of emotions as no emotion is considered to be superior to others (Turner & Ortony, 1992).

Thus the dimension model aims to capture the range of subjective emotion experience that does not appear to be reflected in basic emotion theory. Furthermore, the dimension approach suggests that the neurological basis consists of two systems, valance and arousal, rather than having several specific neurological pathways for each emotion. However, it cannot explain the established discriminatory abilities across emotion types in infants and across cultures to the same extent as basic emotion theory.

In summary, there is some indication that basic emotions are pancultural and can be readily recognised from facial expressions; although, there is a lack of consensus as to which emotions are basic. Moreover, evidence for the neurobiological distinctiveness of each basic emotion is yet to be established. Finally, the evidence used to support the basic emotion theory is often based on prototypical facial expressions that do not reflect the complexity of emotion expressions displayed in real world interactions (Russell, Bachorowski, & Fernandez-Dols, 2003). In contrast the dimension approach may capture the variation in affective states that is amiss in the basic emotion theory. Therefore, emotion recognition research that focuses on the basic emotions is important but may not capture the full extent of emotion recognition ability across different emotion states.

Regardless of the criticisms applied to the basic emotion theory, there is compelling evidence that certain emotion types can be recognised with a high degree of accuracy from facial expressions and this is largely reliable across cultures, albeit with some element of learnt cultural variation. If this is the case then all things being equal OAs should be as able as YAs when recognising basic emotions. However, there are many documented developmental changes that can occur across adulthood, such as differential emotion experience, declines in some cognitive skills, and selective reductions in neural activity and volume. As a consequence of these changes with age recognition ability of basic emotions, and perhaps other emotion states, may differ between OAs and YAs.

1.7.1.1 ***Emotion recognition in OAs using basic and non-basic emotions.*** Studies in the field tend to use basic emotions to investigate emotion recognition ability in OAs. For example, of the studies included in Table 1.1, 34 measure distinct basic emotions, six report findings along emotion valence, and five include some non-basic emotions. Of those studies that measure emotion valence OAs tend to be as accurate as YAs when emotions cues are presented in dynamic faces, words, and semantic sentences (Di Domenico, Palumbo, Mammarella, & Fairfield, 2015; Keightley, Winocur, Burianova, Hongwanishkul, & Grady, 2006; Schaffer, Wisniewski, Dahdah,

& Froming, 2009). In contrast, when studies in the field measure distinct basic emotions then OAs are less able than YAs to recognise some emotions from faces, visual sentences, prosodic sentences, and non-verbal vocalisations (e.g., Chaby, Boullay, Chetouani, & Plaza, 2015; Isaacowitz et al., 2007; Mill, Allik, Realo, & Valk, 2009; Stanley & Isaacowitz, 2015). In general emotion recognition ability is lower in OAs relative to YAs and these impairments are selective across emotion types (Ruffman, 2011).

However, given the possibility that the basic emotions do not capture all of the variation in expressed and experienced emotions, it is important to comprehend whether emotion recognition impairments with age extend beyond these select innate emotion types. A few studies have provided evidence of difficulties in recognising non-basic emotions in OAs compared to YAs (e.g., Lambrecht, Kriefelts, & Wildgruber, 2012; Orbello, Grim, Talbott, & Ross, 2005). For example, Lima et al. (2014) measured emotion recognition ability of several basic emotions (fear, anger, disgust, and sadness) as well as vocalisations of achievement, amusement, pleasure, and relief. OAs were less sensitive than YAs to detect the target emotion across all emotion types. Similarly Lembrecht, Kriefelts, and Wildgruber (2012) reported that with age adults were less able to recognise alluring expressions in dynamic faces and prosodic words presented either simultaneously or separately. However, OAs were as able as YAs in determining emotion states, such as envy and shame, in stories (Phillips, MacLean, & Allen, 2002). Taken together the findings suggest that recognition deficits in OAs relative to YAs may not be confined to negative basic emotions but the extent of emotion recognition deficits for basic and non-basic emotions may depend on the presentation or stimuli type. Furthermore, there are many affective states, such as pride, that appear to have had little or no empirical investigation in the field. Thus, it is unclear whether OAs and YAs differ in their ability to recognise these emotion types.

Whilst it is important to understand OAs' ability to recognise basic emotions, a focus on these emotions ignores other emotion states. Measuring recognition ability of non-basic emotions in OAs, therefore, may advance our understanding regarding the extent of age-related changes in emotion recognition in OAs (Philips & Slessor, 2011). Thus extending findings beyond the basic emotions may provide a more complete picture of emotion recognition development across the lifespan (Philips & Slessor, 2011).

1.7.1.1.1 *The current study*. The current research measured emotion recognition of several basic emotions to further establish age-related emotion recognition ability in OAs and to allow comparisons to be made with previous research. Importantly, Phase 2 of the current research programme used both basic and non-basic emotions to assess emotion recognition ability. Notably the addition of some non-basic emotions in the emotion recognition task extends the knowledge of emotion recognition in OAs beyond that of the basic emotions.

1.7.1.2. ***Theme 1a-Older age participants find it more difficult than younger age participants to recognise negative emotions.*** Most studies report that OAs have reduced recognition ability than YAs for at least one negative emotion. However, there are inconsistencies across studies regarding the actual emotion type that OAs have difficulty in recognising (Charles & Campos, 2011). This theme serves to highlight the variation in results for age-related recognition deficits in OAs across the negative emotions.

The variations in findings occur both across studies that use different presentation types and between studies that use similar presentation types. The information in Table 1.1 demonstrates the inconsistencies in the findings in the field and these are highlighted by the following studies. When comparing findings from a sample of studies that have measured the same six basic emotion types (happy, surprise, fear, anger, sadness, and disgust) OAs were less able than YAs to recognise fearful facial expressions (Circelli, Clark, & Cronin, 2013); fear, anger, and sadness from facial expressions and sad prosodic sentences (Wong, Cronin-Golomb, & Neargarder, 2005); and happy and angry faces alongside fear, anger, disgust, happy, and surprise in visual sentences (Isaacowitz et al. 2007). This brief summary indicates that age-related emotion specific recognition deficits in OAs may vary both within similar presentation types (e.g., facial expressions) and across different presentation types (faces, sounds, and sentences).

In contrast to the decline in recognition ability for most negative emotions evidence suggests that the ability to recognise disgust from facial expressions is either maintained or improves in older age (Calder et al., 2003; Suzuki et al., 2007; Wong, Cronin-Golomb, & Neargarder, 2005). A few studies, however, imply that the ability to recognise disgust from faces may decline in older age (Sze et al., 2012) especially in older-older adults, aged 80 years plus (Williams et al., 2009). However, of the few studies in the field that use presentation types other than facial expressions it appears that in older age accuracy for recognising disgust is maintained for prosodic sentences (Wong, Cronin-Golomb, & Neargarder, 2005) or declines for read sentences (Isaacowitz et al. 2007). Therefore, differences in the ability to recognise disgust between YAs and OAs vary across presentation types. Taken together the findings appear to suggest that when OAs have recognition difficulties they are likely to be for a negative emotion; however, the actual emotion for which OAs have impaired recognition, compared to YAs, varies across studies. Furthermore, disgust recognition may increase in older age but this seems to depend on the presentation type.

The variation in OAs' ability to recognise specific emotions may reflect age-related changes in neural activation. For example, as discussed earlier in the chapter disgust recognition has been associated with activity in the basal ganglia and insula

(Calder, Keane, Manes, Antoun, & Young, 2000; Calder, Lawrence, & Young, 2001) and these brain areas are not thought to be susceptible to age-related changes (Ruffman et al., 2008). This neural stability with age may explain maintained ability in OAs for disgust recognition (Calder et al., 2003). In contrast, fear has been associated with activation in the amygdala and there is reported reduced amygdala activation in OAs compared to YAs (Cacioppo, Berntson, & Decety, 2012; St.Jacques, Bessette-Symons, & Cabeza, 2009). These neural changes may explain difficulties in fear recognition in OAs (e.g., Mill, Allik, Realo, & Valk, 2009). Other emotion specific neural networks are less clear; however, changes in the OFC and dopamine levels in older age may explain age-related deficits for anger recognition, whereas reduced recognition of sad faces in older age might be related to neurological changes in the cingulate cortex (Blair, Morris, Frith, Perrett, & Dolan, 1999; Ruffman et al., 2008). However, if a neurological explanation accounted for all of the variance in emotion recognition ability between OAs and YAs then it may be expected that there would be consistency across studies regarding which emotion types are difficult for OAs to recognise compared to YAs. Therefore, the between-study inconsistencies in findings in the area reduce the viability that a neurological explanation can fully explain emotion recognition differences between YAs and OAs.

To summarise there are general trends for emotion recognition ability in OAs. Specifically, OAs appear to have difficulties in recognising some negative emotions. However, close inspection of the results highlight inconsistencies within these trends, as not all studies report age-related impairments across fear, anger, and sadness or maintenance for disgust. It is possible that the varying findings in the field are best explained by OAs' emotion recognition ability. On the other hand, the results may arise from between-study methodological differences or confounding intrinsic sample differences. For example, methodological differences in task demands, such as the number of response choices or contextual influences, may affect performance on emotion recognition tasks (Charles & Campos, 2011; Orgeta, 2010). It is conceivable that emotion recognition tasks with higher task demands may disadvantage OAs more than YAs due to OAs reduced cognitive abilities with age. Furthermore, OAs appear to utilise contextual cues more than YAs so tasks with reduced context may also disadvantage OAs more than YAs (Noh & Isaacowitz, 2013). Therefore, any between-study variance in the method makes comparisons difficult and limits our understanding of emotion recognition ability in OAs (Charles & Campos, 2011; Hamman, 2012). These methodological issues (variations in: the number of response options, contextual cues, and between samples) are now discussed in further detail.

First the number of emotions used in an emotion recognition task can vary between studies. One of the problems with this inconsistency is that typically each emotion is included in the response options and increasing the number of response options corresponds with an increase in errors (Banse & Scherer, 1996; Orgeta, 2010) and makes tasks more difficult (Demenescu et al., 2014). Given that some cognitive abilities decline with older age then OAs may be less able to meet the demands of task when tasks have a high number of response options. Inspection of the methodologies used in the field demonstrates the diversity in the number of emotions measured from two emotions (e.g., Mitchell, 2007) to eight emotion states (e.g., Keightley et al., 2006). OAs sometimes have more age-related emotion recognition impairments as the number of response options increase. For example, of those studies that have two or three response options OAs tend to have maintained emotion recognition ability relative to YAs in words (Keightley et al., 2006), morphed faces (Di Domenico, Palumbo, Mammarella, & Fairfield, 2015), and dynamic faces (Krendl & Ambady, 2010). In contrast, age-related emotion recognition deficits in OAs are commonly reported in tasks that have more than three response options (e.g., Chaby, Boullay, Chetouani, &

Plaza, 2015; Kessels, Montagne, Hendriks, Perrett, & de Haan, 2014). Therefore, when the number of emotion options increases task demands then OAs may be more likely to have emotion recognition impairments compared to YAs.

Furthermore, emotion recognition accuracy might be affected by the degree of contextual cues in the stimuli. There is evidence that OAs use contextual cues more than YAs when making emotion recognition judgements (Noh & Isaacowitz, 2013). If this is the case then variations in the contextual cues presented in the stimuli might produce differing results across studies. For example, given that OAs may use context more than YAs then OAs are likely to benefit from contextually rich stimuli more than YAs. Conversely, when a stimulus has low levels of context then OAs maybe more disadvantaged on the task than YAs. Indeed, when affective verbal and facial expressions are simultaneously presented then emotion recognition ability in OAs is equal to YAs despite OAs having poorer emotion recognition ability on separate presentations (Chaby, Boullay, Chetouani, & Plaza, 2015). Furthermore, age-related emotion recognition deficits from static faces are not observed from dynamic faces or from read stories (Krendl & Ambady, 2010; Phillips, MacLean, & Allen, 2002), or the size of the age-related deficit is reduced in dynamic compared to static faces (Grainger, Henry, Phillips, Vanman, & Allan, 2015). It is important, therefore, to consider the degree of contextual cues across presentation types when comparing findings, as accuracy may reflect processing differences of contextual cues between YAs and OAs.

Finally, variations in findings in the field may arise from confounding intrinsic sample differences. Samples might vary on many aspects including age range, gender composition, cognitive functioning, and personality traits, and these factors might influence emotion processing (e.g., Parker, Taylor, & Bagby, 1993; Sucksmith, Allison, Baron-Cohen, Chakrabarti, & Hoekstra, 2013). Confounding sample differences may occur between the age groups within a particular study. If this is the case then any age-related differences in emotion recognition ability between YAs and OAs may be a consequence of differences in sample characteristics other than emotion recognition ability and this is discussed in more detail in Chapter 2 (Section 2.2.2).

In addition to variations in sample characteristics between YAs and OAs within a study, between-studies differences in same age samples may prevent reliable comparisons in the field. For example, Table 1.2 (see Appendix 1.2) highlights the differences in the age range of the YA and OA samples used across studies. The youngest mean age of an OA sample was 58.30 years (Montagne et al., 2007), whereas the oldest mean age was 75.80 years (Krendl & Ambady, 2010a). Furthermore, the oldest adult within a sample ranged from 91 years (e.g., Stanley & Isaacowitz, 2015) to 70 years (e.g., Calder et al., 2003a). Given that aging is associated with cognitive and neurological changes (Raz, 2005; Salthouse, 1980) it is logical to assume that those studies that include biologically older OAs will have an OA sample that is more likely to be negatively impacted by the age-related cognitive and neurological changes than a younger OA sample. Indeed the OAs in Krendl and Ambady (2010) were the oldest sample in the literature and the authors reported that emotion recognition ability was lower in OAs than YAs across all of the emotions measured. In contrast, findings from the youngest OA sample in the field suggest that OAs are less able than YAs to recognise three of the six emotion measured (Montagne et al., 2007). It is possible, therefore, that any between-study differences in emotion recognition ability in OAs may reflect disparities in the OA samples across studies.

Further to differences in age groups, there is some evidence that females perform better on emotion recognition tasks than males (e.g., Thayer & Johnsen, 2000). If this is the case then having a higher proportion of males to females in a sample might lower the mean accuracy on an emotion recognition task and vice versa. In this manner between-study differences in age-related emotion recognition ability might result from disparities in the gender composition either between studies or between the YAs and the OAs within a given study, or even a combination of both of these. Table 1.2 demonstrates the variations in gender between samples across separate studies. Typically samples tend to include a higher proportion of females than males in both age groups (e.g., Chaby et al., 2015) with a few samples having equal proportions of males and females (e.g., Keightley et al., 2006) and some samples have more males than females (e.g., Montagne et al., 2007). Arguably to avoid possible confounds, regarding better emotion recognition ability in females than males, samples should include similar gender compositions especially across age groups and when this is not feasible then results should be considered in line with these differences. Taken together the between-study sample disparities in age ranges and gender can make cross-study comparisons problematic. It is, therefore, important to avoid confounding sample differences by inviting the same participants to conduct tasks across presentation types and to consider findings within the context of the male-to-female sample composition across age groups.

1.7.1.2.1 ***The current study.*** The current study attempts to overcome the outlined methodological and sample differences that make comparisons across studies difficult. In both phases of the research programme the tasks were specifically designed to control for methodological differences by limiting, as far as possible, the variation in the degree of contextual cues between stimuli types (static facial expressions, non-verbal vocalisations, and visual single words or dynamic faces and prosodic sentences) and by using the same number of response options in each task. These aspects are explained further in the method section in Chapters 2 and 7. Furthermore, to avoid potential confounds of intrinsic sample differences the same participants were invited to conduct all experiments in each phase of the research. Also the findings need to be considered within the context of any differences in possible confounding sample characteristics between the OAs and YAs including gender, intelligence, empathy, personality, and mood. Taken together the experiments were designed to increase the confidence that any emotion recognition differences between the age groups and across the presentation types are a function of emotion processing and not a function of methodological or sample differences. Furthermore, the tightly controlled method means that findings can be meaningfully compared across presentation types.

1.7.1.3 ***Theme 1b-The ability to recognise positive emotions is preserved in older age participants.*** There appears to be a divergent development pathway for recognition ability for negative emotions, with the exception perhaps of disgust, and positive emotions. Whilst negative emotion recognition ability tends to decline with age, recognition of happiness is often reported as being stable in adulthood (e.g., Calder et al., 2003). Again there are variations across studies with some suggesting that recognition of happy facial expressions is impaired in OAs compared to YAs (Isaacowitz et al., 2007; Krendl, Rule, & Ambady, 2014: Sasson et al., 2010). However, the size of the age-related decline for recognising happiness in facial expressions is often smaller than the size of decline for negative emotions (Sasson et al., 2010). The apparent robustness of the general development trend for positive and negative emotion recognition is emphasised in a summary of the research in the field (Isaacowitz et al., 2007). Of the 13 emotion recognition studies included in the review (all studies measured facial expressions except for one study that measured affective vocalisations) only one demonstrated an age-related decline in OAs for recognising positive emotions. There seems to be evidence, therefore, that recognition ability for positive emotions is maintained in older age at least from faces.

However, elsewhere age-related impairments in OAs for recognising positive emotions have been reported for happy facial expressions (e.g., Krendl & Ambady, 2010; Isaacowitz et al., 2007); happy morphed facial expressions (Horning, Cornwall, &

Davis, 2012); happiness in dynamic stimuli across different intensity levels with the exception of 100% intensity (Monatgne, Kessels, De Haan, & Perrett, 2007) and cross-modal, vocal, and visual presentations (Lambrecht, Kriefelts, & Wildgruber, 2012). In light of these findings it is possible that OAs do not have a maintained ability to recognise positive emotions. Taken together the evidence regarding OAs' ability to recognise happiness remains unclear but any reduction in this ability does not appear to be as severe as the age-related impairments for specific negative emotions.

It is possible that the disparity between OAs' ability to recognise negative and positive emotions reflects a positivity effect as discussed in Section 1. 4. This may manifest from a shift of attention away from negative emotion stimuli and selective attention towards positive emotion stimuli (Carstensen & Mikels, 2005). If this were the case then the processing shift in OAs would enhance processing of positive emotion cues alongside reduced processing of negative emotion cues to a greater extent than YAs. Alternatively, an apparent maintenance in emotion recognition ability for positive emotions with advancing age may not reflect a positivity effect in emotion recognition ability in OAs but could be a consequence of the experimental design of the studies reporting such an effect. For instance, traditional forced-choice tasks generally include only one positive emotion amongst an array of negative emotions. It is arguably easier to distinguish a positive emotion than a specific negative emotion from several negative emotions (Isaacowitz & Stanley, 2011). Thus, the simplicity of selecting a positive emotion may mask any age-related recognition differences (Isaacowitz 2007; Murphy, Lehrfeld, & Isaacowitz, 2010). Therefore, preserved recognition accuracy for positive emotions in older age may not reflect a positivity effect but rather the ease of selecting a positive emotion within the typical forced-choice design. Further research is required to tease apart these two possible accounts of maintained recognition ability for positive emotion in OAs.

Given the lack of clarity regarding why positive emotion recognition ability is often maintained in OAs, experiments should be designed to tap into YAs' and OAs' ability to discern between various types of positive emotions (Hunter, Phillips, & MacPherson, 2010; Murphy, Lehrfeld, & Isaacowitz, 2010). In this manner task difficulty will be increased and may avoid the possible ceiling effects that might serve to mask age-related differences in previous research. To this end the existence of the positivity effect in emotion recognition ability in OAs can be more robustly tested.

1.7.1.3.1 *The current study***.** In Phase 1 of the current research the extent of a possible positivity effect will be measured across three presentation types. It is logical to assume that a processing shift with age towards positive emotions will also exist in communication channels other than faces. The current study will, therefore, extend the understanding regarding the prevalence of a positivity effect in emotion recognition ability in OAs beyond facial expressions to non-verbal vocalisations and words. Furthermore, to clarify why OAs have maintained ability for recognising positive emotions, Phase 2 includes an innovative task that was designed to tease apart the possible positivity effect from the simplicity of the task. To achieve this one emotion recognition task in Phase 2 measured several positive emotions and one negative emotion. On this task a positivity effect would be demonstrated if the ratio for accurately recognising positive over negative emotion was greater in OAs than YAs. For example, OAs have higher recognition of positive emotions than negative emotions and this may be reflected in maintained recognition of positive emotions alongside age-related deficits for negative emotions. Alternatively, if findings demonstrate higher recognition of negative compared to positive emotions and this is similar for both YAs and OAs then the pattern of emotion recognition ability reported in the literature is likely to be a function of the task design. In this manner Phase 2 may help to explain the general trend reported in the field of maintained positive emotion recognition in older age.

1.7.2 Theme 2 - Most studies of older adults use facial expressions as stimuli.

This theme refers to the type of presentation and stimuli types used in the age-related emotion recognition literature. To date the majority of studies in the field have used facial expressions as stimuli (as opposed to sounds, body gestures, and words) (Isaacowitz & Stanley, 2011) and this is understandable given the evidence of universality of emotion cues present in facial expressions (Ekman, 2003). This trend is confirmed in Table 1.1 as it plainly details that more studies have used faces than any other communication channel. It is clearly important to understand emotion recognition ability in OAs from faces, as facial expressions are an important conveyer of emotion cues. However, a focus on facial expressions limits our understanding as to the breadth of age-related emotion recognition deficits in OAs, as emotions are portrayed in other communication channels including vocalisations and words (Isaacowitz & Stanley, 2011).

Before proceeding further a clarification of terminology is needed. There are several terms used to describe different formats used in the emotion recognition tasks and some of these terms are used interchangeably in the literature. However, the concepts are somewhat distinctive. Figure 1.1 demonstrates the distinctions between aspects of the emotion recognition task (sensory modality, presentation types, and stimuli types) made in the current thesis.

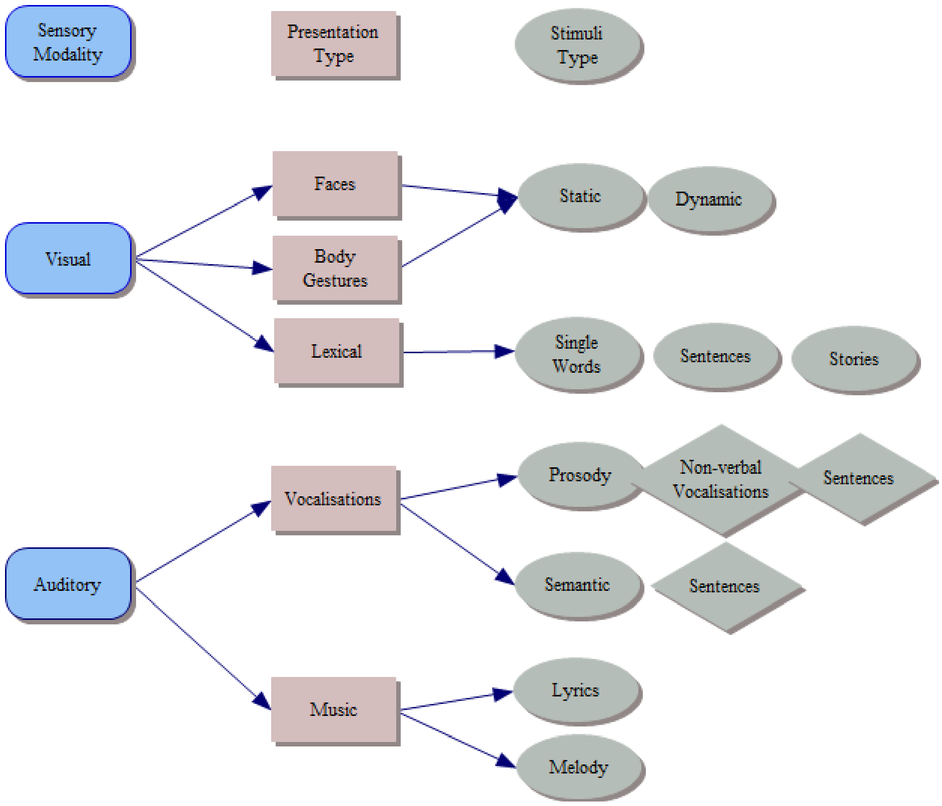


Figure 1.1. The graphic serves to distinguish concepts and terminology that are used to describe aspects of the tasks used in emotion recognition experiments.

To date evidence from the age-related literature suggests that emotion recognition is not uniform across modalities, presentation, and stimuli types. For example, age-related emotion recognition ability declines in OAs from prosodic sentences (Shaffer, Wisniewski, Dahdah, & Froming, 2009) and read words (Grunwald et al., 1999) but not semantic sentences (Shaffer et al., 2009) or read stories (Phillips, MacLean, & Allen, 2002). Specifically, Schaffer, Wisniewski, Dahdah, and Froming (2009) measured emotion recognition ability across facial expressions, prosodic and semantic sentences. The authors reported that overall emotion recognition ability from faces and semantic sentences did not differ between OAs and YAs, whereas older age accounted for the decline in emotion recognition accuracy from prosodic sentences. This differential pattern seems to suggest that emotion recognition ability in OAs, compared to YAs, depends on the modality, presentation, and stimuli type used in the task.

In contrast some researchers have found a general decline with age of emotion recognition across different presentation types (e.g., Demenescu, Mathiak, & Mathiak, 2014; Lambrecht, Kriefelts, & Wildgruber, 2012). For example, OAs had lower overall emotion recognition accuracy from prosodic words and facial expressions than YAs and middle-aged adults (35-55 years of age) (Demenescu, Mathiak, & Mathiak, 2014). Given that these emotion recognition tasks are based on two different sensory modalities (i.e., visual and auditory) the age-related impairment suggests a general decline with age in emotion recognition ability across modality types.

Further to emotion recognition ability differences across modality, presentation, and stimuli types there may be interactions between an emotion and the presentation or stimuli types. For example, in Isaacowitz et al. (2007) emotion recognition ability in OAs was assessed using two visual tasks, read sentences and static facial expressions, across emotion types (happy, sad, fear, anger, surprise, disgust, and neutral). The findings suggest that emotion recognition ability was lower for both faces and read sentences in OAs compared to YAs. However, on the read sentence task OAs were less accurate than YAs at recognising happy, fear, anger, disgust, and surprise but OAs only had impairments in anger and happy recognition from facial expressions. These findings suggest that emotion recognition ability in OAs compared to YAs depends on both the emotion and presentation type.

In summary, the pattern of emotion recognition ability in OAs appears to differ across modality, presentation, stimuli, and emotion types. As a consequence a research focus on emotion recognition ability from facial expressions constrains our understanding of emotion recognition ability in OAs (Suzuki, Hoshino, Shigemasu, & Kawamura, 2007). It is important to understand OAs' ability to discern between emotions displayed in facial expressions but to gain a holistic insight into emotion recognition ability in OAs other channels of communication should receive comparable empirical attention.

1.7.2.1 *The current study.* To address the limitations of an empirical focus on facial expressions the current research assesses emotion recognition ability across several presentation and stimuli types. In Phase 1 the same OAs and YAs conducted emotion recognition tasks based on static facial expressions, non-verbal vocalisations, and single words. Taken together the different tasks provide a more complete picture of age-related emotion recognition ability. This design will enable conclusions to be made regarding the uniformity, or variability, of emotion recognition ability in OAs across presentation types. To further understand emotion recognition ability in OAs beyond static faces the tasks in Phase 2 were designed to assess emotion recognition ability across separate and cross-modal presentations of dynamic facial expressions and prosodic sentences. Importantly, by employing several different presentation formats and stimuli types the methodology used in both Phase 1 and Phase 2 serve to extend our understanding of age-related emotion recognition ability beyond that of facial expressions.

1.7.3 Theme 3 - Studies of emotion recognition in older age participants lack ecological validity.

This theme highlights the possible impact of using tasks with low ecological validity on emotion recognition ability in OAs. Ecological validity refers to how representative a task is of natural processing and behaviour (Field, 2012). It is important to consider ecological validity as the emotion recognition impairments in OAs, relative to YAs, maybe specific to laboratory tasks; thus, may not be observed in real world interactions (Phillips & Slessor, 2011). It is reasonable to assume that tasks using static faces may not tap into the multiple and dynamic, contextually rich cues that are experienced in real world social transactions (Isaacowitz & Stanley, 2011). Furthermore, emotion recognition tasks may fail to include emotional, motivational, and situational cues that OAs use in their everyday social interactions so do not reflect everyday communications (Schlegel & Scherer, 2015). Given the reduced cues in many of the traditional tasks the observations that OAs are less able than YAs when judging some emotions from these tasks may result from impoverished cues (such as the absence of unfolding facial expressions and body gestures) rather than emotion recognition ability per se. As such, it is feasible that emotion recognition ability in OAs may be comparable to YAs when tasks include stimuli with higher ecological validity than the traditional tasks.

An experience perspective suggests that OAs, due to their advanced years, arguably have more experience of social interactions compared to YAs. As such OAs might use their knowledge of social interactions, which involve multiple information channels and dynamically presented emotion information, to form their emotion recognition judgements (Sze, Goodkind, Gyurak, & Levenson, 2012). In this manner the lack of these cues in static facial expressions may make the traditional emotion recognition task more difficult for OAs than tasks with more cues (Charles & Campos, 2011). Finally, reliance on contextual cues may become more important with age as a compensatory mechanism for sensory decline (Isaacowitz & Stanley, 2011). Again if this is the case then the traditional emotion recognition tasks might not tap into emotion recognition ability in OAs when more emotion and contextual cues are available.

In this manner tasks with a higher degree of ecological validity may yield different findings regarding emotion recognition ability in OAs than those reported from traditional forced-choice tasks (Isaacowitz & Stanley, 2011). Furthermore, increasing ecological validity so tasks better replicate real world processing will enhance understanding of emotion recognition ability in OAs in more natural scenarios (Charles

& Campos, 2011). There are several ways to increase the ecological validity of the traditional tasks, for instance, using dynamic facial expressions or using cross-modal stimuli (simultaneously presented facial and vocal expressions).

Dynamic facial expressions are arguably more ecologically valid than static faces and might tap into real world, natural processing (Freund & Isaacowitz, 2014). As such the unfolding expressions in dynamic stimuli may provide important cues necessary for emotion discrimination that static stimuli lack (Murphy, Lehrfeld, & Isaacowitz, 2010). Few studies in the field, however, have used dynamic faces (Murphy, Lehrfeld, & Isaacowitz, 2010) (except see Calder et al., 2003; Grainger et al., 2015; Krendl & Ambady, 2010; Stanley & Isaacowitz, 2015; Sullivan and Ruffman, 2004). One such study though reported that, compared to YAs, OAs had deficits in recognising happiness, fear, sadness, and anger from static facial expressions but there was no age-related decline in general emotion recognition ability from dynamic facial expressions (Krendl & Ambady, 2010). However, the findings are somewhat difficult to compare as the method was different between the dynamic and the static tasks. For instance, the dynamic task required emotion recognition judgements to be made by emotion valence rather than from several emotion types as was required in the static face task. As such the dynamic face task was arguably less cognitively demanding than the static face task, and this may account for the disparate findings. Therefore, it is unclear whether the different findings across the stimuli types result from the level of ecological validity of the stimuli or was due to the disparity in task difficulty.

However, of the studies that have used dynamic facial expressions few report age-related differences in OAs for accurate recognition across discrete emotions. One such study that did differentiate between happy, alluring, anger, disgust, and neutral expressions from dynamic faces demonstrated a linear decline with age across all emotions (Lambrecht, Kriefelts, & Wildgruber, 2012). However, the researchers looked at correlations thus did not determine whether emotion recognition accuracy between OAs and YAs was significantly different. Furthermore, only three basic emotions were included in the task so the findings cannot inform on the recognition ability in OAs from dynamic expressions of fear, sadness, and surprise. Consequently, it is unclear whether OAs have recognition impairments, compared to YAs, for specific emotion types when tasks use dynamic faces. With this in mind it is important for research to use dynamic stimuli to determine whether the emotion specific recognition deficits observed in OAs compared to YAs from static facial expressions are replicated with more ecologically valid and contextually rich stimuli (Isaacowitz et al., 2007).

Similar to tasks that use facial expressions as stimuli the degree of ecological validity in the task can also influence emotion recognition ability from vocalisations. For instance, affective vocalisations can be expressed as short outbursts (screams or laughter), or vocal prosody (the intonation in the voice) in the form of short non-verbal cues or sentences. It may be argued that short outbursts and prosodic sentences are representative of naturally occurring emotions, whereas short prosodic sounds such as “ahh” are not frequently heard in natural environments. It is possible that prosodic sentences and words have more contextual cues than short non-verbal prosodic expressions. Thus these extra cues may increase emotion recognition accuracy. Indeed, Orbelo, Grim, Talbott, and Ross (2005) reported that impairments in task performance in OAs, compared to YAs, increased as the amount of linguistic or lexical information decreased. This finding suggests that emotion recognition ability in OAs is lower in tasks that are least representative of real world vocalisations. As such age-related emotion recognition deficits in OAs may be exaggerated in tasks with lower levels of ecological validity.

Turning to lexical based emotion recognition tasks the degree of ecological validity can vary across single words, sentences, or stories. It is logical to assume that given the volume of information across these stimuli types the contextual cues will be highest for stories and lowest for single words. Furthermore, it is likely that stories have higher levels of ecological validity than single words as stories are commonly read in everyday behaviour but making decisions from reading a single word is probably a less frequent occurrence. Thus emotion recognition ability in OAs may differ as a consequence of the contextual cues and ecological validity of lexical stimuli. Indeed, when participants are required to make emotion judgements when reading a story OAs perform as well as YAs (Phillips, MacLean, & Allen, 2002). In contrast, emotion recognition is impaired in OAs, compared to YAs, when making emotion judgements from single words and sentences (Grunwald, 1999; Isaacowitz et al., 2007). The disparate results between stories, sentences, and words may indicate that OAs benefit more than YAs from contextually rich cues provided in stories.

Whilst measuring presentation types separately provides a controlled methodology for gleaning information of the processing ability in the target format (i.e., visual facial expressions) this design lacks ecological validity as real world social interactions comprise a number of visual and verbal cues. Therefore, there is a need for research to include cross-modal experiments as real world emotion recognition results from the interpretation of several sources of emotion cues (Isaacowitz & Stanley, 2011; Phillips & Slessor, 2011). Furthermore, cross-modal stimuli increase contextual cues and context increases accuracy and confidence of emotion judgements (Bullock & Russel, 1986). Given the additional cues in cross-modal tasks and the documented differences in the use of contextual cues between YAs and OAs, then cross-modal tasks may support emotion recognition judgements in OAs more than YAs (Isaacowitz & Stanley, 2011).

The advantage of having access to multiple streams of information has been evidenced in the field by using cross-modal tasks (Chaby, Boullay, Chetouani, & Plaza, 2015; Hunter, Phillips, & MacPherson, 2010b; Lembrecht, Kreifelts, & Wildgruber, 2012; Sze, Goodkind, Gyurak, & Levenson, 2012). In particular OAs seem to benefit from additional information to a greater extent than YAs. For example, Chaby, Boullay, Chetouani, and Plaza (2015) tested age-related emotion recognition ability using unimodal and cross-modal presentations of static facial expressions and non-verbal auditory expressions. OAs were less accurate than YAs when facial and auditory expressions were presented separately, with particular difficulties for recognising sad, angry, and disgusted faces and angry and fearful auditory expressions. However, when the facial and auditory expressions were presented together then OAs and YAs had similar emotion recognition accuracy for all emotion types (happy, sad, fear, disgust, and neutral) with the exception of an age-related deficit for anger recognition in OAs. The results suggest that OAs benefit from additional cues in cross-modal to a greater extent than YAs when making emotion recognition judgements.

In summary, across all presentation types age-related emotion recognition deficits in OAs appear to be reduced as ecological validity increases. Whilst it is of interest to understand emotion recognition ability in OAs from controlled tasks the lack of ecological validity makes generalising the findings to real world processing difficult. Therefore, the traditional forced-choice tasks may tell us little about how OAs recognise emotions in naturally occurring social interactions.

1.7.3.1 *The current study.* To aid comparisons with previous research the emotion recognition stimuli in Phase 1 were similar to the traditional forced-choice emotion recognition tasks so had low levels of ecological validity. The specific stimuli types were purposefully chosen to control for contextual cues to allow for comparisons of findings across presentation types. However, the stimuli used in Phase 2 were carefully selected to have a higher degree of ecological validity in comparison to the traditional emotion recognition tasks. This was achieved by measuring emotion recognition using dynamic facial expressions, rather than static images, and prosodic sentences, rather than non-verbal vocalisations. Further, face and auditory stimuli were simultaneously presented to replicate real-world situations in which emotion information is received from various communication channels. Whilst age-related emotion recognition studies sometimes have used dynamic and cross-modal stimuli the current research extends finding across several discrete emotion types.

1.7.4 Theme 4 - It is unclear to what extent older age performance on emotion recognition tasks is attributable to cognitive decline.

Given changes in some cognitive abilities in OAs (as outlined in section 1.2) it is important to consider whether studies in the field might be confounded by an age-related demise in some cognitive abilities (Hedden & Gabrieli, 2004; Salthouse, 2009). Specifically, emotion recognition often results from a complex integration of cognitive processes including detecting changing emotions expressions, processing of visual or auditory inputs, and discriminating between emotions (Phan et al. 2002; Sze, Goodkind, Gyurak, & Levenson, 2012). It is, therefore, conceivable that the age-related impairments in emotion recognition in OAs are a consequence of changes in cognitive processing with natural aging rather than emotion processing (Somerville, Fani, & McClure-Tone, 2011). Thus, it is important to disentangle age-related decline in emotion recognition ability from age-related changes in cognitive processing.

Several studies in the area have explored the relationship between cognitive functioning and emotion recognition. Orgeta and Phillips (2008) report that disparities in recognition accuracy for facial expressions of fear, anger, and sadness between YAs and OAs are associated with slowing of processing speed with older age. Furthermore, accounting for processing speed reduced the size of the age-related differences in emotion recognition ability in OAs from dynamic faces (West et al., 2012). These findings suggest that processing speed may be a specific predictor of age-related emotion recognition impairments in OAs.

Further evidence has found that fluid intelligence, memory (immediate and delayed recall), and processing speed partially accounted for the variance in recognition ability across emotions from faces (Horning, Cornwall, & Davis, 2012). Specifically fluid intelligence predicted emotion recognition accuracy for fear, anger, disgust, and surprise in OAs. Recognition of fear was also predicted by memory, whilst processing speed predicted recognition for sad and happy faces in OAs. However, once age was accounted for the predictors for fear were lost. The findings imply that cognitive functioning has differential effects on emotion recognition ability in OAs across emotion types and age may be a better predictor of fear recognition than cognitive functioning.

There is further evidence that cognitive decline, specifically executive functioning, may have differential effects of emotion recognition across emotion types. Executive functioning includes higher order cognitive abilities including set shifting, inhibition, motivation, manipulating information, verbal fluency, and planning (Wechsler, 1981). Circelli, Clark, and Cronin-Golomb (2013) report that executive functioning is related to recognition of sad facial expressions in OAs. Also lower executive functioning (as measured by amalgamated scores of word fluency, arithmetic, card sorting, and memory) was related to lower anger recognition in OAs (Krendl & Ambady, 2010). However, whilst the tasks test cognitive abilities they do not capture all of the cognitive abilities encompassed within the concept of executive function, such as set shifting and inhibition, so may not measure full executive function. Nevertheless, taken together the presented evidence demonstrates variations in findings suggesting a complex relationship between specific cognitive abilities and recognition ability for specific emotion types.

In contrast, some evidence suggests that differences between OAs and YAs in emotion recognition ability are not associated with cognitive abilities. For example, non-verbal emotion recognition ability was not related to education, cognitive status, or memory (Lima, Alves, Scott, & Castro, 2014). However, the OA sample in Lima, Alves, Scott, and Castro (2014) comprised of younger-older adults (mean age of 61 years) as such these OAs may not have undergone cognitive demise to the same extent as older-older adult samples. Hence, in Lima et al. the age-related cognitive decline in OAs may not be sufficiently advanced to demonstrate an association with emotion recognition ability. However, evidence from several other studies corroborate with the findings reported by Lima and colleagues. For instance, age-related impairments in recognising affective prosody in OAs were not accounted for by cognitive ability such as list recognition, story recall, and Stroop tests (Orbelo, Grim, Talbott, & Ross, 2005). Furthermore, Keightley, Winocur, Burianova, Hongwanishkul, and Grady (2006) found that cognitive functioning, measured by several abilities including verbal knowledge and fluency; working memory; and inhibition, did not account for emotion recognition differences from static faces between YAs and OAs. More specifically, fluid intelligence did not account for the variance in adults' ability to match vocal expressions to either emotion word labels or facial expressions (Ryan, Murray, & Ruffman, 2010). Impairments for accurately recognising anger and sadness in OAs, compared to YAs, from morphed facial expressions were not attenuated when processing speed and fluid intelligence was accounted for (Sullivan & Ruffman, 2004a). Nor were age-related differences in emotion recognition ability in OAs from facial expressions related to fluid and crystallised intelligence, or education (Phillips, Maclean, & Allen, 2002) or accounted for by executive function (West et al., 2012). Finally, Lambrecht, Kriefelts and Wildgruber (2012) stated that age-related declines in emotion recognition of facial expressions and prosodic vocalisations still existed once cognitive ability (working memory and verbal intelligence) was accounted for. Taken together these findings suggest that cognitive demise in older age does not account for differences in emotion recognition ability between YAs and OAs.

Given the disparate findings regarding the association between cognitive performance and emotion recognition ability it remains unclear what impact, if any, cognitive decline with age has on emotion recognition performance in OAs. It is possible that OAs use compensatory mechanisms (such as previous experience) to overcome age-related cognitive change during emotion recognition (Isaacowitz & Stanley, 2011). These adaptive behaviours may serve to mask the effects of an age-related decline in cognitive functioning on emotion recognition ability in OAs. Nevertheless, the majority of research suggests that cognitive performance is not related to emotion recognition ability (Ruffman, 2011).

Rather than accounting for specific cognitive abilities on emotion recognition accuracy it may be more promising to account for OAs' ability to meet the processing demands of the task. In this manner, instead of isolating particular cognitive functions, information can be gleaned regarding OAs' ability to complete the task. One way of measuring the ability to meet the demands of the task is to use non-emotion tasks. Incorporating non-emotion tasks alongside emotion tasks can help to tease apart emotion and cognitive performance. To achieve this a non-emotion task should be carefully designed such that it places the same cognitive demands on the participants as the emotion task. In theory, as long as the emotion and non-emotion tasks are closely matched for task demands, comparable accuracy between YAs and OAs on non-emotion tasks would suggest that OAs are as able to meet the demands of the task as YAs. Therefore, any age-related difficulties in emotion recognition ability in OAs are likely to result from age group differences in emotion processing rather than from more general cognitive abilities.

Sullivan and Ruffman (2004) included several non-emotion tasks (a morphed object, gender discrimination task, and beaker judgement task). Their findings suggest that age-related emotion recognition difficulties in OAs are not due to face processing abilities or task demands, as OAs performed well on the non-emotion and face tasks. However, the emotion and non-emotion tasks used in Sullivan and Ruffman (2004) had methodological variations. For example, the gender identification task only required a judgement from two options whilst the emotion recognition task required judgements to be made from several response options. Good performance on the non-emotion tasks compared to emotion tasks, therefore, might be a consequence of methodological inconsistencies between the tasks making the non-emotion task less demanding and easier than the emotion task. Arguably conclusions from non-emotion tasks are stronger when the emotion and non-emotion tasks are matched as a far as possible on task demands.

In an alternative study Grunwald et al. (1999) assessed emotion recognition ability in OAs and YAs using words and sentences. Participants selected which emotion they believed was represented by a single word (gloomy), a group of three words (putrid, slime, stench), or a sentence ("he felt the urge to hit someone"). Similar non-emotion tasks were also used for comparison. OAs were less accurate across all tasks, with the exception of the word identification tasks, suggesting that OAs found the tasks more difficult than YAs regardless of content. In this instance it is possible that a lesser ability to meet the demands of the tasks in OAs than YAs contributed to the age-related emotion recognition deficits in OAs. However, a lack of methodological detail regarding the non-emotion tasks makes it unclear whether the emotion and non-emotion tasks had similar task demands.

In conclusion, whilst there is a logical argument that emotion recognition impairment with age is related to age-related decline in cognitive ability it appears that there is little evidence that the two concepts are related. A few studies have found that specific emotion recognition impairments in OAs, compared to YAs, are associated with certain cognitive functions, such as fluid intelligence and processing speed. Yet the majority of the research, using several measures of cognition, have found no or only partial correlations between emotion recognition and cognitive abilities including fluid and verbal intelligence and processing speed. In some cases age is a stronger predictor of emotion recognition than cognitive ability. However, it may be naïve to overlook the potential contribution of cognitive ability on task performance. It would be prudent for researchers to control for any potential age-related differences in cognitive abilities by matching YAs and OAs on several cognitive functions including verbal and fluid intelligence. Furthermore, experiments should include both non-emotion and emotion tasks with similar task demands. In this manner results from emotion recognition tasks can be interpreted more confidently as a consequence of either emotion or cognitive processing.

1.7.4.1 *The current study.* To reduce the possible confound of cognitive ability on emotion recognition ability for Phase 1 and Phase 2, OAs were at least matched with YAs on fluid and verbal intelligence. The OAs did have higher levels of verbal intelligence than the YAs but the direction of this age group difference should not reduce OAs' emotion recognition ability. In this manner any differences in emotion recognition ability between YAs and OAs are not likely to result from lower intelligence in OAs than YAs. Furthermore, the inclusion in Phase 1 of non-emotion tasks that are as procedurally similar to the emotion task is novel. The similarity in procedure of the emotion and non-emotion tasks (i.e., same number of response items, same format of presentation, and same number of trials) means that the tasks are matched as far as possible for task demands. Whilst other studies have accounted for face processing and procedural ability (e.g., Sullivan & Ruffman, 2004) the current researcher is not aware of previous research that has rigorously controlled for methodological differences between the emotion and non-emotion task.

1.8 Conclusion

To date a wealth of research in the field has made a fundamental contribution to our understanding of how emotion recognition ability changes into older adulthood. The accumulation of evidence indicates that in general OAs have some difficulties compared to YAs in their emotion recognition ability. Whilst this research is central to our understanding of emotion recognition development there are several factors that need further clarification. Particularly there is a need to provide clarity to the extent of age-related differences in OAs across emotion, presentation, and stimuli types. When trying to understand exactly which emotions are vulnerable to age-related decline a review of the literature reveals a series of inconsistent results that fail to provide a common pattern as to which specific emotions are affected. This lack of clarity might result from differences in methodology, stimuli types, and sample characteristics; hence, there is a need to control for some of these potential confounds. Furthermore, the field would benefit from findings beyond those from facial expressions, basic emotions, and stimuli types with low ecological validity. To clarify the interpretation of emotion recognition differences between YAs and OAs it would be useful to use non-emotion tasks to discern between general processing and emotion processing ability. Finally, research is required to determine whether emotion recognition ability in laboratory tasks is reflective of more global measures of social functioning.

1.9 Research Programme Aims

The experiments and tasks used in this research programme were specifically designed and carefully selected to advance the current understanding of emotion recognition ability in OAs.

The central aims in Phase 1 were:

1. To understand the pattern of emotion recognition ability in OAs across discrete emotions types and three presentation types.
2. To extend our knowledge of emotion recognition ability in OAs beyond an experimental focus on facial expressions by using procedurally similar tasks that have non-verbal vocalisations and single words as stimuli.
3. To use a within-participants design to reduce possible confounds of intrinsic sample differences across presentation types.
4. To attempt to match age groups on intelligence, education and gender, empathy, alexithymia, affect, anxiety, and personality: factors that might otherwise confound interpretation of results in the field.
5. To use non-emotion tasks that have, as far as possible, similar task demands to the emotion task to determine OAs' and YAs' ability to process both emotion and non-emotion information.
6. To understand emotion recognition differences between younger-older and older-older adults.

To further advance our knowledge of emotion recognition ability in OAs the aims of Phase 2 were:

1. To understand emotion recognition ability in OAs using tasks that are more reflective of real world transactions by using stimuli with increased ecological validity than is found in the traditional tasks.
2. To understand the breadth of emotion recognition ability in OAs across discrete emotions using dynamic facial expressions, nonsense prosodic sentences, and cross-modal (visual and auditory) presentations.
3. To disentangle whether accuracy for positive emotion recognition in OAs can be explained by a positivity effect or task simplicity.

4. To extend the understanding of emotion recognition ability in OAs beyond the basic emotions typically studied.
5. To determine whether emotion recognition ability is a reflection of a wider problem in social functioning in older age.
6. To understand emotion recognition differences between younger-older and older-older adults.

1.10 The Contribution to Knowledge of the Current Research Programme

This research programme will make important advancements to the current knowledge of emotion recognition ability in OAs. The novel approach of controlling for some methodological and sample differences across emotion tasks using different presentation types (faces, sounds, and words) will allow for cross-study comparisons to be made. Moreover, including carefully designed non-emotion tasks that are, as far as possible, matched for task demands to the emotion task will help to make informative comparisons between non-emotion and emotion processing. Further, increasing ecological validity in closely matched experimental tasks will demonstrate whether there is general emotion recognition demise or if age-related deficits are limited to tasks with reduced ecological validity. The research will also assess aspects of social functioning that are too often amiss in emotion recognition research. Thus revealing whether the age-related deficit is general to social functioning or whether the deficits are limited to emotion recognition. Finally, the innovative approach of reversing the emotion valance of the traditional emotion recognition task will help to tease apart the positivity effect from task design as an explanation for the typically reported pattern of emotion recognition in OAs.

Phase 1

Chapter 2- General Method

In Phase 1 three experiments were carefully designed to measure emotion recognition accuracy, and non-emotion processing, in the same OAs and YAs across three presentation types: static faces, non-verbal vocalisations, and single words. This chapter details the methodological considerations that went into designing the study and how the data was prepared for analysis. Of note some of the detail in the method section is also applicable to Phase 2 and this is highlighted when this is the case.

2.1. Experimental design choices

Inconsistencies in task procedure, contextual cues in the stimuli, and task demands make comparisons in the field difficult. Therefore, to enable meaningful comparisons across the emotion tasks and between the emotion and non-emotion tasks many of the design choices for the current tasks served to reduce these methodological inconstancies. Tables 2.1 and 2.2 (in Appendix 2. 1) provide an overview of the methods used in the area using facial expressions and auditory stimuli and highlight variations including the number of trials and the number of emotions included in the emotion recognition tasks. Few studies in the field have used lexical tasks as stimuli so it was not necessary to create a similar table for the single word task. These and other design considerations are now explained.

2.1.1. Cross-sectional studies.

In both Phase 1 and Phase 2 cross-sectional studies were used as this design is time efficient compared to longitudinal studies that can take decades to complete (Freund & Isaacowitz, 2013). However, it is acknowledged that cross-sectional studies cannot explain age as a causal factor to outcomes as a third unknown construct may lead to age-related differences. Further, the use of extreme age groups (i.e., YAs and OAs), typical of cross sectional studies, may lead to exaggerated age effects as findings may reflect age group differences due to cohort effects (Freund & Isaacowitz, 2013). It is, therefore, difficult to determine whether any age-related differences are due to naturally occurring changes with age or as a consequence of the time, history, and social contexts experienced by the age groups that vary across time.

The age ranges for each age group in the current research were similar to some of the age ranges used in the area (e.g., Calder et al., 2003; Sullivan & Ruffman, 2004): YAs were aged between 19-30 years and OAs from 59 years upwards. However, there is some disparity in the age ranges used between studies in the area (see Table 1.2; Appendix 1.2). A general lack of consensus as to what defines older age may account for the between-study inconsistency regarding the age ranges for OA samples. For example, the World Health Organisation (WHO, 2002) states that 65 years is typically considered as being elderly but older populations often include adults from 60 years of age.

Moreover, OAs samples can span a large age range. Given the neurological and cognitive changes in older age (e.g., Hartshorne & Germine, 2015; Raz, 2000) there maybe differential emotion recognition ability between those in early old age (younger-older adults) compared to those more advanced in older age (older-older adults). For example, from 70 years of age OAs demonstrate some cognitive impairment in abilities, such as lexical retrieval, that until then have been resistant to age-related decline (Zec, Markwell, Burkett, & Larsen, 2005). Therefore, the end of the seventh decade may be a demarcation for further cognitive decline in natural aging; hence, emotion recognition ability may decline with advancing older age. Thus in both Phase 1 and Phase 2 emotion recognition ability was compared between YAs, younger-older adults (under 70 years of age), and older-older adults (over 70 years of age). However, it is still important to compare findings between the extreme age groups (YAs and OAs) to allow comparisons with previous research.

2.1.2. The need for within-participants design across experiments.

To reduce sample differences across experiments the same individuals were invited to participate in all experiments in Phase 1. Conducting several experiments with the same participants avoids any influences of confounding intrinsic sample differences and thus allows for direct comparisons to be made across tasks.

2.1.3 The modality, presentation, and stimuli types used in the experiments.

The stimuli types used in Phase 1 include static facial expressions, non-verbal vocalisations, and single words. The three types of stimuli are not the only channels through which emotions are communicated but were chosen as they vary by modality and presentation formats: visual (face and words) and auditory (non-verbal vocalisations). Facial expressions were included to enable comparisons to previous research. Single words were included as a contrast to facial expressions but still relying on visual processing. Finally, non-verbal vocalisations were used as an alternative to visual processing. In this manner the current research taps into a broad spectrum of emotion recognition abilities rather than a focus on one or two presentation types that is typical of the literature (e.g., Krendl, Rule, & Ambady, 2014)

Alternative emotion communication channels were considered, namely body gestures and music. Research suggests that OAs and YAs differ in their ability to distinguish between affective body gestures (Montepare, Koff, Zaitchik, & Albert, 1999; Ruffman, Sullivan, & Dittrich, 2009). However, there did not appear to be a suitable dataset of affective body gestures that met the stipulated criteria (i.e., sufficient examples of each emotion type, produced by OAs and YAs, evidence of reliability and validity). In addition the perception of the emotion content in music may be subjective and also familiarity with the stimuli would be difficult to regulate. Therefore, these presentation types were not used in the current research.

The stimuli in Phase 1 were drawn from datasets that met the criteria necessary to achieve the task aims and are detailed in the relevant subsequent chapters (Chapters 3, 4, and 5). Importantly the stimuli types were carefully selected to minimise the difference in contextual cues between the emotion tasks. Given that OAs may use contextual cues more than YAs when making emotion recognition judgements (Noh & Isaacowitz, 2013), then disparity in the degree of contextual information among the stimuli types could contribute to any possible differences in the pattern of emotion recognition ability in OAs across tasks. Thus, to reduce this possibility the stimuli included static facial expressions, non-verbal vocalisations, and single words as static faces do not have dynamic or verbal cues, non-verbal vocalisations do not have semantic or verbal cues, and single words have reduced semantic cues than sentences. In this manner the stimuli would provide sufficient cues to enable emotion recognition but with limited contextual cues.

2.1.4 Using forced-choice tasks.

Much of the research in the field has utilised forced-choice tasks where participants have a limited number of response options available to them. The limitations of this method have been acknowledged in Chapter 1.7. Whilst acknowledging the limitations of forced-choice tasks the current research used such a format for two reasons. First, forced-choice tasks allow for meaningful comparisons with previous research. Second, an alternative method to forced-choice is free labelling (when participants generate their own emotion label that best represents the presented emotion) but these tasks may result in a diversity of terms making analysis difficult to interpret. Therefore, for ease of comparisons and to aid interpretation forced-choice tasks were used.

2.1.5 The number of emotion types included in the task.

The number of response options may contribute to inconsistent findings in the field. Specifically, in one study OAs were less able to recognise two emotions when selecting from six options; however, OAs were less able to recognise one emotion when selecting from four options (Orgeta, 2010). Thus increased task demands, as measured by the number of emotion options, may disadvantage OAs more than YAs due to cognitive aging. To avoid the potential impact of variable task demands on OAs' emotion recognition the same number of options were included across all of the emotion recognition tasks in Phase 1. Information in Tables 2.1 and Table 2.2 (Appendix 2.1) suggest that a common practice is to include six-emotion choices options (44% of studies); therefore, the current research used a six item forced-choice task to be comparable with many of the studies in the field.

2.1.6 The use of basic emotions in the tasks.

The experiments in Phase 1 measured recognition ability of five basic emotions. The advantage of concentrating on a select number of emotion types allows for cross-study comparisons and a limited number of emotion types support a parsimonious and scientific study of emotion (Johnson-Laird & Oatley, 1992). Ultimately, however, the emotions included in the current task were restricted by the emotions included in the selected databases. In the current study the FACES (Ebner, Riediger, & Lindenberger, 2010) database was used for the facial expression stimuli and this dataset includes five emotions (happiness, sadness, fear, anger, and disgust) and neutral faces. The FACES stimuli do not provide examples of surprised facial expressions so this emotion type could not be included in the task. The exclusion of surprise, however, may be a strength of the study as facial expressions of fear and surprise share similar facial actions (such as wide eyes), which may account for confusions in recognising fearful expressions as surprise (Calder et al., 2003). Therefore, omitting surprise from the current tasks will overcome any response confusions between fear and surprise.

In addition to investigating adults' ability in discerning between emotion types it is of interest to understand their ability to recognise when no emotion is being portrayed (neutral), as OAs may confuse emotion and neutral expressions more than YAs (Isaacowitz et al., 2007). Indeed, evidence suggests that OAs and YAs did not differ in attributing anger, happiness, or sadness to neutral faces, whereas OAs attributed higher levels of surprise to neutral faces than YAs (Lawrie, Jackson, & Phillips, 2018). Thus, to gain insight into non-emotion processing within an emotion recognition task it is of empirical interest to include a neutral option. Therefore, the emotion tasks in Phase 1 included neutral stimuli alongside the emotions of happy, sad, fear, anger, and disgust.

2.1.7 The number of trials per category.

The number of trials in a task can vary between studies (see Table 2.1, Appendix 2.1). However, too few trials may reduce the sensitivity of the task to detect differences between groups, whereas too many trials can lead to fatigue or practice effects. To be in line with some research in the field (e.g., Horning, Cornwell, & Davis, 2012) the current study used six trials per condition in all of the emotion and non-emotion tasks in Phase 1.

2.1.8 Response times.

A pilot study was run to, amongst other things, determine an optimal response cut-off limit for each trial. The cut-off in the experimental tasks was set at 4000 ms given that response times in the pilot study fell within this time frame for most of the emotions (see Appendix 2.2 and Section 2.2.1.3). Further, RTs ranging from 1500 ms to 3000 ms, depending on the emotion type, have been reported from research using self-paced emotion recognition tasks (Williams et al., 2009); thus it was concluded that 4000 ms was a suitable time limit.

2.2 Materials

The materials used in Phase 1 included a test battery (see Table 2.2.1) alongside a demographic questionnaire (those tasks also used in Phase 2 are highlighted in Table 2.2.1). The tasks in the test battery were included for two reasons. First, to understand any age differences in cognitive, emotion, and personality characteristics that may influence emotion recognition ability; thus, potentially confounding the interpretation of the results. Second, to investigate relationships between these characteristics and emotion recognition ability. However, correlation analysis revealed only a few significant relationships between emotion recognition accuracy and any of the cognitive, emotion, and personality measures (see Appendix 2.3). Henceforth, the purpose of the measured sample characteristics was to aid the interpretation of the performance on the emotion recognition tasks as direct or indirect effects of emotion recognition. In addition to the test battery three computer-based experiments (Experiment 1-facial expressions, Experiment 2-non-verbal vocalisations, and Experiment 3-single words) each including an emotion recognition task and a non-emotion task were conducted.

2.2.1 Computer-based tasks.

Six computer-based tasks were created to assess emotion recognition skills and non-emotion processing across three presentation types (static faces, non-verbal vocalisations, and single words).

2.2.1.1 Emotion recognition tasks. In Chapter 1 several methodological inconsistencies in the field that may account for the between-study differences in emotion recognition ability in OAs were discussed. Such methodological differences limit our ability to make cross-study comparisons. Thus, to enable meaningful comparisons across the three experiments in Phase 1 the emotion recognition tasks were designed to be as procedurally similar to each other as possible. Specifically, the emotion experiments in Phase 1 had similar methods: the same emotion types (happy, sad, fear, anger, disgust, and neutral); the same number of response options (six); the equivalent number of trials per category (six per emotion type); and a 4000 ms response time per trial. Further, the visual appearance of the task was matched, as far as possible, across experiments; on each task the response labels were presented underneath the stimuli (a sound icon was presented on the screen during the auditory task).

Finally, the tasks were also designed to avoid possible response bias as far as possible. A response bias is when a participant responds to a task or questionnaire in a systematic way rather than in the manner that is required by the task (Paulhuss, 1991). For example, participants may press a response key more often than other response keys depending on their position in a scale. To control for the effects of such a response bias, the position of the emotion labels were counterbalanced and this was achieved by creating several versions of the tasks and varying the position of the response labels across each version. The exception to counterbalancing was the neutral category, as this served to act as a control in the task so the neutral label did not change position.

2.2.1.2 The non-emotion tasks. In addition to the three emotion tasks, each experiment in Phase 1 included a corresponding non-emotion task (i.e., static faces, short non-verbal sounds, and single words). The inclusion of a non-emotion task that is similar in design and procedure to the emotion task is a novel feature of the research in Phase 1. Orgeta and Phillips (2008) call for research to incorporate non-emotion tasks alongside emotion tasks to determine whether findings in the field reflect deficits in emotion processing or a more general processing impairment. Thus, in the current research, and to be comparable to the emotion tasks, the non-emotion tasks measured non-emotion processing of faces, short sounds, and single words. The tasks were as procedurally comparable to the emotion task as possible; the non-emotion tasks had the same number of trials, response options, and time limit as the emotion tasks. The similarity in methodology was to match task demands across the emotion and non-emotion tasks as far as possible; thus, enabling meaningful comparisons.

For each task the participants were required to attend to and perceive the physical or audio qualities of the stimuli, retrieve and apply knowledge of the properties to the stimuli, form a categorical judgement, discriminate between six options, select a label, and enter a motor response via a response box. Therefore, not only were the demands the same on each trial but the similarities in the number of trials and the time limit ensured that the task demands between the emotion and non-emotion tasks were as matched as far as possible. The tasks were only dissimilar in the content type (emotion or non-emotion). The similarities between the emotion and the non-emotion tasks enables meaningful conclusions to be made regarding whether the findings on the emotion task can be best explained by emotion processing or general processing ability. For example, if the emotion task is more difficult for both age groups (a main effect of content type) than the non-emotion task then any age-related emotion recognition differences are likely to be due to processing of the emotion stimuli. In contrast, if OAs are less accurate than YAs on both the emotion and non-emotion task (a main effect of age group) then it is probable that OAs have a more general processing deficit that is not limited to emotion processing.

Some researchers have included non-emotion tasks in their studies to investigate the influence of task demands on the emotion recognition task performance. For example, Circelli, Clark, and Cronin-Golomb (2013) used landscapes (canyon, city, forest, mountain, shore, town, and tropical) as a non-emotion task. The procedure between the emotion and landscape tasks were similar, as participants had to make categorical judgements between seven choices and each task consisted of 10 trials per category. OAs and YAs performed as equally well as each other on the landscape task suggesting that poorer recognition ability of fearful facial expressions in the same OAs, compared to YAs, is unlikely to result from task demands. However, faces portray social cues that arguably are not reflected in landscapes, thus age-related differences in emotion recognition could be attributed to age-related differences in face processing ability (Kiffel, Campenella, & Bruyer, 2005; McKone, Kanwisher, & Duchaine, 2007).

It is, therefore, important that non-emotion tasks test the ability to make non-emotion judgements from stimuli that are as similar as possible to those used in the emotion task.

There is evidence, however, that face-processing ability is not related to age-related emotion recognition differences. Suzuki, Hoshino, and Shigemasu (2007) used a face identification task where participants were required to select from the given options which face was the same as the target face. The findings suggest that emotion recognition accuracy for specific emotion types did not significantly correlate with accuracy on the face-matching task for either YAs or OAs. Whilst correlational analysis does not imply causation the findings suggest that it is unlikely that the age-related emotion recognition deficits are related to face processing abilities. However, there were a few procedural differences between the tasks that have the potential to confound the interpretation of the findings. For instance, the emotion task had 48 trials, as such, had slightly higher task demands than the non-emotion task, which had 30 trials. It is possible that age-related deficits may reflect higher fatigue effects in the emotion task than the non-emotion task. Therefore, to enable meaningful comparisons between the emotion and non-emotion tasks the current research used tasks that were, as far as possible, procedurally alike and used similar stimuli. The specific choice of stimuli for the non-emotion tasks is discussed in more detail in Chapters 3-5, however, static faces displaying neutral expressions, short animal sounds, and words related to parts of the body were used as non-emotion stimuli.

2.2.1.3 Pilot study. All of the computer-based tasks were piloted to ensure good content validity, in that each stimulus is a good measure of the target behaviour (Burns, 1996) (see Appendix 2.2). For the current tasks content validity was determined by how accurately the participants chose the correct label for each target emotion or non-emotion stimulus. Strictly speaking in the current pilot study the ability to detect the target above that of chance was 17% (1/6 chance = 17% accuracy). This criteria, however, is lenient so content validity was set at 50% accuracy. Furthermore, the pilot study also assessed whether the emotion and non-emotion tasks differed in accuracy, as it is possible that participants found one of the tasks easier than the other despite the tight methodological controls between the emotion and non-emotion task. Any difference in task difficulty would reduce the ability to make informative comparisons between the two.

Fourteen volunteers (two males and 12 females) responded to a request for participants. Participants were aged between 39 years and 71 years of age ($M = 47.14$ years; $SD = 10.41$ years). In general the tasks had good content validity and any stimulus that failed to meet the criteria were replaced by a suitable stimulus used in the practice trials. In all two emotion words, two non-emotion sounds, and two emotion sounds were replaced. As a result of the changes the tasks were considered to have good content validity. Furthermore, there were no differences in accuracy between the emotion and non-emotion tasks on the face and sound tasks (both *p*s > .05); thus, neither task appeared to be easier than the other. However, the non-emotion words task had higher accuracy than the emotion word task, $t(12) = 3.57$, $p = 0.004$ (out of a maximum of 36 the mean accuracy was 30.15 [$SD = 2.4$] for emotion words and 33.15 [$SD = 1.40$] for non-emotion words). Therefore, the non-emotion word task might be easier than the emotion task and this needs to be considered when comparing findings on the emotion and non-emotion word tasks.

2.2.2. Standardised tasks.

Table 2.2.1

The Standardised Tasks used in Phase 1 of the Current Research

Variable being measured	Test used	Author
Speed of Processing	MMSE2-EV Digit Symbol Coding*	Folstein, Folstein, & McHugh (1975)
Verbal intelligence	The Mill Hill Vocabulary Scale- Multiple choice subtest*	Raven, Raven & Court (1998)
Fluid intelligence	Raven's Standard Progressive Matrices-Plus*	Raven (2008)
Personality	NEO-Five Factor Inventory (NFFI)	Costa & McCrae (1992)
Empathy	The Empathy Quotient-S[1]	Wakabayashi et al. (2006)
Mood	Positive and Negative Affect Schedule (PANAS)*	Watson, Clark, & Tellegen (1988)
State and trait anxiety	State and Trait Anxiety Inventory (STAI)	Spielberger, Gorsuch, Lushene, Vagg, & Jacobs (1970)
Alexithymia	The Toronto Alexithymia Scale (TAS-20)	Bagby, Parker, & Taylor (1994)

* These tasks were also used in Phase 2. [1] downloaded from ARC free access

2.2.2.1 *Intelligence.* As previously discussed in Chapter 1 cognitive functioning, such as intelligence may change with age and it is possible that these changes impact on emotion recognition accuracy. Intelligence has been conceptualised as two fundamental components: fluid and crystallised intelligence (Cattell, 1963). Essentially crystallised intelligence is learnt knowledge through culture, experience, and education including verbal information and declarative knowledge, whereas learnt knowledge has little impact on fluid abilities that require the ability to solve problems (Johnson & Bouchard, 2005). More recently crystallised intelligence has been conceptualised as two abilities: verbal ability and declarative knowledge (Schipolowski, Wilhelm, & Schroeders, 2014). Consequently, researchers may need to distinguish between the two areas of crystallised intelligence as well as between fluid and crystallised intelligence. Due to the nature of the task used in Phases 1 and 2, crystallised intelligence will henceforth be referred to as verbal intelligence.

2.2.2.1.1 ***Verbal intelligence.*** There is evidence that verbal intelligence increases with age (Verhaeghen, 2003). It is important to measure verbal intelligence as higher levels of this ability may reduce the size of emotion recognition deficits (Montebarocci, Surcinelli, Rossi, & Baldaro, 2011). There are several tools designed to measure verbal intelligence including the Wechsler Adult Intelligence Scale (WAIS-IV; Wechsler, 2008); Peabody Picture Vocabulary Test (PPVT™-4; Dunn & Dunn, 2007); the National Adult Reading Test (NART; Nelson & Wilson, 1991); and the Mill Hill Vocabulary Scale (MHVS; Raven, Raven, & Court, 1998a). Most research reporting maintenance of verbal abilities in older age have utilised a version of the WAIS (Kaufman, Johnson, & Liu, 2008). For the current research the multiple-choice subtest of the MHVS was chosen over other measures of verbal intelligence, as the task is similar in procedure to the emotion and non-emotion tasks, particularly the word tasks, used in Phase 1. For example, both the emotion word and the verbal intelligence tasks require participants to select from six options which word they believe is semantically related to the target word; thus, similar processing requirements allow for meaningful comparisons to be made.

The Mill Hill subtest consists of 44 words each with six response options and participants are required to select which of the six options is closest in meaning to the target word. The task starts with commonly encountered words, such as "tomato", and progresses to less frequent words, for example "minatory". A point is given for each correct answer. The test has evidence of test retest reliability and validity (Owens & Richardson, 1979; Raven, 2008).

2.2.2.1.2 ***Fluid intelligence.*** Fluid intelligence is often reported as declining in older age (e.g., McArdle, Ferrer-Caja, Hamagami, & Woodcock, 2002) and this decline in non-clinical OAs may provide an early preclinical indicator of Alzheimer's Disease (AD) (Harrington et al., 2017). There are differentiating views regarding whether fluid intelligence is related to emotion recognition ability: Mayer, Salovey, and Caruso (2003) suggest that fluid intelligence may influence emotion recognition ability whilst Gardner (2000) suggests that fluid and emotion intelligence (which includes emotion recognition ability) are independent of each other. There is evidence that fluid intelligence, as measured by the matrix-reasoning subtest of the WAIS, may predict emotion recognition of faces depicting fear, anger, disgust, and surprise (Horning, Cornwall, & Davis, 2012). In contrast, Sullivan and Ruffman (2004a) and Ryan, Murray, and Ruffman (2010) both found no evidence for an association between emotion recognition ability in OAs and fluid intelligence as measured by the Culture Fair Intelligence Test (Cattell & Cattell, 1959). It is, therefore, possible that the disparate findings between the aforementioned studies are a consequence of some intrinsic element particular to the fluid ability measures. For example, the Culture Fair is time limited, whereas the WAIS is self-paced. Whilst the association between fluid intelligence and emotion recognition ability is unclear it is prudent to interpret age-related emotion recognition ability within the context of any age group differences in fluid intelligence.

The Raven's Standard Progressive Matrices-Plus (RPM; Raven, 2008) is an alternative to the aforementioned measures of fluid intelligence and was administered in the current study. The RPM is similar in processing demands to the emotion and non-emotion tasks, as all of the tasks require participants to attend to the physical elements of the stimuli and make discriminatory judgements from the given options. In this manner the task is more suitable than some of the alternative measures of fluid intelligence such as the Block Design subtask of the Wechsler Adult Intelligence Scale (WASI; Wechsler, 1997), which requires participants to manipulate patterned cubes to recreate a presented design.

Furthermore, the plus version of the Raven's Progressive Matrices was chosen instead of other versions of the test (e.g., Coloured Progressive Matrices [Raven, Court, & Raven, 1995] and Standard Progressive Matrices Classic [Raven, Raven, & Court, 2004]) as it is a more challenging test designed to avoid ceiling effects (Raven, 2008). The test comprises of five subsets of twelve visual patterns. Each subset starts with a simple example and progresses to more difficult cases. Participants are required to study a series of incomplete visual patterns and to determine which of the provided options best completes each pattern. The task is not time limited but generally lasts for 45 minutes (Raven, 2008). Scores are collated by allocating a point to each correct response. The test has evidence for test-retest reliability (Raven, 2008).

2.2.2.2 Processing speed. The speed in which we process information declines with age and Salthouse (1991) proposes that a decline in speed of processing is fundamental to many age-related cognitive differences in OAs, including executive functioning and intelligence. For example, an age-related reduction in verbal fluency was largely explained by speed of processing (Bryan, Luszcz, & Crawford, 1997) and categorical fluency is predicted by lexical speed (Shao, Janse, Visser, & Meyer, 2014). Hence, processing speed is an important cognitive process as it may impact on the proficiency of other cognitive skills.

The MMSE-2 measure of processing speed was administered in the current research as it is procedurally similar but has a shorter time duration to the digit-symbol substitution task (WAIS; Wechsler, 1997) that is commonly used in the literature. The task requires participants to complete a symbol-digit coding exercise. Participants are presented with a key consisting of numbers 1-9 and a corresponding symbol (e.g. "o",

"<", "+") is shown beneath the target number. Under the key is a series of boxes with the target number on the top and an empty space below into which participants draw the corresponding symbol from the key. The exercise is time limited to 30 seconds. Participants have to complete as much of the task within the time limit and a point is rewarded for each correct symbol-digit correspondence. The total maximum score for the timed task is 35.

2.2.2.3 Alexithymia. Alexithymia is the inability to differentiate between emotion types and express one's own emotions (Krystal, 1979; Taylor, 1984) and this may influence the ability to recognise emotions in others (Lane et al., 1996). Indeed, evidence suggests that adults high in alexithymia, as tested by the Toronto Alexithymia Scale (TAS-20; Taylor, Bagby & Parker, 1992), are less able to recognise emotions from static facial expressions than adults with moderate or low levels of alexithymia (Parker, Taylor, & Bagby, 1993). Furthermore, evidence suggests that alexithymia is a stronger predictor of emotion recognition ability than autism (Cook, Brewer, Shah, & Bird, 2013).

To date there is inconsistent evidence regarding the effect of adult age on levels of alexithymia. For example, some suggest that OAs and YAs do not differ in their level of alexithymia (Henry et al., 2006), whereas levels of alexithymia were positively related with age in adults whose ages ranged from 24 years to 79 years (Paradiso, Vaidya, McCormick, Jones, & Robinson, 2008). Given the potential influence of alexithymia on emotion recognition ability and the possible increase in the prevalence of alexithymia in older age (Mattila, Salminen, Nummi, & Joukamaa, 2006) it is important for findings in the field to be understood within the context of any age differences in alexithymia. Despite its potential influence alexithymia is rarely measured in the field. One study, however, did report emotion recognition deficits from facial expressions in OAs compared to YAs, despite the age groups having similar levels of alexithymia (Keightley et al., 2006). However, there is a gap in the literature regarding the possible influence of alexithymia on emotion recognition differences between YAs and OAs, specifically in channels other than facial expressions.

There are several tools available to measure alexithymia including the Observer Alexithymia Scale (OAS; Haviland, Warren, & Riggs, 2000); the Toronto Structured Interview for Alexithymia (TSIA; Bagby, Taylor, Parker, & Dickens, 2006); and the modified Beth Israel Hospital Psychosomatic Questionnaire (M-BIQ; Bagby, Taylor, & Parker, 1994). Most of these tasks were not suitable for the current research as they were either time consuming tasks, such as interviews or observations, or were designed for clinical use. Given the issues regarding application and administration of the aforementioned assessments the current study used the Toronto Alexithymia Scale (TAS-20; Taylor, Bagby & Parker, 1992), as it is quick to administer and is regularly used as a research tool for alexithymia (e.g., Henry et al., 2006).

The TAS-20 comprises of 20 questions designed to measure an individual's understanding of emotion experience. In particular the instrument is used to determine a participant’s ability: to identify feelings (e.g., "I am often confused about what emotion I am feeling"); to describe feelings (e.g., "It is difficult for me to find the right words to describe how I am feeling"); in externally (or internally) oriented thinking (e.g., "I prefer to analyse problems rather than just describe them"). Participants are required to rate how much they agree with each statement on a five point Likert Scale (1 = strongly disagree; 5 = strongly agree). Therefore, scores range from 20 up to 100. The TAS-20 has evidence of internal consistency and test retest reliability (Bagby, Parker & Taylor, 1994).

2.2.2.4 Empathy. Empathy is generally considered as the ability an individual has to share and understand the emotion of another person (Shaffer & Kipp, 2007). This definition suggests that there is a cognitive (understanding) element as well as an affective (emotion experience) function to empathy and is in line with researchers such as Davis (1983, 1994) and Baron-Cohen and Wheelwright (2004). However, beyond this there is little consensus as to what constitutes empathy (Baldner & McGinley, 2014). Some theorists believe that empathy is multidimensional concept that includes situational and dispositional empathy (Davis, 1983). Specifically, situational empathy refers to the level of empathy an individual has in a given situation; whereas, dispositional empathy is considered to be relatively stable as it is the level of empathy typical of an individual (Davis, 1983).

Regarding age-related differences of empathetic ability in adulthood some evidence suggests that OAs have lower levels of cognitive empathy than YAs but the age groups do not differ in emotional empathy (Beadle et al., 2012; Phillips, MacLean & Allen, 2002). Furthermore, Hoffman (1984) stated that individual differences in empathy might account for differences in emotion processing; thus implying that empathy may influence emotion recognition ability. Indeed self-reported low empathy is related to lower emotion recognition scores (Sucksmith, Allison, Baron-Cohen, Chakrabarti, & Hoekstra, 2013). Taken together evidence suggests that it is important to understand age group differences in empathy when investigating age-related emotion recognition ability in OAs.

A popular measure of empathy in research is the Interpersonal Reactivity Index (Davis, 1980). This self-report task includes tests for cognitive and affective empathy. The task includes 28 items constituting four subscales (perspective-taking, empathetic concern, personal distress, and fantasy). However, the fantasy scale tends to diverge from the concept of empathy as an emotional and cognitive reaction to a real event and may, therefore, also measure imagination ability (Baron-Cohen & Wheelwright, 2004). For this reason the task was not used as a measure of empathy in the current research.

Instead the current study used the Empathy Quotient-Short (EQ-S; Wakabayashi et al., 2006) as this measure taps into both cognitive and affective empathy and is quick to administer. The 40 item self-report questionnaire is based on the full Empathy Quotient (EQ; Baron-Cohen & Wheelwright, 2004). Twenty-two of these items are test questions (e.g., "I can easily tell if someone else wants to enter a conversation") and eighteen are fillers (e.g., "People often tell me that I went too far in driving my point home in a discussion"). Participants are required to state how strongly they agree or disagree with each statement on a four point scale (strongly agree, slightly agree, slightly disagree, and strongly disagree). The possible total scores for the EQ-Short range from zero to 44. The EQ-Short has demonstrated reliability and internal consistency (Wakabayashi et al., 2006).

2.2.2.5 Affect. Mood is defined as a prolonged period of core affect that is not directly triggered by external stimuli (Russell, 2003). Further, people capable of high positive affect are considered to have better emotional-social intelligence (Bar-On, 2006). Thus, it is likely that high positive affect may also influence emotion recognition ability, an integral part of social intelligence (Feldman, Philippot, & Custrini, 1991). Furthermore, emotion recognition is enhanced with congruent, compared to incongruent, affective expressions and affective states (Schmid & Mast, 2010). Indeed, evidence suggests that negative affect may account for some of the emotion recognition differences between YAs and OAs (Phillips & Allen, 2004) including lower accuracy in recognition of sad facial expressions in OAs (Suzuki, Hoshino, Shigemasu, & Kawamura, 2007). More specifically, compared to controls induced sad mood in OAs and YAs resulted in higher rates of perceived intensity of sadness in sad faces for both age groups, whereas lower rates of perceived intensity of happiness in happy faces were reported for OAs but not YAs (Lawrie, Jackson, & Phillips, 2018). Therefore, mood states may influence emotion recognition depending upon age and emotion type. Thus, it is important to understand levels of affect in YAs and OAs when interpreting findings regarding age-related differences in emotion recognition accuracy.

Several tools are available that measure affect. A relatively new measure allows for affect to be distinguished between discrete emotion types (anger, disgust, fear, anxiety, sadness, happiness, relaxation, and desire) (Harmon-Jones, Bastian, & Harmon-Jones, 2016). Unfortunately, this tool was released for use too late for the current research but it would make an interesting instrument to link experiences and recognition of congruent discrete emotions. Alternative measures of subjective affect include the Brief Mood Introspection Scale (BMIS; Mayer & Gaschke, 1988), a self-report measure of positive and negative affect. In this task participants state how much of a feeling they have experienced (including jittery, peppy, happy, and tired) on a scale of "definitely do not feel", "do not feel", "slightly feel", and "definitely feel". However, the subjective feeling of peppy is not a common term, as such there may be individual differences regarding the definition and experience of this state. Furthermore, the scale includes "definitely do not feel", and "do not feel" but these are arguably the same response option; thus, there is redundancy in the scale. Other instruments that measure affect include The Profile of Mood States (POMS; McNair, Lorr, & Droppleman, 1981) measuring blends of emotions, and the Multiple Affect Adjective Checklist (MAACL; Zuckerman, Lubin, & Robins, 1965) measuring anxiety, depression, hostility, positive affect, and sensation seeking. However, the MAACL includes measures that may not reflect mood, such as sensation seeking, and the emotion blends in the POMS may not capture distinct positive and negative moods. Consequently, neither task is a suitable measure of positive and negative affect for the current research.

Therefore, to measure affect in the current research programme the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) was administered. This is quick and efficient measure of affect and is used extensively in the field (e.g., Demenescu, Mathiak, & Mathiak, 2014). The task includes 20 emotion words (ten positive such as "interested" and ten negative words including "scared"). Participants rate how much of each affective state they are experiencing at the present time using a five point Likert Scale (very slightly or not at all [1] to extremely [5]). Scores are calculated by summing the ratings for the positive words and negative words, giving two separate measures of affect. The maximum score within each subset is 50 and the lowest score is 10. The validity and reliability of the scale is reported in detail in Watson, Clark, and Tellegen (1988).

2.2.2.6 Anxiety. Anxiety is the physiological, psychological, and behavioural response to experiencing or anticipating a negative situation (McNaughton & Gray, 2000). Spielberger (1972) suggested that there are two forms of anxiety: state anxiety refers to arousal within an individual in response to an event, whereas trait anxiety explains individual differences in sensitivity to anxiety. Individuals with high sensitivity to anxiety may use coping strategies to avoid anticipated negative experiences (McNaughton & Gray, 2000). However, those with maladaptive levels of anxiety may have an attention bias towards negative threatening situations (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007). Furthermore, it has been found that non-clinical individuals with higher levels of state anxiety may attend to threatening information more than individuals with lower state anxiety (Mogg, Bradley, De Bono, & Painter, 1997). Thus, levels of trait and state anxiety may differentially influence attention to negative stimuli and this may have implications for recognising negative emotions. For example, adults with high trait anxiety accurately recognised fearful faces more than adults with lower levels of trait anxiety (Surcinelli, Codispoti, Montebarocci, Rossi, & Baldaro, 2006). It is currently unclear how any differential levels of anxiety between YAs and OAs may impact on emotion recognition ability. Research suggests that OAs have lower levels of anxiety than YAs and this may impact on perceived emotion intensity from stories (Phillips & Allen, 2004). Specifically in that study, compared to YAs, OAs had lower levels of depression and anxiety and rated happy and sad faces as less intense. It is possible therefore, that the positive emotion state in OAs reduced intensity ratings, whereas the more negative emotion state of YAs led to increased perceptions in levels of emotion intensity (Phillips & Allen, 2004). Given the possible influence of anxiety on emotion recognition ability it is prudent to understand whether age-related emotion recognition differences can be explained in terms of age group differences in levels of anxiety.

Several instruments can measure levels of anxiety including the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) and the Becks Anxiety Inventory (BAI; Beck, Epstein, Brown & Steer, 1988). These measures, however, have evidence that they may not be suitable to use with older adults due to either reduced validity (Julian, 2011) or recording of physical manifestations of anxiety that may be similar in physical characteristics to medical conditions that are more likely to exist in OAs than YAs, such as increased heart rate (Morin et al., 1999). Therefore, to account for any possible associations between anxiety levels and emotion recognition ability a measure of both state and trait anxiety was administered in the current research. The State and Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg & Jacobs, 1970) is a 40 item self-report measure of anxiety. Twenty items assess state (current) anxiety (e.g., I feel calm) and trait (general) anxiety (e.g., I am content). Participants state how often they experience the situation on a four-part scale ranging from "almost never" to "almost always". Scores are summed for each subsection and range from twenty to eighty.

2.2.2.7 Personality. In brief, personality concerns an individual's typical behaviour, thought processes, and experience of emotions and affect (Shiner & Caspi, 2003). Trait theories of personality suggest that the several factors that constitute personality are relatively stable over the lifespan (Cattell, 1965; Eysenck, 1947). Specifically, the Big Five trait theory proposes that personality comprises of five facets: openness, conscientiousness, extroversion, agreeableness, and neuroticism (Costa & McCrae, 1992). The personality test used in Phase 1 is based on this theory.

It is important to measure personality, as it is feasible that certain personality traits may influence emotion recognition ability. For example, neuroticism is characterised by high anxiety, irrational behaviour, and emotional instability (Eysenck & Eysenck, 1985a). The high emotion responsiveness suggests that a neurotic individual may have a high awareness of emotional information and this may lead them to have increased emotion recognition ability (Mayer & Salovey, 1988). On the other hand individuals high in neuroticism may avoid negative emotion experiences to protect themselves from negative emotions and this in turn may limit observations of negative emotion in others (Matsumoto et al., 2000). It is unclear which of these arguments is most accurate; however, regardless of the opposing opinions it is possible that emotion recognition ability may differ between individuals depending on their levels of neuroticism. Therefore, it is important to consider the levels of neuroticism in OAs and YAs when interpreting any age group differences in emotion recognition ability.

In a similar fashion individuals high in openness to experience are likely to feel intense and varied emotion states, whereas low levels of openness may indicate less sensitivity to emotionally arousing information (Costa & McCrae, 1992; McCrae & Costa, 1997). Furthermore, individuals with high levels of openness should display an interest in others including their emotion state (Matsumoto et al., 2000). Again evidence suggests that individuals with higher levels of openness are more able to recognise facial expressions of emotion than those who have low levels of openness (Zhang, Song, Liu, & Liu, 2016).

Further, extraversion is a trait that reflects the ability to socialise and is linked with optimism and friendliness, sociability and impulsiveness (Eysenck & Eysenck, 1985a; Rocklin & Ravelle, 1981). High levels of extraversion are associated with increased intensity and frequency of facial displays of positive affect (Ruch & Deckers, 1993). Furthermore, to achieve social goals an individual high in extroversion should be motivated to read the emotion state in others (Matsumoto et al., 2000). It should be expected, therefore, that individuals high in extroversion should have good emotion recognition ability. Likewise, the trait of agreeableness is classified as having modesty, and being of tender mindedness (Costa & MaCrae, 1985) and these attributes are relevant for social interaction (Maltby, Day, & Macaskill, 2010). However, evidence regarding relationships between emotion recognition ability and extraversion or agreeableness is scarce. Taken together some of the Big Five personality traits may influence emotion recognition accuracy but the extent of the effect may differ across personality traits and further evidence is required to substantiate the relationships.

Evidence suggests that, perhaps due to greater emotion control, levels of neuroticism, extroversion, and openness declines with age, whereas levels of agreeableness and conscientiousness increase with age (McCrae et al., 1999). Despite reported differences in personality traits between OAs and YAs, little research has investigated the role of personality traits on emotion recognition ability in OAs (except see Mill, Allik, Realo, & Valk, 2009). However, given the findings that at least some personality traits may affect emotion recognition accuracy it is worthwhile to understand age group differences in the Big Five.

There are several measures of personality including the Multidimensional Personality Questionnaire (MPQ; Tellegen & Waller, 2008) and the Eysenck Personality Inventory (EPI; Eysenck, 1964). These tasks differ regarding the numbers of facets of personality; the MPQ is a very broad measure of personality (Rushton &

Irwing, 2009), whereas the EPI includes only three personality traits. The current study used the NEO-Five Factor Inventory (NEO-FFI; Costa & McCrae, 1992) as it provides a middle ground between the MPQ and EPI regarding the numbers of traits measured, is a widely used research tool (e.g., Williams et al., 2006), and has evidence of validity and reliability (Robins, Fraley, Roberts, & Trzesniewski, 2001). In this manner, the NEO-FFI was considered by the researcher to be the most suitable instrument to measure personality traits.

The NEO-FFI is a self-report measure that taps into five factors of personality: openness (e.g., "Once I find the right way to do something, I stick to it"); conscientiousness (e.g., "I keep my belongings neat and clean"); extroversion (e.g., "I like to have a lot of people around me"); agreeableness (e.g., " I try to be courteous to everyone I meet"); and neuroticism (e.g., "I am not a worrier"). Each subcategory has twelve questions giving a total of 60 items. Participants are required to answer how strongly they agree or disagree with each statement on a five item scale (strongly disagree to strongly agree). Scores are calculated on the subscales within each trait type thus scores can range from 48 to zero.

2.2.2.8 Demographic information. A demographic questionnaire was designed by the researcher (see Appendix 2.4) and includes 10 main questions covering age in years, ethnicity, gender, education, work experience, computer literacy, and health status. In this manner, any differences between the OA and YA samples regarding education and the ratio of males to females can be understood. Furthermore, self-reported status for health, vision, and hearing screened participants as being suitable to take part in the research.

2.3 Participants

Seventy-two participants were recruited in Phase 1 of the current research and this exceeds, according to G*power analysis (Erdfelder, Faul, & Buchner, 1996), the number required to enable sufficient power to detect a statistical significance. To estimate the power needed in the current research the G*power parameters were set at a mixed 2*6 ANOVA with an effect size of 0.25[1] , and a family wise error rate (FWER) at $p < .05$; the results indicated a minimum requirement of 36 participants.

A voluntary sample ($N = 72$) responded to an advert placed on university websites and notice boards and sent to social organisations for retired individuals. YAs were university students (age range 18-29 years: 8 males and 28 females) and OAs were members of a local social society (age range 59-84 years: 12 males and 24 females). However, one OA self-reported as having less than normal hearing; thus, their data was not used in some of the final analysis as they did not conduct the audio task. This left an OA sample of 35 (age range 59-81 years; 11 males and 24 females). Importantly to reduce possible effects of sample differences the same adults were invited to complete all three experiments in Phase 1. All participants received either a £10 high street voucher or course credits in return for their time.

The age groups did not significantly differ in the proportion of males and females, $\chi^2(1, N = 72) = 0.29$, $p = .430$, with a small effect Cramer's V = 0.12. However, it is noted that there were more females in the study than males and this needs to be considered when interpreting the results. The age groups were also matched on level of education, as there was no association between the age groups on the highest level of qualification attained when collapsed across three categories (i.e., no qualification, GCSE/O'Level, and Higher Education) with most of the YAs and OAs

[1] This effect size errs on the side of caution as it represents some of the smaller effect sizes reported in the meta-analysis of age-related emotion recognition research by Ruffman et al. (2009).

falling into the higher education category, $\chi^2(2, N = 72) = 5.37$, $p = .054$, with a small effect size Cramer's V = 0.27 (YA = 100% higher education; OA = 86.1% higher education). OAs, however, had spent more years in education than YAs.

Whilst all participants self-declared as healthy and lived independently it is prudent to screen for cognitive health in age-related research due to possible cognitive changes with age. The majority of research in the field uses the Mini Mental State Exam (MMSE; Folstein, Folstein, & McHugh, 1975) as a screening tool. There are as many as 39 measures designed to detect cognitive impairment (Cullen, O'Neill, Evans, Cohen, & Lawlor, 2007). For example, the Mini Cog (Borson, Scanlan, Chen, & Ganguli, 2003), which includes a three-word memory task and clock-drawing task, is freely available to clinicians (Cordell et al., 2013). However, the current study is not attempting to diagnose dementia, rather a tool was required that could detect cognitive impairment over and above that expected for the individual's age. Indeed the MMSE has some overlap with the Mini Cog as it also includes a word memory and clock task but the MMSE has evidence that it is the most sensitive of the available tools to detect moderate cognitive impairment (Cordell et al., 2013). Given that short tasks, such as the Mini Cog, have evidence for detection of cognitive impairment and that the MMSE is the most commonly used cognitive screening tool used in research, the MMSE-2 Brief Version (MMSE-2 BV; Folstein, Folstein, White, & Messer, 2010) was deemed to be a suitable measure in the current research. Moreover, the MMSE-2 BV is suitable for quick screening and this was important to avoid participant fatigue due to the extensive test battery. Further, the MMSE-BV has evidence of validity as it includes the most sensitive indicators of cognitive change in the MMSE as well as good test-retest reliability (Folstein, Folstein, White, & Messer, 2010). As such the MMSE-2 BV is a suitable research measure of cognitive health.

The MMSE-2 BV provides a brief measure of immediate and short-term memory as well as testing understanding of place and time. A point is awarded for each correct answer with a possible maximum score of 16. A performance target was set for the MMSE-BV to increase the likelihood that OAs and YAs were matched on cognitive function. However, age-related research has used various parameters for the MMSE-BV from 10/16 (Walsh, 2013) up to 13/16 (Finger et al., 2014). To reflect the more stringent of these criteria and so reducing the chances of age-related cognitive demise influencing the experimental findings the MMSE BV cut off was set at 13/16. All of the OAs achieved this score with the exception of one who achieved 12/16 and this was within the norms for age and education level and removal of the data did not materially change the current results. It is typical that OAs are screened for cognitive health but in the current study YAs also completed the MMSE-BV to ensure that YAs and OAs were matched on cognitive functioning ($p > .05$) (see Table 2.3.1). Thus as a sample there was no evidence of detrimental cognitive decline in the OAs compared to YAs.

Further to declines in some cognitive functions with age OAs are also susceptible to reduced sensory abilities. It is possible that a decline in sensory abilities such as hearing and sight with age may reduce OAs' competence on the tasks; however, hearing differences do not appear to account for age-related differences in emotion recognition ability from auditory stimuli (Dupuis & Pichora-Fuller, 2015; Orbelo, Grim, Talbott, & Ross, 2005). Thus an objective measure of hearing and vision was not included. Instead, participants self-reported as having normal or adjusted to normal hearing and vision.

In an attempt to mirror the anticipated characteristics of the university students, whom constituted the YAs sample, the OAs were specifically recruited from a social group that promotes physical and intellectual activities. However, despite this, the YA and OA samples may differ on characteristics that may influence emotion recognition ability. It was important, therefore, to understand the cognitive, socio-emotional, mood and personality profile of the samples so that any age-related differences in emotion recognition ability can be more confidently attributed to emotion processing rather than some other influencing characteristic.

Table 2.3.1 details the descriptive statistics and where appropriate the inferential statistics comparing YAs and OAs on the measured sample characteristics. In summary, OAs and YAs were similar in levels of fluid intelligence, extroversion, and empathy. In contrast, compared to YAs, OAs had lower levels of alexithymia, negative affect, state and trait anxiety alongside higher levels of conscientiousness, agreeableness, openness, verbal intelligence, and positive affect. The OAs also had slower processing speed than YAs. Therefore, with the exception of processing speed OAs appear to be not disadvantaged, compared to YAs, on many of the potential confounds to emotion recognition ability. In this manner, any age-related emotion recognition deficits in OAs are unlikely to result from many of the potential confounding variables including intelligence, alexithymia, or empathy.

Table 2.3.1
Characteristics of the Younger and Older Adults who Took Part in Phase 1

	Younger adults		Older adults				95% CI		
Measure	*M*	*SD*	*M*	*SD*	*t* (70)	*p*	*LL*	*UL*	*d*
Age (years)	20.19	2.71	70.53	5.92					
Education (years)	14.99	1.73	16.89	3.51	3.43	.006	-3.14	- 0.55	0.69
Alexithymia (100)	46.42	9.54	39.06	9.65	3.26	**.002**	2.85	11.87	0.77
Positive affect (50)	27.22	6.26	34.75	5.61	5.37	**<.001**	-10.32	-4.73	1.27
Negative affect (50)	12.56	3.60	10.81	2.40	2.43	**.018**	0.31	3.19	0.57
State anxiety (80)	33.31	7.13	25.22	5.59	5.35	**<.001**	5.07	11.10	1.26
Trait anxiety (80)	43.89	10.77	34.31	7.33	4.41	**<.001**	5.24	13.92	1.04
Empathy (44)	25.92	8.16	25.14	6.84	0.44	.663	-2.76	4.32	*ns*
Verbal intelligence (44)	26.81	3.98	37.70	3.41	12.45	**<.001**	-12.63	-9.15	2.94
Fluid intelligence (30)	18.53	2.60	19.42	3.24	1.28	0.203	-2.27	0.49	*ns*
MMSE-BV (16)	15.03	0.91	15.08	1.05	0.24	0.811	-0.52	0.41	*ns*
Speed of processing (35)	21.75	4.18	16.97	3.36	5.35	**<.001**	3.00	6.56	1.26
Neuroticism (48)	25.33	8.48	15.28	7.93	5.20	**<.001**	6.20	13.91	1.22
Extroversion (48)	28.50	6.78	28.17	5.33	0.23	.817	-2.53	3.20	*ns*
Openness (48)	27.17	5.41	30.17	6.86	2.06	**.043**	-5.90	-0.10	0.49
Agreeableness (48)	30.06	6.36	34.56	6.18	3.05	**.003**	-7.45	-1.55	0.72
Conscientiousness (48)	28.08	8.21	36.94	6.14	5.19	**<.001**	12.27	-5.45	-1.22

Note. CI = confidence interval; LL= lower level; UL = upper level, ns = nonsignificant; For most measures higher means are seen as positive with the exception that lower scores are more desirable for alexithymia, negative affect, anxiety and neuroticism; (X)=maximum possible score

2.3.1 Comparing the current sample to normative data.

It is also important to understand whether the participants in the current study are typical of the general population by comparing the mean scores to normative data where available. The norms for the PANAS are based on adults ranging in age from 18-91 years; the mean score for positive affect was 31, whereas the mean score for negative affect was 16 (Crawford & Henry, 2004). The OAs in the current study tend to have higher levels of positive affect, whereas the YAs tend to have marginally lower levels of positive affect than the normative data would suggest as typical. In contrast, both OAs and YAs in the current study appear to have lower levels of current negative affect than normative data would suggest is typical.

Regarding emotion understanding the OAs appear to have lower levels of alexithymia than the normative data would suggest as typical, whereas YAs seem to have typical levels (Mean = 45.57; SD = 11.35) (Parker, Taylor, & Bagby, 2003). Therefore, the age group difference between YAs and OAs for alexithymia in the current study is likely to be exaggerated by the atypical levels in the OA participants. Furthermore, the level of empathy in YAs and OAs is similar to the normative data (M = 27.5) (Wakabayashi et al., 2006).

Turning to intelligence, the OAs appear to be on the 90th percentile but the YAs appear to be on the 50th percentile for fluid intelligence (Raven, 2008). However, there is no normative data available for only the multiple-choice section for verbal intelligence. Finally, regarding personality traits YAs seem to have higher levels of neuroticism than norms (M = 19.50), whereas OAs have lower levels; both age groups are similar to the normative data for extroversion (M = 27.10); YAs have similar levels of openness to the norms (M = 26.50) but OAs have higher levels than the normative data; YAs have lower levels of agreeableness (M = 34.56) but OAs have higher levels than the normative data; finally, YAs have lower levels of conscientiousness, whereas OAs have higher levels than normative data (*M* = 32.10) (Egan, Deary, & Austin, 2000).

Taken together, the findings suggest that the OAs and YAs samples are marginally dissimilar to the normative data on many characteristics. However, the scores are not vastly different to the norms so the samples largely reflect the population. Moreover, age corrected norms suggest that the OAs in the current study appear to be at the higher end of the population for fluid intelligence and this needs to be considered when interpreting and generalising the results.

2.3.2 Younger-older and older-older adults.

To gain a more fine grained understanding of emotion recognition development in older age younger-older adults (*n* = 18; *M* age = 65.67 years; *SD* = 2.81) and older-older adults were compared (*n* = 18; *M* age = 75.39 years; *SD* = 3.78). The full sample characteristics of the split age groups are provided in the appendices (see Appendix 2.5). In summary, with a few exceptions comparisons between the YAs and the two older age groups were similar to the comparisons between the YAs and OAs. However, the younger-older adults had significantly higher levels of fluid intelligence than both older-older adults and YAs. Younger-older adults also had higher scores on MMSE than older-older adults although there was no significant difference between either of the older age groups and YAs. Finally, younger-older adults had faster processing speed than older-older adults. No other comparisons reached significance (*p*s > .05).

2.4 Procedure

All of the participants completed the tasks individually, in a quiet room. At the start of the session participants first read the participant information sheet and gave informed consent (see Appendix 2.6 and 2.7) then the MMSE 2-BV (Folstein, Folstein, & McHugh, 1975) was administered to ensure that the participants met the cognitive functioning criteria, and this was followed by the demographic questionnaire. Next half of the sample completed the computer-based tasks then the standardised tasks (i.e., the emotion and non-emotion tasks were followed by the pen and paper measures) and the other half of the sample conducted the standardised tasks before the computer-based tasks (i.e., the pen and paper tasks were followed by the emotion and non-emotion tasks). The order of the computer-based tasks was counterbalanced across presentation types (facial expressions, non-verbal vocalisations, and single words) and content type (emotion and non-emotion) to avoid carry over or fatigue effects. However, the tasks within the same presentation type were administered in succession to each other, for example, the two face tasks were conducted one after the other. The order for the administration of the standardised tasks, with the exception of the MMSE-BV, was also counterbalanced.

For the computer-based tasks the laptop computer was positioned at a comfortable distance approximately 40 cm away from the participant and a six-button response box was set in front of the laptop. As a guide the response buttons were labelled with numbers one to six with the corresponding option label above the buttons (see Figure 2.5.1). The researcher read standardised instructions before each task and these were summarised on the computer screen at the start of each experiment (see Appendix 2.8, 2.9, and 2.10). In brief the participants were required to decide which of the presented labels best described the stimulus and enter the response using the response box. For example, on the emotion face task the participants were required to select which of the labels (happy, sad, fear, anger, disgust, or neutral) they believed best represented the emotion presented in the facial expression. The participants were asked to respond as accurately and quickly as possible and were informed that they had four seconds to respond to each stimulus. Participants completed eight practice trials before commencing with the experimental task. The stimuli in the practice trials, although similar to that of the experimental trials, did not appear in the experimental trials. If participants failed to reach 50% accuracy on the practice trials they were given the opportunity to repeat it. This was to ensure that participants understood the task instructions. Participants were given the chance to have any questions regarding the task answered by the researcher both before and after the practice trials. When the participant was ready they continued onto the experimental phase. The same procedure was repeated for all six computer-based tasks.

For the standardised tasks participants followed the instructions provided on the forms and the researcher verbally reiterated these. To reduce the length of the session and to avoid stress and fatigue the participants only completed half of the Raven's Progressive Matrices Task (answered odd numbers only). In addition, participants were allowed to take a break at any time should they wish to. The OAs took longer to complete the session (approximately 1.5 hours but a few participants took up to 3.5 hours including breaks) than the YAs (approximately 1 hour and none elected to have a break). Upon completion of the tasks participants were debriefed (see Appendix 2.11) and thanked for their time.

2.5 Instruments

The emotion and non-emotion tasks were run, on an HP Elite book laptop with a 16-inch monitor, via E prime 2 software (Psychology Software Tools, Pittsburgh, PA). The responses to these tasks were entered via a six-button response box (see Figure 2.5.1). Finally a stopwatch was used to measure the time on the speed of processing task.

Figure 2.5.1. The response box used in the computer-based tasks.

2.6 Treatment of the Data

2.6.1. Missing data.

The data for the standardised tasks was reviewed for missing data. It is important to deal with missing data effectively as it might reduce the power to find a significant outcome and might alter the bias of the data (Roth, 1994). In the current research mean imputation was used for replacing missing data in the standardised tasks, as this is a traditional method for dealing with missing data (Scheffer, 2002). The advantage of mean scores imputation is that data is retained for analysis, which would otherwise be lost using a deletion method (removal of all of the participant's data) (Roth, 1994). In all four participants (three OAs and one YA) had missing data for speed of processing, and two adults (one OA and one YA) had missing data for fluid intelligence. Missing data on the computer-based tasks resulted from time outs. Information regarding the percentage of time outs per emotion for each presentation type for OAs and YAs is reported in Appendix 2.12. In summary, OAs had more time outs for each emotion and across all presentation types than YAs.

2.6.2 Assumptions for parametric tests

The data in Phase 1 and Phase 2 were investigated for skewness and normality. Skewness refers to how the data deviates from a normal distribution curve (Field, 2012). Skewed data violates the parametric assumption of normal distribution. Most of the data met acceptability of skew, set at 1.96 for $p > .05$ (Field, 2012) (see Appendix 2.13). Normality is how the data fits with population data and it suggests that a sample is representative of the target population (Field, 2012). Problems with normality may lead to a false *p* value in the statistical analysis. In the current research normality was determined by investigating histograms and the Shapiro Wilk Test (see Appendix 2.14). Not all of the data met the criteria of normality, however, the size of the sample in the current research (N =72) is considered to be a large dataset thus should naturally reflect the target population hence normality should not be an issue (Field, 2012; Sauro, 2013). Finally, tests of homogeneity of variance determine whether variations within the data are similar between conditions (Field, 2012). This was determined in the current research with Levene's Test of Variance. Where homogeneity of variance is violated ($p < .05$) then non-assumed variance is reported.

2.6.3. Controlling for multiple comparisons.

When determining statistical significance using a *p* value set at the family wise error rate (FWER), $p < .05$, researchers accept a 5% (alpha level of 5%) chance that the significant result might be an error, this is known as a Type I error (Feise, 2002). That is there is a 5% chance that an effect is said to be significant when in fact there is no effect in the target population. The probability of making a Type 1 error increases with the number of comparisons made (assuming that the comparisons are independent of each other). As a result a true null hypothesis might be rejected unless the inflated possibility of making the error is controlled. Bonferroni correction (Holm, 1979) is a popular method used to lower the statistically significant threshold rate and is calculated by dividing FWER ($p < .05$) by the number of comparisons made (Morgan, 2007). This correction is useful but the FWER might become very low when a high number of comparisons are required; thus may lead to Type II errors, a false null hypothesis is retained when an effect is actually present. In the current thesis to control for the inflated chance of Type 1 errors Bonferroni corrections were applied when up to three comparisons were made. However, when controlling for Type 1 errors across several comparisons Bonferroni corrections are considered too conservative and may lead to Type 2 errors (Streiner, 2015). Alternative tests for controlling for the effects of multiple comparisons include the Sidak test, Holms corrections, and the Hochberg method (Streiner, 2015). However, these tests are often as conservative or nearly as conservative as Bonferroni corrections. For example, some of the analysis in the current research includes six or 15 comparisons giving Bonferroni corrections of .0083 and .0033 respectively. These alpha levels would also apply to the lowest *p* value in the Holms test, and possibly in the Hochberg method, whereas the Sidak test using the equation $1\text{-}(1\text{-alpha})^{1/n}$, gives an alpha level at .0085 or .0034 for 6 and 15 comparisons respectively, similar values to the Bonferroni test. Thus there appears to be little or no advantage of using these tests over Bonferroni corrections in the current research.

The problem with the low alpha levels is that by controlling for Type 1 errors we increase the chance of making Type 2 errors (Mudge, Baker, Edge, & Houlahan, 2012). Some researchers are so concerned about the implications of making Type 2 errors that they argue that Bonferroni, or similar, corrections are not necessary (Perneger, 1998). However, these arguments are mainly presented for clinical studies where the implications of a Type 2 error can have extreme consequences. The debate around how best to control for Type 1 and Type 2 errors continues and there is not a consensus on how to achieve a reasonable balance between the two.

Given that the named methods for controlling for Type 1 errors appear to be as conservative as Bonferroni corrections I used an alternative approach. To reduce the chance of making either Type 1 or Type 2 errors alpha was set at 1% ($p < .01$). The rationale for this specific value is that *p* values have been classed at conventional levels as highly significant ($p < .01$), marginally significant ($p < .05$), and not statistically significant ($p < .10$) (Gelman, 2012), therefore by adopting the stricter of these values we are likely to detect highly significant results. Furthermore, this alpha level has been used in previous research including Cain et al. (2004) and Calvo and Castillo (2001) so is deemed acceptable practice to control for the chance of inflated Type 1 errors and reducing the chance of Type 2 errors.

However, the all or nothing approach to simply interpreting data based solely on *p* values has been criticised (for a review see McLean & Ernest, 1998). Several other factors should be considered when interpreting statistical significance including the risk of Type 2 errors, as discussed above, and the size of the effect (McLean & Ernest, 1998). Given the somewhat strict alpha level in the current research the effect sizes will be used to interpret marginal results (values that can be rounded down to the set alpha level; specifically those values between $p = .01$ and $p = .014$) in that medium to large effect sizes will be considered as marginally significant results.

2.6.4 Effect size.

When considering statistical significance, the probability that there is an effect in the population, it is also important to understand the size of the effect (Feise, 2002). For the current research the following effect sizes are used: Cohen's *d* (Cohen, 1969) for t tests, partial eta squared (η_p^2) for ANOVA analysis, and Pearson's *r* for parametric correlations or Spearman's *rho* for non-parametric correlations (see Table 2.6.1 for definitions of the sizes of the effects). As stated above effect sizes will be used to interpret marginally significant/nonsignificant findings throughout this thesis.

Table 2.6.1.

Estimates for the Size of Effect (Cohen, 1992)

Effect size	Cohen's *d*	ηp^2	Pearson's r or Spearman's rho
Small	0.2	0.01	0.1
Medium	0.5	0.06	0.3
Large	0.8	0.14	0.5

2.7. Summary

The experiments in Phase 1 were carefully designed to be procedurally similar to each other in that they required participants to attend to the stimuli, make categorical judgements, select a response from six labels, and enter a motor response by pressing a button on the response box. In addition each task had the same number of trials and a 4000 ms response limit. Not only were the three emotion tasks matched for processing demands, as far as possible, but also the emotion and non-emotion tasks within a specific experiment were visually and procedurally similar to each other, so that task demands were as comparable as possible. The careful design of the tasks allows for meaningful comparisons to be made both across the presentation types and between the emotion and non-emotion tasks. Furthermore, many sample characteristics were measured to help interpret results, as age-related differences in emotion recognition may reflect indirect effects of another variable. The characteristic profile of the OAs compared to that of the YAs suggests that, with the exception of processing speed, the direction of any age-related differences in the measured cognitive abilities, socio-emotion skills, and personality traits are unlikely to reduce OAs' ability to recognise emotions.

Chapter 3 – Experiment 1: The Effect of Age on Emotion Recognition from Static Faces

3.1. Introduction

Experiment 1 is the first in a series of three experiments that were designed to investigate emotion recognition in older adults (OAs) using tasks that were controlled for possible methodological confounds. The subsequent experiments are reported in Chapters 5 (non-verbal vocalisations) and 6 (single words) but this chapter focuses on static faces. Each experiment included an emotion recognition task as well as a non-emotion task with both tasks closely matched on tasks demands. All three chapters need to be considered together to give a broad understanding of emotion recognition ability in OAs (see Chapter 6). Importantly, compared to YA participants the OA participants were not disadvantaged in many aspects that may influence emotion recognition ability such as extroversion, empathy, alexithymia, and intelligence. Thus findings can be more confidently attributed to emotion recognition ability rather than previous research that has not accounted for these abilities.

To allow for comparisons with previous research it is important for the current study to include an emotion recognition task using static facial expressions. The literature in the field provides evidence that OAs, compared to YAs, have difficulties in recognising emotions from faces (e.g., Demenescu, Mathiak & Mathiak, 2014; Grainger, Henry, Phillips, Vanman, & Allen, 2015; Sasson et al., 2010). Furthermore, a meta-analysis suggests that OAs are less accurate than YAs at recognising the negative emotions of sadness, fear, and anger (Ruffman, Henry, Livingstone, & Phillips, 2008). However, it should be noted that not all studies report emotion recognition deficits for all three emotions. For instance, as shown in Table 1.1 (Appendix 1.1) of the 18 studies that measured emotion recognition of fear, anger, and sadness from static faces only six studies reported recognition deficits in OAs, compared to YAs, across all three emotion types. Moreover, in the same 18 studies OAs were less able than YAs to recognise fear or anger in 11 studies and deficits for sadness were observed in 15 studies. Whilst the evidence suggests that OAs are less able than YAs to identify at least one negative emotion the specific emotion deficit can differ between studies. The fact that some studies failed to find emotion recognition difficulties in OAs for fear and anger, and to a lesser extent sadness, demonstrates that some inconsistencies exist in the field regarding which emotion types OAs are less able to recognise than YAs.

The observed between-study variations for age-related recognition deficits in OAs for fearful, angry, and sad faces also extend to other emotion types including happiness and disgust. For example, OAs are less able than YAs to recognise happiness from static faces in four out of 18 studies included in Table 1.1, whereas other findings suggest there are no differences in recognition ability for happiness between OAs and YAs. Regarding disgust recognition from static faces four studies indicate that OAs are more able than YAs, four other studies state that OAs are less able than YAs, and ten studies report no differences between the age groups (see Table 1.1). Therefore, OAs' recognition ability for disgusted and happy faces remains unclear.

The variation in findings in the field may reflect methodological differences between studies, such as the number of response options, and these limit cross-study comparisons. Furthermore, few studies attempt to account for many of the potential differences in sample characteristic between OAs and YAs. It is possible that these methodological and sample differences can account for some of the between-study inconsistencies regarding which emotions are difficult for OAs to recognise compared to YAs.

Methodological differences can include variations in task demands such as: time constraints (self-paced versus restricted time); working memory demands (whether or not the face is visible when the response is given); and processing demands (more forced-choice options requires increased processing demands as additional options need to be eliminated before arriving at a decision). The established decline in several cognitive domains with natural aging (e.g., Hartshorne & Germine, 2015) may mean that OAs are disadvantaged more than YAs with an increase in the task demands. Thus, OAs may have lower emotion recognition ability than YAs when tasks are more demanding.

Given the possible effect of task demands on emotion recognition accuracy it is important to try to isolate the ability to meet task demands from emotion processing. A non-emotion task can be used to measure processing ability in the absence of emotion content. However, as documented in previous chapters comparisons between emotion and non-emotion tasks are best achieved when the tasks share similar task demands, procedures, and stimuli. Essentially the main difference between the current emotion and non-emotion tasks was the type of judgement that participants were required to make, for instance whether between emotion types or by sex and age group. To the researcher's knowledge the current experiment is the first to use an emotion and non-emotion task that have been carefully designed to reduce the methodological differences between the tasks as far as possible.

In addition to the differences in methodology, between-studies dissimilarities in sample characteristics including cognitive abilities, emotional skills, or personality traits may account for the variability in findings in the field, as is discussed below. If sample differences are not understood then it is difficult to explain any age-related emotion recognition deficits in OAs as a function of difficulties in emotion processing, as the impairments may arise from other confounding group differences. Unfortunately, there is inconsistency across studies in the field regarding which cognitive, emotion, or personality aspects are measured alongside emotion recognition ability (see Table 3.1 in Appendix 3.1). These omissions present two main challenges: First, it is difficult to understand which characteristics may affect emotion recognition ability in OAs. Second, it remains unclear whether findings in some previous studies might be better explained by age-related differences in a variable other than emotion recognition ability, per se.

Many studies in the area have, however, included a measure of education; education is a useful measure as it is related to levels of intelligence and social economic status (Rindermann, 2008). Findings from these studies suggest that when OAs either have significantly fewer years in education or lower education levels than YAs, then OAs appear to have age-related recognition deficits for numerous emotion types (e.g., Mill, Allik, Realo, & Valk, 2009; Orgeta & Phillips, 2009). In contrast, when the number of years in education is either matched or higher in OAs, compared to YAs, then OAs often appear to be less able than YAs to recognise one emotion from facial expressions or have a general decline (Circelli, Clark, & Cronin-Golomb, 2013; Grainger et al., 2015b; Suzuki, Hoshino, Shigemasu, & Kawamura, 2007). However, in one study OAs were matched with YAs on years in education and the OAs had recognition deficits for four out of the six emotions measured (Hunter, Phillips, & MacPherson, 2010a). Thus there are differences in the breadth of emotion recognition deficits between these studies and between-study variations in task demands may provide one possible explanation for these findings. For example, in the study conducted by Hunter, Phillips, and MacPherson (2010a) the availability of the stimuli was time restricted (5000 ms), whereas the stimulus was available until a response was given in other studies. Thus the findings indicate that higher memory demands may have greater implications on OAs' emotion recognition accuracy than years in education. Nevertheless, given the suggested pattern regarding education and age-related differences in emotion recognition ability between YAs and OAs, it is prudent for research in the field to match OAs and YAs on education level.

Whilst education maybe related to intelligence, intelligence also provides one measure of cognitive ability but the results in the field regarding the role of intelligence are somewhat complex. Some evidence suggests that when OAs and YAs were matched on both verbal and fluid intelligence then OAs were less able to recognise two out of six emotion types (Schaffer, Wisniewski, Dahdah, & Froming, 2009). However, similar age-related deficits are reported when OAs had lower levels of fluid intelligence coupled with comparable verbal intelligence to YAs (e.g., Phillips, MacLean, & Allen, 2002; Sullivan & Ruffman, 2004). Thus it appears that similar levels of intelligence in OAs and YAs may not protect against age-related emotion recognition deficits in OAs. It is possible, however, that lower levels of intelligence in OAs than YAs may exacerbate any age-related differences. To reduce this possibility OAs should be at least matched with YAs on levels of intelligence.

Few studies in the field using facial expressions have measured sample characteristics of personality, affect, empathy, and alexithymia; thus, it is unclear whether these variables can explain age-related differences in emotion recognition ability in OAs. However, it does appear from one study that OAs still have some emotion recognition deficits compared to YAs when age groups are matched on the big five personality traits and alexithymia (Keightley, Winocur, Burianova, Hongwanishkul, & Grady, 2006). Therefore, to understand whether any differences in emotion recognition ability between OAs and YAs are direct or indirect effects, the findings need to be discussed within the context of age group differences in characteristics that may influence emotion recognition ability, such as alexithymia, anxiety, and empathy (Parker, Taylor, & Bagby, 1993; Surcinelli, Codispoti, Montebarocci, Rossi, & Baldaro, 2006; Sucksmith, Allison, Baron-Cohen, Chakrabarti, & Hoekstra, 2013).

In addition to the differences between OAs and YAs, OA samples may vary between studies on several aspects, such as age. For example, due to natural aging older-older adults, typically over 70 years of age, are likely to have more advanced cognitive and neurological changes than younger-older adults, between 60-70 years of age (Zec, Markwell, Burkett, & Larsen, 2005). These progressive changes may account for some of the between-study variations in the number of age-related emotion recognition deficits. It may be expected then that older-older adults will have recognition deficits across more emotion types than younger-older adults.

In summary, the between-study methodological and sample differences may help to explain the variations of findings in the field. Importantly, methodological inconsistencies and a failure to account for possible confounding characteristics between the age groups makes it difficult to understand the extent of age-related differences in emotion recognition ability. The current experiment was designed to address these issues by using an emotion recognition task that is comparable to preceding research in that it uses static facial expressions and a forced-choice task. Essentially however, the experiment was carefully designed to tighten up some of the methodological issues observed in previous research including controlling for unnecessary task demands. To reduce the possible impact of confounding sample differences the current study specifically recruited OAs who did not have lower levels of education, fluid and verbal intelligence, positive mood, and empathy, or higher levels of negative affect or alexithymia than YAs. In this manner it is unlikely that any age-related emotion recognition deficits in OAs result from these skills and traits; thus findings can be more confidently attributed to emotion recognition ability than some of the previous research in the area. Furthermore, to investigate the influence of advancing older age on task performance the current research not only compared accuracy for emotion recognition between YAs and OAs but comparisons were made between younger-older adults (59-69 years) and older-older adults (70 years and over). Finally, a non-emotion task was included in the experiment to determine whether any age-related differences in emotion recognition ability could be explained by OAs' and YAs' ability to conduct the task. To achieve this the aims of the experiment were:

- To use a task specifically designed to be similar to previous research using facial expressions in that the emotion recognition task was forced-choice and measured the recognition of five basic emotions plus a neutral option. However, the stimuli remained on the screen until the time limit was reached and the photographs of facial expressions had limited contextual cues.
- To measure many sample characteristics including education status, intellectual ability, empathy, alexithymia, personality traits, and current affect to help explain the findings regarding emotion recognition ability.
- To determine whether differences in emotion recognition ability between YAs and OAs could be explained by age group differences in the ability to meet the task demands, a non-emotion task with similar task demands to the emotion task was included.
- To understand whether emotion recognition ability deteriorates further with advancing older age findings were compared between younger-older and older-older adults.
- Finally, the emotion task was also designed to be comparable to the emotion recognition tasks used in Experiments 2 and 3.

3.2 Hypotheses

It was predicted that OAs would have lower emotion recognition accuracy than YAs. Particular age-related difficulties were anticipated when recognising at least one of the negative emotions of anger, fear, or sadness. Age-related declines for accurately recognising happy and disgusted faces were not expected. When comparing across three age-groups it was predicted that older-older adults would have more age-related emotion recognition deficits compared to the YAs and younger-older adults. Finally, it was hypothesised that OAs and YAs would not differ in face processing ability or the ability to meet the task demands, as measured by the non-emotion task.

3.3 Method

The experiment comprises of two tasks: an emotion recognition task and a non-emotion task. The general method including design and participant information for all of the experiments in Phase 1 of the research programme have been reported in Chapter 2. Further methodological detail that is specific to Experiment 1 is now given.

3.3.1 Materials.

The current experiment used images selected from the FACES database (Ebner, Riediger, & Lindenberger, 2010) as this database fulfilled the requirements of the experimental design including a degree of ecological validity (e.g., colour images); OAs were represented; expressions included different basic emotions; and the dataset had sufficient images to create the emotion and non-emotion tasks without the need to repeat any individual image. The importance of these criteria is now explained.

Emotion recognition research often uses a variation of the Ekman faces (i.e., Facial Expressions of Emotion: Stimuli and Tests [FEEST]; Young, Perrett, Calder, Sprengelmeyer, & Ekman, 2002; Japanese and Caucasian Facial Expressions of Emotion [JACFEE]; Matsumoto, & Ekman, 1988; Pictures of Facial Affect [POFA]; Ekman & Friesen, 1976; and the Hexagon task consisting of morphed images of one Ekman poser JJ [e.g., Calder et al., 2003; Sullivan & Ruffman, 2004]). Using variations of the same database provides consistencies within the stimuli across studies and enables informative comparisons (Suzuki, Hoshino, Shigemasu, & Kawamura, 2007).

However, the Ekman and Friesen (1976) dataset consists of black and white or grey scale photographs using photograph imagery of its time, so the images appear dated. Hence the resolution detail may not be as sharp as current photographic technology will allow and this, alongside the black and white format, further reduces ecological validity of the stimuli (Horning, Cornwall, & Davis, 2012). Furthermore, the expressions used in the Ekman and Friesen (1976) faces are based on prototypes that require facial muscle movements to be consistent with the Facial Action Coding System (FACS; Ekman & Friesen, 1978). This system uses action codes that represent a particular configuration of facial muscle movements considered to typify a specific facial expression. Supposedly when the facial muscle movements map onto the expected emotion specific action codes then there is confidence that the expression represents the target emotion. Results from studies using FACs based stimuli suggest that emotion recognition accuracy differs between emotion types with happiness or surprise being the easiest to recognise (Matsumato & Hwang, 2011). However, these exemplars are criticised as they are seen as extreme caricatures of an emotion expression and are specifically designed to enable discrimination between emotion types (Barrett, Lindquist, & Gendron, 2007). Consequently, the exemplars lack the range of emotion expressions that are observed in real social interactions (Russell, Bachorowski, & Fernandez-Dols, 2003). To overcome this issue, instead of only using emotion prototypes the models in the FACES database went through an emotion induction phase and were trained to produce optimum expressions. Thus, the emotions portrayed in the current experiment are arguably more naturalistic than images using a prototypical approach, such as the faces in Ekman and Friesen (1976).

An alternative dataset to those based on the Ekman faces is the Diagnostic Analysis of Nonverbal Behaviour (DANVA 2; Nowicki, 2004). The images within this dataset are in colour with background information (e.g., set in a classroom environment). However, these photographs were not used in the current study as OAs tend to have proportionately more age-related emotion recognition deficits in tasks based on images taken from the DANVA 2 than from Ekman and Friesen (e.g., Calder et al., 2003; Circelli, Clark, & Cronin-Golomb, 2013; Krendl & Ambady, 2010; Krendl, Rule, & Ambady, 2014; Stanley & Isaacowitz, 2015). Given that OAs appear to process contextual cues more than YAs (Isaacowitz & Stanley, 2011) then the background context in the DANVA 2 images may not provide useful information to support OAs' emotion recognition ability. Thus to avoid potential contextual cues the images used in the current experiment are presented on a plain background.

Another consideration when selecting a suitable database was the age range of the actors portraying the emotion, as encoder's age may influence emotion recognition accuracy (Anastasi & Rhodes, 2005). OAs and YAs have more experience in social interactions with same age individuals and this may produce an own-age bias in processing faces (Bartlett & Fulton, 1991; Isaacowitz & Stanley, 2011; Phillips & Slessor, 2011). However, the extent of an own-age bias is unclear as there are inconstancies as to its existence. For example, one study provides evidence for an own age bias as OAs had higher emotion recognition accuracy when expressions were portrayed by OA actors than YA actors; the findings were vice versa for YAs (Ebner, He, & Johnson, 2011c). In contrast, facial expressions displayed by OAs can be difficult to read for all adults regardless of age (Riediger, Voelke, Ebner, & Lindenberger, 2011); possibly due to the physical changes in the face that occur with age, such as wrinkles and lower expression intensity (Fölster, Hess, & Werheid, 2014; Hess, Adams, Simard, Stevenson, & Kleck, 2012; Porcheron, Mauger, & Russell, 2013;

Riediger et al., 2011). Moreover, the age of the actor might differentially affect processing of different emotions, as evidence suggests that when emotions are presented by YAs the categorisation of happy faces is faster than angry or sad faces but there was no emotion specific differences when emotion were presented by OAs (Craig & Lipp, 2018). Despite the possible own-age bias the majority of research investigating age-related emotion recognition ability have only used YA actors to portray facial expressions (e.g., Calder et al., 2003; Isaacowitz et al., 2007; Sullivan & Ruffman, 2004) and this may disadvantage task performance in OAs (Ebner et al., 2010). Given the potential of an own-age processing bias it is good practice to include facial expressions of actors representing a spread of ages (Phillips & Slessor, 2011). Therefore, one advantage of the FACES dataset is that it includes models across a spread of ages. Thus in the current study the selected models represented YAs (age range 19-31 years), middle-aged adult (age range 39-55 years) and OAs (age 69-80 years).

A further advantage of the FACES dataset is that it comprises 2,052 high quality digital coloured images of 171 models displaying 5 discrete emotion states of (happiness, sad, fear, anger, and disgust, plus neutral expressions); thus contains sufficient images required to create the current emotion and non-emotion tasks. Furthermore, the database has good validity of the target expression with disgust recognition having the lowest accuracy (68%) and fear recognition the highest accuracy (96%) (Ebner et al., 2010). Taken together, the images in the FACES database provided the most suitable stimuli for the current research as it is a dataset with: high quality photographs, it uses an induction technique to increase the ecological validity of the expressions posed by the models, holds numerous examples, and it includes images of OA models.

Regarding the design of the emotion recognition task several factors that may compromise task validity were considered, including familiarity effects and encoder effects. First, repeated exposure to a stimulus may produce familiarity effects that can alter the perceiver's judgement of the stimuli (Zajonc, 1968) and may reduce the validity of a task. To avoid the risk of familiarity effects in the current experiment six different experimental versions were created with each model appearing only once in a given version. Thus, participants only had a single exposure to any given model. Second, the ability to accurately recognise an emotion can depend on the skill a particular model has in accurately portraying the target emotion (i.e., the encoder's ability) (Brunswick, 1956). To address the possibility of variations in encoding ability across actors each model presented each of the six emotion types only once across the six experimental versions. In this manner if a model were less able than other models to accurately portray emotions then this encoder effect would be minimised.

Each emotion recognition task consisted of 36 experimental trials and eight practice trials (see Appendix 3.2). Thirty-six photographs of models were used in the experimental trials with each model portraying one of the six emotion states (happy, sad, fear, anger, disgust and neutral), as such a total of 224 images were used (36 models × 6 emotion states + 8 practice trials). Of the 36 models in the experimental trials 12 were YAs (age range between 19 and 31 years), 12 middle-aged adults (age range between 39 and 55 years) and 12 OAs (age range between 70 and 77 years) and each age group had six male models and six female models. Finally, within each of the experimental versions there were six trials for each emotion type (6 trials × 6 emotion types). The models in the practice task did not appear in the experimental task and the practice trials measured each emotion once and neutral expressions three times.

The stimuli were head and shoulder colour images of a model portraying one of six facial expressions (see Figure 3.3.1). Each trial had the same layout but the model and emotion expression varied. Each photograph was presented in the centre of the computer screen and the emotion labels appeared under the image in Arial and font size 18. The numbers 1 to 6 were presented as a guide to participants as to which numerical key they should press on the response box.

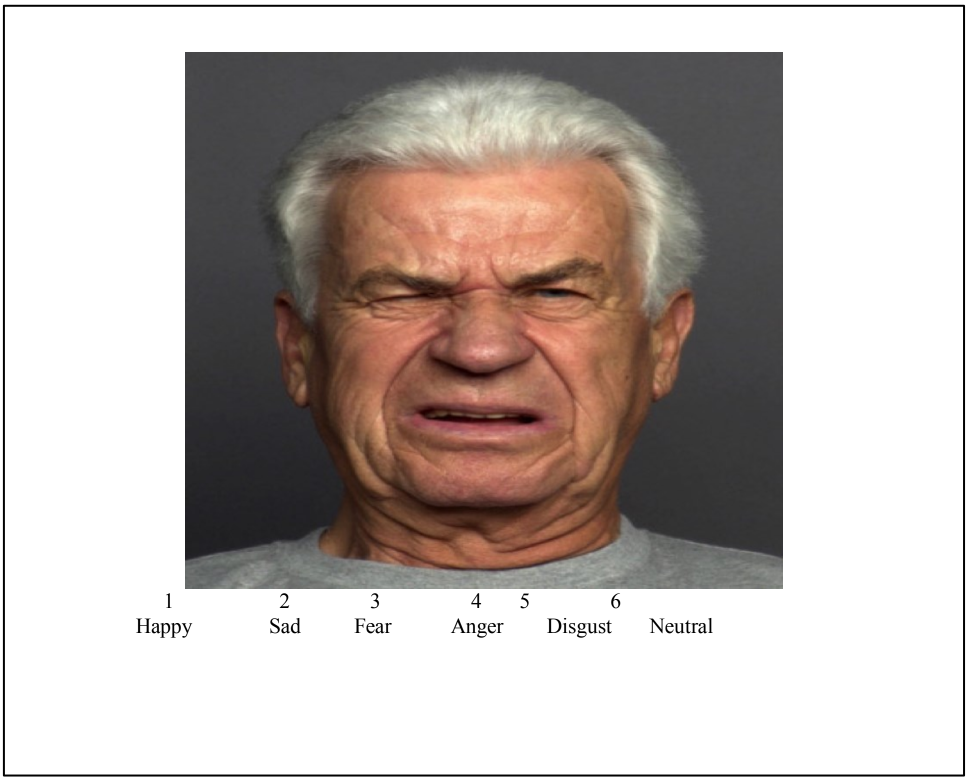


Figure 3.3.1. An example of the emotion recognition task using static faces. In this instance the correct response is 5 (disgust). Image reproduced with permission as per FACES database agreement section 7

3.3.2 Procedure.

The sequence and timings for the trials in the task are presented in Figure 3.3.2. The stimulus was displayed until a response was recorded or for a maximum of 4000 ms. This continued for all 36 trials until the end of the experiment. The order of the trials was randomised for each participant.

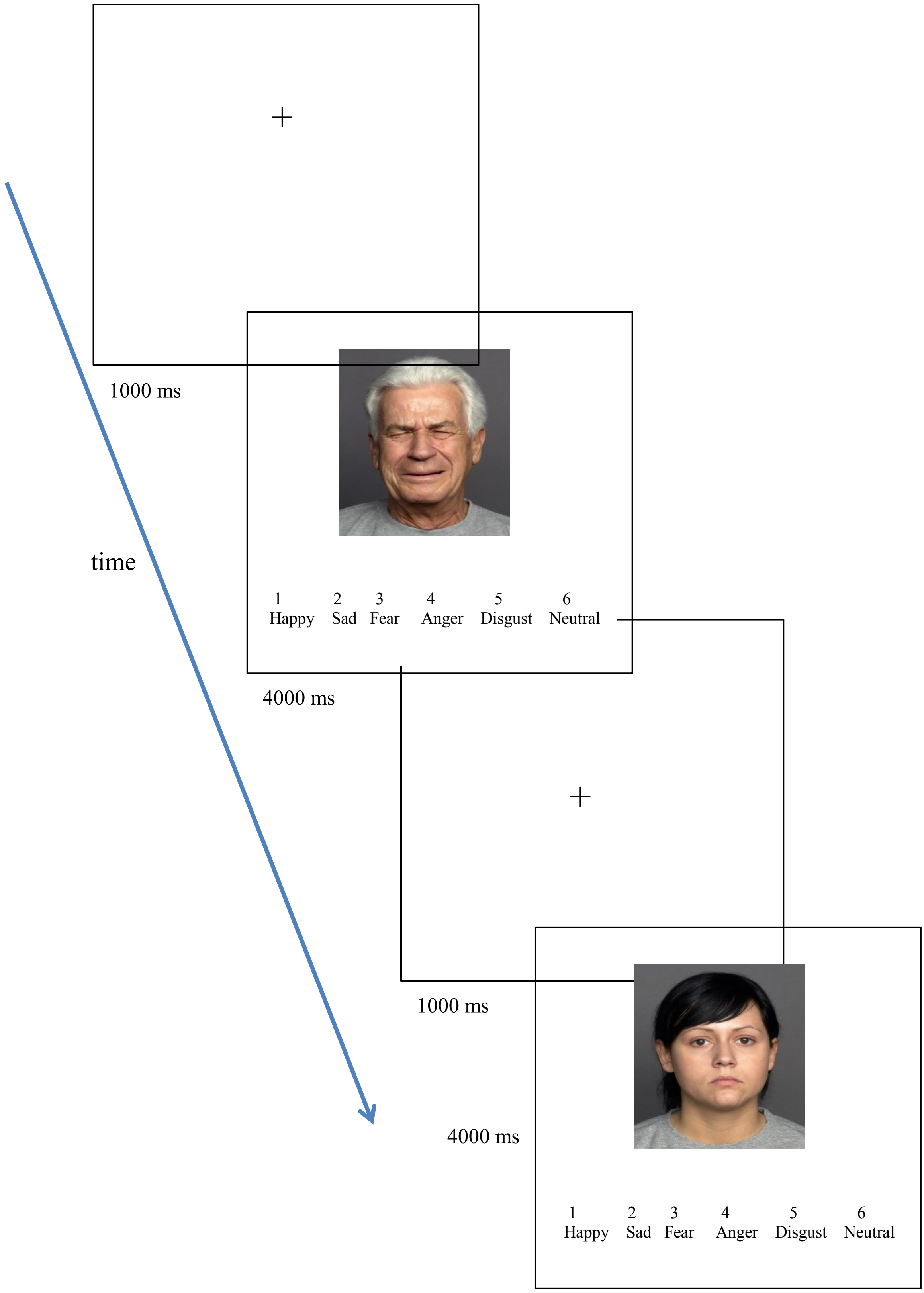


Figure 3.3.2. The order of presentation and duration for each slide in the trials used in Experiment 1. Images reproduced with permission as per FACES database agreement section 7

3.3.3 The non-emotion task.

The non-emotion task tested the ability of YAs and OAs to categorise faces by age group and sex (male young, female young, male middle-aged, female middle-aged or male older, female older) (see Figure 3.3.3). Importantly, the non-emotion face task was specifically designed to have similar task demands to the emotion task. As was the case for the emotion task, the images for the non-emotion stimuli were taken from the FACES database (Ebner et al., 2010). However, the images selected were unique to the non-emotion task and only consisted of neutral expressions. Specific similarities between the emotion and non-emotion task include a computer-based forced choice task using E prime software, a 4000 ms response time limit, 36 images presented in the experimental trials, six response options, and six trials per category. Thus the emotion and non-emotion tasks followed the same procedure. In this manner the two tasks were matched as far as possible for task demand in that the motor skills for entering the response was the same, the cognitive demands were the same as participants were required to make judgements from the same number of forced-choice options on both tasks, and the risk of cognitive fatigue was similar.

Each of the 36 trials had the same layout but the model varied across trials. A total of forty-four images of models displaying neutral facial expressions were used (36 images in the experimental task and eight images in the practice task). For the experimental trials the selected images were of 18 male (six YAs, six middle-aged adults, and six OAs) and 18 female models (six YAs, six middle-aged adults, and six OAs). The order of the trials was randomised across participants. Definitions of the age groups were given on laminated A4 paper and were accessible throughout the task (see Appendix 3.3). The procedure on the non-emotion task was the same as the emotion task (i.e., order and duration of slides presentations). The practice task consisted of two examples of the middle-aged categories and one example for each of the younger and older aged categories.

Figure 3.3.3. An example of the non-emotion recognition task using static faces. In this instance the correct response would be 2 (Female Young). Image reproduced with permission as per FACES database agreement section 7

3.4 Results

Several stages of analysis were undertaken. The initial analysis investigated the central research question concerning the emotion recognition ability in OAs and YAs for both total accuracy and across distinct emotion types. Furthermore, the effects of advancing age (i.e., cognitive decline) in the OAs may influence findings; hence, emotion recognition ability in older-older adults was also investigated by splitting the older adult sample into two separate groups (younger-older adults and older-older adults). Finally, age-related comparisons were made between the emotion and non-emotion tasks. For post hoc tests only the significant findings are reported, full outputs can be found in the appendices (see Appendix 3.4).

3.4.1 Emotion recognition analysis.

Table 3.4.1

Descriptive Statistics for Emotion Recognition Accuracy by Emotion Type and Age Group (maximum M = 6)

Emotion	YAs		OAs		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*
Happy	5.86	0.42	5.80	0.47	5.83	0.45
Sad	3.89	1.45	3.43	1.91	3.66	1.70
Fear	4.08	1.66	3.54	1.88	3.82	0.45
Anger	3.94	1.24	2.97	1.88	3.46	1.65
Disgust	4.31	1.24	4.91	1.22	4.61	1.30
Neutral	4.94	1.43	5.09	0.92	5.01	0.49
Total/36	27.03	3.77	25.74	4.38	26.39	4.10

For analysis the data from the six experimental versions were collapsed to create one data set. Descriptive statistics are presented in Table 3.4.1. To analyse emotion recognition ability across the two age groups a mixed factorial 2*6 ANOVA with age group (YAs and OAs) as the between-participants IV and emotion type (happy, sad, fear, anger, disgust and neutral) as the within-participant IV was conducted. Emotion recognition accuracy was the DV (maximum score = 6). Mauchly's test of sphericity was significant suggesting that the assumption of sphericity was violated, $\chi^2(14) = 52.34$, $p < .001$, so Greenhouse Geisser corrected values are reported. There was a significant main effect of emotion type, $F(4.12, 284.55) = 33.27$, $p < .001$, $\eta_p^2 = 0.33$. Post hoc paired t-tests, with $\alpha = 1\%$, were conducted to investigate which emotions were more accurately recognised. Happy faces were more accurately recognised than all other emotion types. Also accuracy for disgust and neutral recognition was greater than for fear, sadness, and anger recognition (see Table 3.4.2).

Table 3.4.2
Inferential Statistics for Emotion Recognition Accuracy by Emotion Type in Experiment 1

Comparison	*t*(70)	*p*	95% CI		*d*
			LL	UL	
Happy>Disgust	7.34	**< .001**	0.89	1.56	1.25
Happy>Fear	9.78	**< .001**	1.60	2.43	1.55
Happy>Sad	10.45	**< .001**	1.76	2.58	1.75
Happy>Anger	11.66	**< .001**	1.96	2.77	1.95
Happy>Neutral	5.53	**< .001**	0.52	1.11	0.90
Disgust>Fear	3.17	**.002**	-1.29	-0.29	0.51
Disgust>Sad	3.68	**< .001**	-1.46	-0.43	0.63
Disgust>Anger	4.55	**< .001**	-1.64	-0.64	0.77
Neutral>Fear	4.65	**< .001**	-1.71	-0.68	0.78
Neutral>Sad	5.00	**< .001**	-1.89	-0.81	0.92
Neutral>Anger	6.00	**< .001**	-2.06	-1.03	1.07
Disgust=Neutral		ns			
Fear=Sad		ns			
Fear=Anger		ns			
Sad=Anger		ns			

Note. ns = nonsignificant. The lowest nonsignificant *p* value was $p = .050$ (disgust-neutral)

There was no significant main effect of age group, $F(1, 69) = 1.76$, $p = .189$, $\eta_p^2 = 0.03$. There was, however, a significant Age Group*Emotion Type interaction, $F(4.12, 284.55) = 3.07$, $p = .016$, $\eta_p^2 = 0.04$ (see Figure 3.4.1).

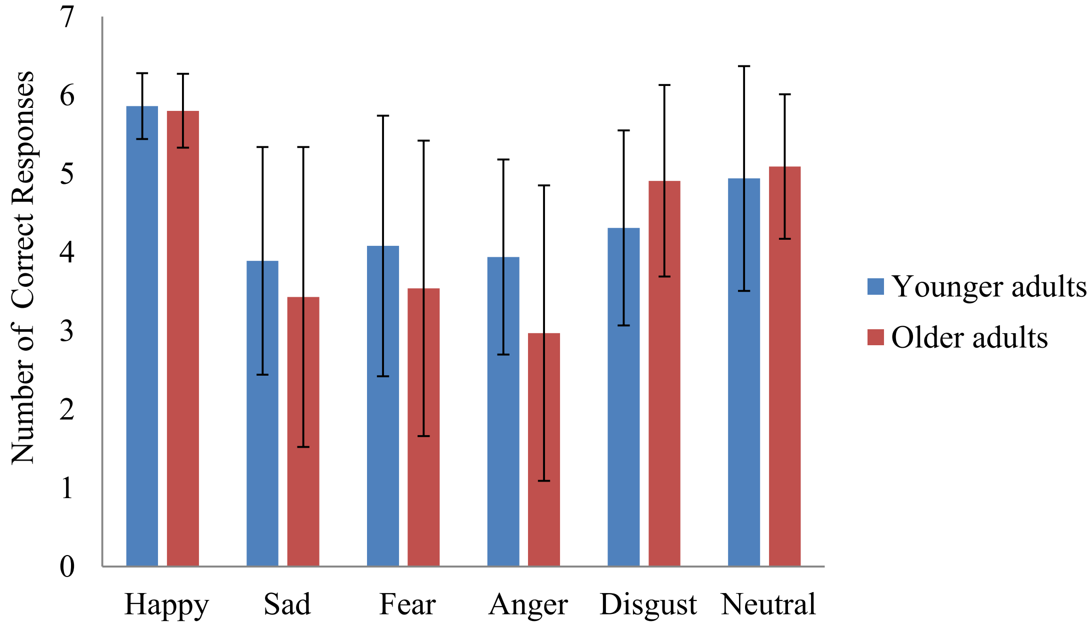


Figure 3.4.1. Emotion recognition accuracy from static faces by age group (YAs $n = 36$; OAs $n = 35$) and emotion type (maximum $M = 6$).

Post hoc comparisons, with α = 1%, revealed that anger recognition was marginally lower in OAs than YAs, $t(69) = 2.56$, $p = .013$, $d = 0.62$. Of interest, despite a nonsignificant age-related difference for disgust recognition ($p = .048$, $d = 0.47$ and this was the lowest nonsignificant p value) the means suggest a trend for higher accuracy in OAs than YAs, this trajectory is not observed for any other emotion type. Furthermore, the interaction can be explained by the different pattern of emotion recognition ability across emotion types between YAs and OAs. Post hoc comparisons, with α = 1%, for emotion recognition accuracy across emotion types for each age group were run to investigate this pattern (see Table 3.4.3 and Table 3.4.4). The findings suggest that the interaction was driven by higher accuracy for disgust recognition compared to sad, fear, and anger recognition in OAs but not in YAs.

Table 3.4.3

Inferential Statistics for Emotion Recognition Ability in ***Younger Adults*** *across Emotion Types*

Comparison	*t*(35)	*p*	95% CI		d
			LL	UL	
Happy>Disgust	6.86	**< .001**	1.09	2.02	1.57
Happy>Fear	6.57	**< .001**	1.23	2.33	1.47
Happy>Anger	9.20	**< .001**	1.49	2.34	2.07
Happy>Sad	7.78	**< .001**	1.46	2.49	1.85
Happy>Neutral	3.82	**.001**	0.43	1.40	0.87
Neutral>Fear	2.66	**.012**	-1.52	-0.20	0.56
Neutral>Sad	2.75	**.009**	-1.84	-0.26	0.73
Neutral>Anger	3.07	**.004**	-1.66	-0.34	0.75
Disgust=Fear		ns			
Disgust=Sad		ns			
Disgust=Anger		ns			
Disgust=Neutral		ns			
Fear=Sad		ns			
Fear=Anger		ns			
Sad=Anger		ns			

Note. ns = nonsignificant. The lowest nonsignificant *p* value was *p* = .062 (disgust-neutral

Table 3.4.4

*Inferential Statistics for Emotion Recognition Ability in **Older Adults** across Emotion Types*

Comparison	*t*(34)	*p*	95% CI		d
			LL	UL	
Happy>Disgust	3.77	**< .001**	0.41	1.36	0.96
Happy>Fear	7.27	**< .001**	1.63	2.89	1.65
Happy>Sad	7.17	**< .001**	1.70	3.04	1.70
Happy>Anger	8.40	**< .001**	2.14	3.51	2.07
Happy>Neutral	4.16	**< .001**	0.37	1.06	0.97
Disgust>Fear	3.69	**< .001**	-0.62	-3.69	0.86
Disgust>Sad	3.86	**< .001**	-2.27	-0.70	0.92
Disgust>Anger	5.51	**< .001**	-2.66	-1.23	1.22
Neutral>Fear	3.88	**< .001**	-2.35	-0.73	1.05
Neutral> Sad	4.36	**< .001**	-2.43	-0.88	1.11
Neutral>Anger	5.51	**< .001**	-2.89	-1.33	1.43
Disgust=Neutral		ns			
Fear=Sad		ns			
Fear=Anger		ns			
Sad=Anger		ns			

Note. ns = nonsignificant. The lowest nonsignificant *p* value was *p* = .127 (fear-anger)

To conclude, regardless of age the emotion with the highest accuracy was happiness and the recognition accuracy for sad, fear, and angry faces was lower than the recognition of happy, disgust, and neutral faces. Regarding the age-related differences, OAs and YAs did not differ in their overall accuracy for recognising emotion from faces but OAs did have a marginal age-related deficit for anger recognition. Whilst the age-related difference in anger may partially account for the significant Age Group*Emotion Type interaction, the interaction is further explained by the differing pattern of recognition ability between OAs and YAs across emotion types. Specifically, OAs had higher disgust recognition compared to sad, fear, and anger recognition, whereas YAs did not differ in their recognition ability across these emotions.

3.4.2 Comparison of the younger-older and older-older samples.

Table 3.4.5

Descriptive Statistics for Emotion Recognition Accuracy by Emotion Type for Younger-older Adults and Older-older Adults (maximum M = 6)

Emotion	Younger-older Adults		Older-older Adults		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*
Happy	5.83	0.38	5.72	0.57	5.82	0.45
Sad	4.22	1.80	2.44	1.75	3.61	1.74
Fear	3.94	1.92	2.94	1.89	3.76	1.83
Anger	3.28	1.67	2.61	2.03	3.44	1.65
Disgust	4.94	0.94	4.83	1.47	4.60	1.47
Neutral	4.94	1.06	5.06	1.06	4.97	1.24
Total	27.17	3.90	23.17	5.08		

The ANOVA analysis was repeated to investigate any age-related emotion recognition differences between YAs, younger-older adults (n = 18, age range 59-69 years) and older-older adults (n = 18, age-range 70-84 years). The older-older adult with reduced hearing was included in this analysis as their data is a legitimate example of emotion recognition ability in advanced older age. The descriptive statistics for the two older age groups are presented in Table 3.4.5.

A mixed factorial 3*6 ANOVA with age group (YA, younger-older, and older-older adults) as the between-participants IV and emotion type (happy, sad, fear, anger, disgust, and neutral) as the within-participants IV was conducted with emotion recognition accuracy as the DV. Mauchly's test of sphericity was significant, $\chi^2(14) = 46.21$, $p < .001$, so Greenhouse Geisser corrected values are reported. There was a significant main effect of emotion type, $F(4.24, 292.36) = 36.19$, $p < .001$, $\eta_p^2 = 0.34$. See previous post hoc tests for main effects of emotion type (Section 3.4.1).

In this analysis a significant main effect of age group was found, $F(2, 69) = 4.69$, $p = .012$, $\eta_p^2 = 0.12$. Post hoc independent t-tests, with Bonferroni adjustment set at $p < .017$, demonstrated that YAs were more accurate at recognising emotions from faces than older-older adults, $t(52) = 2.79$, $p = .007$, $d = 1.22$. However, when controlling for multiple comparisons, the younger-older adults were not more accurate at recognising emotion faces than the older-older adults ($p = .024$). There was no significant difference in emotion recognition ability between YAs and younger-older adults ($p = .900$). Finally, there was a significant Age Group*Emotion Type interaction, $F(8.47, 292.36) = 2.93$, $p = .003$, $\eta_p^2 = 0.08$ (see Figure 3.4.2).

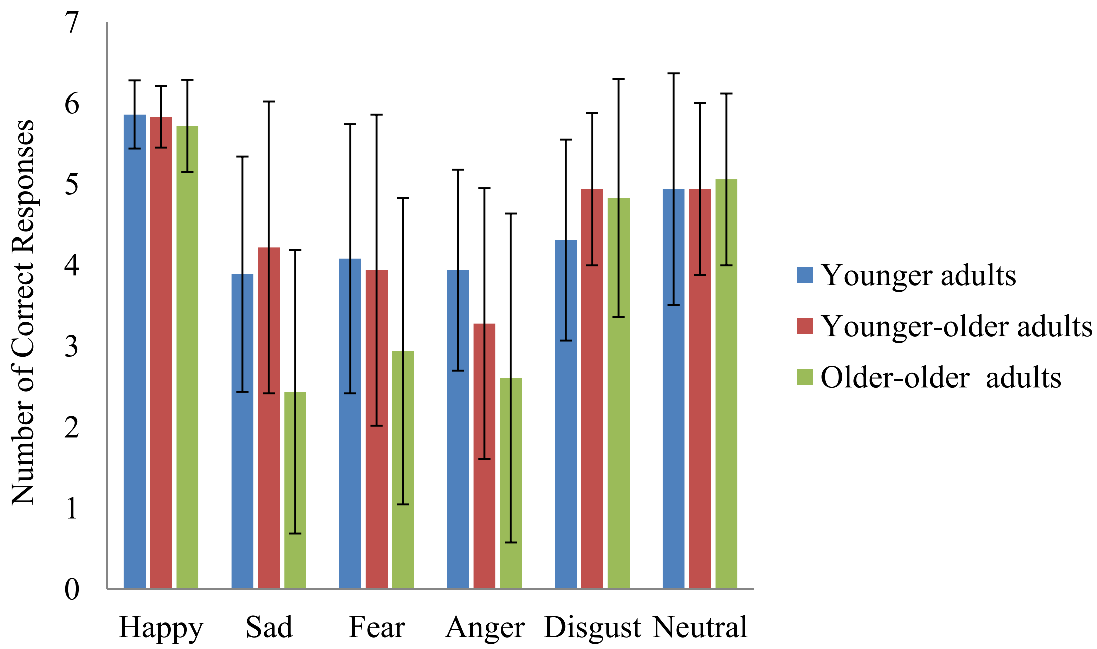


Figure 3.4.2. Emotion recognition accuracy by age group (YAs $n = 36$; younger-older $n = 18$; older-old adults $n = 18$) and emotion type (maximum $M = 6$).

Post hoc t-tests, with α = 1%, revealed that YAs and younger-older adults were more accurate than older-older adults at recognising sad faces, $t(52) = 3.21$, $p = .002$, $d = 1.32$, and, $t(34) = 3.00$, $p = .005$, $d = 1.03$, respectively. All other comparisons were nonsignificant (all *ps* > .01; lowest nonsignificant $p = .018$ anger between YAs and older-older adults).

The interaction can also be explained by the age-related differences in the pattern of emotion recognition ability across emotion types (see Table 3.4.6 and Table

3.4.7). Emotion recognition accuracy across emotion types in YAs has been previously presented (see Table 3.4.3). For younger-older adults accuracy was greater for recognising happiness than all other emotion types. Further, anger recognition ability was lower than disgust and neutral recognition. All other emotion comparisons in younger-older adults were nonsignificant (all *p*s > .01).

Table 3.4.6

*Inferential Statistics for Emotion Recognition Ability in **Younger-older Adults** Across Emotion Types*

Comparison	*t*(17)	*p*	95% CI		d
			LL	UL	
Happy>Disgust	3.92	**.001**	0.41	1.37	1.24
Happy>Fear	4.35	**< .001**	0.97	2.81	1.37
Happy>Sad	4.06	**.001**	0.77	2.45	1.24
Happy>Anger	6.86	**< .001**	1.77	3.34	2.11
Happy>Neutral	3.50	**.003**	0.35	1.43	1.12
Disgust>Anger	3.70	**.002**	-2.61	-0.72	1.23
Neutral>Anger	3.07	**. 007**	-2.81	-0.52	1.19
Disgust=Fear		ns			
Disgust=Sad		ns			
Fear=Neutral		ns			
Sad=Neutral		ns			
Disgust=Neutral		ns			
Fear=Sad		ns			
Fear=Anger		ns			
Sad=Anger		ns			

Note. ns = nonsignificant . The lowest nonsignificant *p* value was *p* = .058 (fear-disgust)

For older-older adults accuracy for recognising happy, disgust, and neutral faces was higher than for sad, fearful, and angry faces. All other comparisons were nonsignificant (all *p*s > .01). Thus it can be seen that the pattern of emotion recognition accuracy across emotion types differs between the two older age groups. Specifically, the different pattern was due to higher accuracy for disgust and neutral recognition compared to sad and fear recognition in older-older adults, which was not found in younger-older adults.

Table 3.4.7

Inferential Statistics for Emotion Recognition Ability in ***Older-older Adults*** *Across Emotion Types*

Comparison	*t*(17)	*p*	95% CI		d
			LL	UL	
Happy >Fear	6.43	**< .001**	1.87	3.69	1.99
Happy >Sad	7.19	**< .001**	2.32	4.24	2.50
Happy >Anger	5.74	**< .001**	1.97	4.25	2.09
Disgust>Fear	3.49	**.003**	-3.03	-0.75	1.12
Disgust>Sad	4.72	**< .001**	-3.46	-1.32	1.48
Disgust>Anger	4.26	**.001**	-3.32	-1.12	1.25
Anger<Neutral	4.65	**< .001**	-3.55	-1.34	1.51
Sad<Neutral	6.09	**< .001**	-3.52	-1.71	1.80
Fear<Neutral	4.19	**.001**	-3.17	-1.05	1.38
Happy =Disgust		ns			
Happy =Neutral		ns			
Disgust=Neutral		ns			
Fear=Sad		ns			
Fear=Anger		ns			
Sad=Anger		ns			

Note. ns = nonsignificant. The lowest nonsignificant p value was $p = .018$, $d = 0.78$ (happy-neutral)

Emotion recognition across emotion types in YAs followed a similar pattern to the younger-older adults and older-older adults with happy recognition having higher accuracy than all other emotion types. However, YAs were better able to recognise neutral expressions than sad, fear, and anger recognition and this was similar to older-older adults but not younger-older adults (where sad and fear recognition did not differ to neutral recognition). Of note, older-older adults were more able to recognise disgust than fear, anger, and sadness and this was not observed for YAs, whereas younger-older adults were only more able to recognise disgust than anger. Therefore, the pattern of emotion recognition accuracy across emotion types partially differed across the age groups.

In summary, older-older adults were less accurate than YAs and younger-older adults when recognising sad faces. The findings suggest that the age-related emotion recognition differences in the current study are due to emotion recognition deficits in the older-older adults and, when accounting for multiple comparisons, emotion recognition accuracy in younger-older adults is preserved relative to YAs.

3.4.3 Comparing accuracy on the emotion and non-emotion tasks.

Table 3.4.8

Descriptive Statistics for Total Accuracy on the Emotion and Non-emotion Tasks by Age Group (maximum M = 36)

	Younger adults		Older adults		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*
Emotion Task	27.03	3.77	25.74	4.38	26.39	4.10
Non-emotion Task	32.11	1.74	32.40	2.46	32.25	2.12
Total/72	59.14	4.37	58.14	5.30		

Since it was not important to understand how participants performed on the non-emotion task for each age/sex classification the results were collapsed across categories to give a possible overall score of 36 (see Table 3.4.8 for descriptive statistics). This was then compared to the overall score on the emotion task. A mixed factorial 2*2 ANOVA with age group (YAs and OAs) as the between-participants IV and content type (emotion and non-emotion) as the within-participants IV was conducted with total accuracy scores as the DV. There was a significant main effect of content type, $F(1,69) = 128.58$, $p < .001$, $\eta_p^2 = 0.65$, with non-emotion content having higher accuracy than emotion content. There was no significant main effect of age group, $F(1,69) = 0.75$, $p = .388$, $\eta_p^2 = 0.01$, nor an Age Group*Content Type interaction, $F(1,69) = 2.31$, $p = .133$,

η_p^2 = 0.03 (see Figure 3.4.3). The absence of either a main effect for age or an interaction effect indicates that OAs were as good as YAs when making categorical judgements from faces. Therefore, task demands or face processing ability are unlikely to contribute to any age-related deficits in emotion recognition ability in OAs.

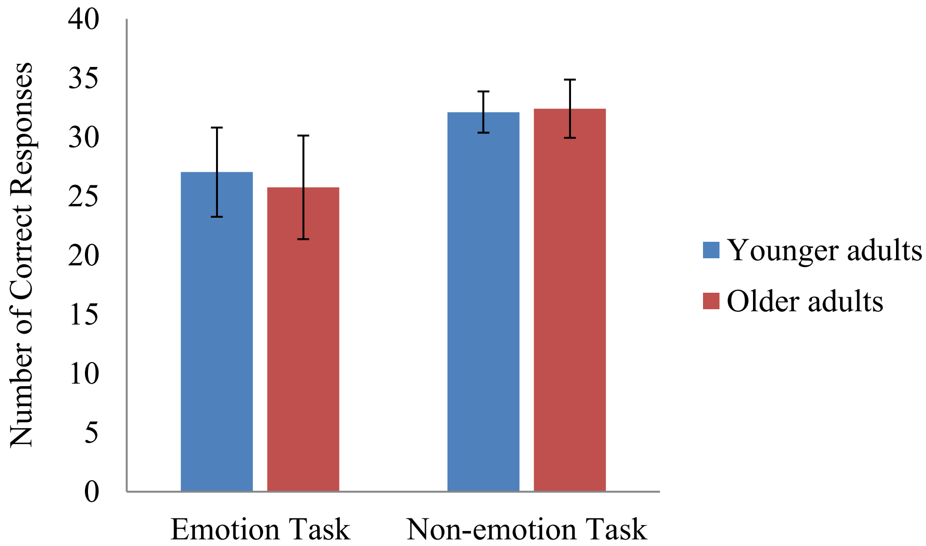


Figure 3.4.3. The total mean accuracy scores on the emotion and non-emotion tasks in Experiment 1 (maximum total score on each task was 36) by age group (YAs n = 36; OAs n = 35).

The same analysis was repeated across three age groups (YAs, younger-older adults, and older-older adults), see Table 3.4.9 for descriptive statistics. A mixed factorial 3*2 ANOVA with age group (YAs, younger-older adults, and older-older adults) as the between-participants IV and content type (emotion and non-emotion) as the within-participants IV was conducted with total accuracy scores as the DV. There was a significant main effect of content type, $F(1,69) = 130.02$, $p < .001$, $\eta_p^2 = 0.65$, with higher accuracy for the non-emotion content (*MM* = 32.24; *SE* = 0.25) than the emotion content (*MM* = 25.93; *SE* = 0.52). There was also a significant main effect of age group, $F(2,69) = 6.16$, $p = .003$, $\eta_p^2 = 0.15$. Older-older adults were significantly less accurate than both YAs, $t(52) = 2.84$, $p = .006$, $d = 0.79$, and younger-older adults,

$t(34) = 2.98$, $p = .005$, $d = 1.02$, but YAs and younger-older adults did not differ in task accuracy ($p = .345$). There was not, however, an Age Group*Content Type interaction, $F(2,69) = 2.29$, $p = .109$, $\eta_p^2 = 0.06$ (see Figure 3.4.4). Thus the older-older adults were less accurate than YAs and younger-older adults across both tasks to the same extent.

Table 3.4.9

Descriptive Statistics for Total Accuracy on the Emotion and Non-emotion Tasks by Younger-older and Older-older adults (maximum M = 36)

	Younger-older adults		Older-older adults	
	M	*SD*	*M*	*SD*
Emotion Task	27.17	3.90	23.61	5.08
Non-emotion Task	33.17	2.55	31.44	2.18
Total/72	60.33	4.36	55.06	6.10

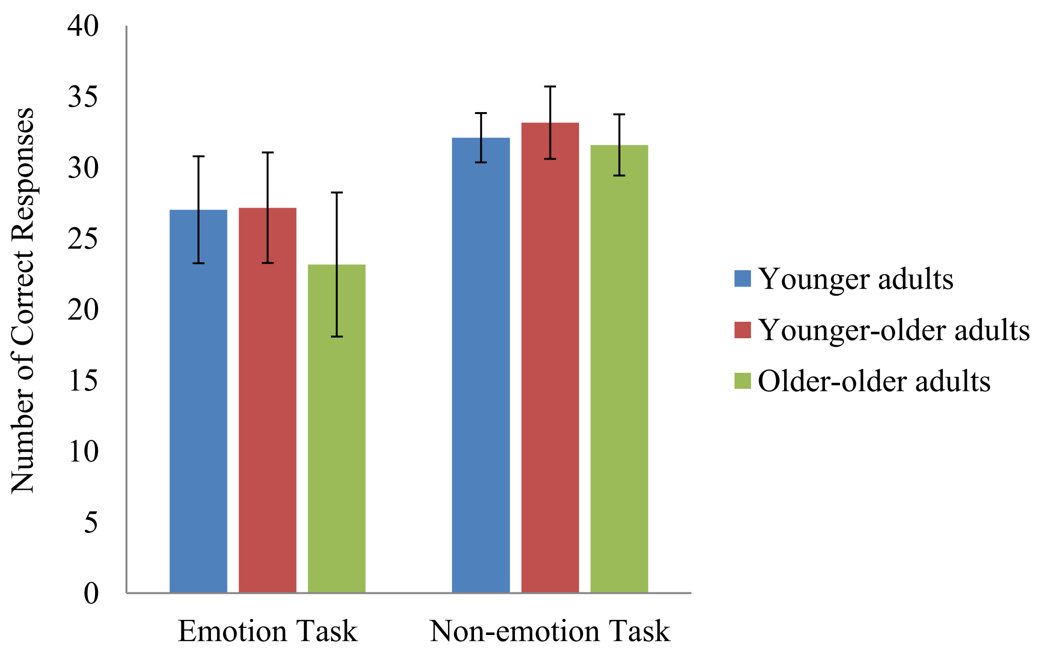


Figure 3.4.4. The total mean accuracy scores on the emotion and non-emotion tasks in Experiment 1 (maximum total score on each task was 36) by age group (YAs $n = 36$; younger-older adults $n = 18$; older-older adults $n = 18$).

In summary, YAs and younger-older adults appear to be more accurate across tasks than older-older adults. Again the findings suggest that the older-older adults are driving the age-related differences. However, the absence of an interaction indicates that the magnitude of the age difference did not differ across the two tasks. Therefore, for older-older adults the demands of the task may have reduced performance on the emotion task rather than emotion processing ability per se, but not to the extent that older-older adults had age-related emotion recognition deficits across all emotion types.

3.5 Discussion

A central aim of Experiment 1 was to understand whether OAs have age-related emotion recognition deficits when the experiment has been specifically designed to reduce many of the methodological and possible effects of sample differences that are evident in previous research. By limiting these possible confounding effects the current results may be more confidently attributed to emotion recognition ability rather than potential confounding variables that make comparisons across the field difficult. A further aim of Experiment 1 was to use a non-emotion task to examine whether the ability to meet task demands could explain age-related differences in emotion recognition accuracy. Finally, a more fine-grained understanding of emotion recognition development in older age was achieved by comparing this ability between YAs, younger-older adults, and older-older adults.

It was hypothesised that OAs would have lower emotion recognition accuracy from static faces than YAs. Furthermore, it was predicted that age-related differences would not be the same across all emotion types. Specifically, OAs would be less accurate than YAs for recognising some negative emotions (sad, fear, or anger), whereas accuracy for disgust or happy recognition would be at least maintained. In contrast it was predicted that YAs and OAs would have comparable accuracy on the non-emotion task. It was also expected that the breadth of age-related emotion recognition deficits would increase with advancing older age. The hypotheses were partially supported. OAs and YAs were comparable overall in emotion recognition ability, which was not predicted. However, when specific emotions were considered the hypothesis was somewhat supported as OAs were less able than YAs to accurately recognise anger, also OAs and YAs did not significantly differ in accuracy for disgust and happy recognition. Furthermore, the number of significant findings regarding age-related recognition deficits for specific emotion types with advancing older age remained at one, as older-older adults were less able to recognise sadness than the younger age groups. Finally, as predicted OAs and YAs did not differ in their ability to make non-emotion judgements from faces; however, older-older adults were less able than YAs and younger-older adults to make non-emotion and emotion categorical judgements from facial expressions.

In the current study OAs and YAs did not differ in their overall emotion recognition ability. A few studies concur with this finding that emotion recognition accuracy is similar across the age groups (e.g., Phillips, MacLean, & Allen, 2002). However, this is in contrast to some evidence that overall emotion recognition accuracy in OAs is lower than YAs on tasks using static faces (e.g., Calder et al. 2003; Isaacowitz et al., 2007; Keightley et al., 2006; Krendl & Ambady, 2010). The disparity in results between studies, however, may be related to the different pattern of emotion recognition ability across emotion types. For instance, in both Keightley et al. (2006) and Krendl and Ambady (2010) OAs, compared to YAs, either had similar or reduced recognition accuracy across emotion types resulting in an overall age-related deficit in emotion recognition accuracy. In contrast, the OAs in the current study had higher mean scores for disgust recognition and were marginally better at identifying neutral facial expressions than YAs, although neither of these differences reached significance. These two specific emotion recognition advantages for OAs, compared to YAs, perhaps balanced out the age-related emotion recognition deficit for anger recognition. As a result the overall emotion recognition accuracy did not significantly differ between OAs and YAs. Therefore, overall emotion recognition accuracy should be treated with caution as it may mask advantages as well as disadvantages for recognition ability across discrete emotion types in OAs compared to YAs.

Furthermore, the present findings demonstrate that, compared to YAs, OAs have reduced emotion recognition ability for anger. An age-related deficit for anger recognition in OAs is consistent with some of the previous age-related emotion recognition research (Calder et al., 2003; Isaacowitz et al., 2007; Phillips, Maclean, & Allen, 2002; Sullivan and Ruffman, 2004a). The current findings suggest, therefore, that age-related emotion recognition deficits in OAs are limited to anger. Given the careful design of the emotion recognition task it is likely that these age-related impairments can be best explained in terms of emotion recognition ability in OAs.

In contrast to the current findings there is evidence of broader age-related emotion recognition deficits in OAs across emotion types. For example, Keightley et al. (2006) reported that OAs had poorer accuracy than YAs for the recognition of two emotions, fear and sadness, whilst Krendl and Ambady (2010) reported that OAs were less able than YAs to recognise four emotions in faces (happy, sad, fear, and anger). The disparity in the breadth of age-related emotion recognition deficits in the literature may reflect sample and methodological differences (e.g., education, gender, stimuli, response time limits). Whilst it is not possible to state exactly which of these differences may account for the discrepancies between studies regarding the breadth of emotion recognition deficits in older age, the age differences between the OA samples may provide a useful explanation. For example, the OA sample in the current study had a mean age of 70 years and a study by Suzuki, Hoshino, Shigemasu and Kawamura (2007) used OAs with a comparable mean age (69.7 years) found only one age-related emotion recognition deficit in OAs (albeit sadness rather than anger). In contrast, the OAs in Krendl and Ambady had a mean age of 75.8 years and the authors reported that OAs were less able to recognise four emotion types than YAs. As such the breadth of age-related emotion recognition deficits in Krendl and Ambady may reflect the advanced age of their OA sample compared to the age of the current OA sample. This argument is somewhat supported by the findings in the current study that older-older adults are less able than YAs to recognise faces overall, as well as sad faces, demonstrating a general decline in emotion recognition ability with advanced older age. It is likely, therefore, that the advanced neurological and cognitive changes that naturally occur with increasing older age (Resnick, Pham, Kraut, Zonderman, & Davatzikos, 2003) impairs the ability of older-older adults to recognise emotions compared to younger-older adults. This possibility is investigated in more detail later in the discussion.

Despite the current findings of age-related impairments for recognition of anger in OAs, the deficits did not extend to fear recognition between OAs and YAs and this is in contrast to previous research (Calder et al., 2003; Keightley et al., 2006; Krendl & Ambady, 2010). Calder at al. (2003) used age groups that were matched for gender and verbal intelligence in a similar fashion to the current study. Yet Calder et al. reported an age-related deficit for fear recognition in OAs. However, Calder et al. included surprise in their experiment and as explained in Chapter 2 (Section 2.1.6) an age-related decline for recognition of fear may reflect confusions between fear and surprise. The absence of surprise in the current task avoided the possible fear-surprise confusion; hence, the current findings imply that OAs are as able as YAs to recognise fear. This would be a plausible explanation only if other studies that excluded surprise from the emotion recognition task also failed to report age-related deficits for fear recognition. However, Krendl and Ambady (2010) did not assess the recognition of surprise nevertheless found an age-related deficit for fear recognition in OAs. However, Krendl and Ambady used images taken from the DANVA 2 (Nowicki & Duke, 1994) and, as explained in Section 3.3.1, tasks based on this dataset appear to produce more age-related deficits than tasks based on alternative datasets. Thus, age-related impairments in recognition for fear in OAs maybe attributed to the choice of the face database or the inclusion of surprise in the task. However, the current study is not compromised by these two methodological issues, thus the maintenance of fear is likely to reflect emotion recognition abilities in OAs.

Finally, regarding findings for the negative emotions, the present study reports higher mean accuracy for disgust in OAs than YAs. However, the p value ($p = .048$) was nonsignificant when multiple comparisons were accounted for. Research has reported superior effects for disgust recognition in OAs compared to YAs (Calder et al. 2003; Suzuki et al., 2007; Wong, Cronin-Golomb, & Neargarder, 2005). A trend for increased accuracy for recognising disgust in older age suggests that emotion recognition ability does not decline with age across all emotions. Calder et al. (2003) and Williams et al. (2009) argue that superior disgust recognition in OAs is a maintained ability rather than an increased ability in old age, as disgust recognition is still developing in YAs. In this manner, age-related differences in disgust recognition are a function of an underdeveloped ability to detect disgust in YAs compared to a matured ability for disgust recognition in OAs (Calder et al., 2003). It should be noted though that there is some evidence that disgust recognition ability is either lower in OAs than YAs (e.g., Isaacowitz et al., 2007) or, as is the case in the current study, similar between the age groups (MacPherson, Phillips, & Della Sala, 2002). Hence an advantage in disgust recognition in OAs than YAs is not consistent across studies.

Regarding positive emotions OAs were as accurate as YAs when recognising happiness from static faces. This preservation of emotion recognition for positive emotion with age, coupled with age-related deficits in OAs for recognising negative emotions, may reflect a positivity effect in OAs (Charles, Mather, & Carstensen, 2003). However, as previously discussed (see Chapter 1, Section 1.7.1.3) a higher ability for happy recognition than other emotion types may also be a function of the task as it is easier to detect a singular positive emotion from an array of negative emotions (Isaacowitz & Stanley, 2011). It is, therefore, difficult to disentangle the two explanations using the typical emotion recognition tasks format. However, to distinguish between the possible influences of positivity effect or task design on the pattern of emotion recognition ability in OAs across emotion types research needs to use tasks specifically designed to tease apart the two concepts. This issue will be addressed in Phase 2 of the current thesis.

Turning to the possibility that emotion recognition deficits may increase with advancing older age, current findings suggest that, compared to YAs and younger-older adults, older-older adults had a recognition deficit for sadness; younger-older adults did not have any specific age-related emotion recognition impairments compared to YAs. Interestingly despite the possible effects of progressive cognitive and neurological changes with older age (e.g., Wilson, 2002) the older-older adults in the current study were still as able as YAs and younger-older adults to recognise happiness, fear, anger, disgust, and neutral faces. Furthermore, it appears that younger-older adults in the current study are as able to recognise emotions as YAs and it is only with advancing age that emotion specific recognition differences between the age groups emerge. The current findings, therefore, suggest that the age of the OA sample needs to be considered when comparing results in the field.

Regarding age-related emotion recognition deficits in older-older adults, the current findings are similar to one study that used an older OA sample than those typically found in the area. Stanley and Isaacowitz (2015) used an OA sample with a mean age of approximately 75 years and compared to YAs these OAs were less accurate at recognising sad and angry faces. This finding is largely in line with the current research, however, age-related impairments for recognising anger in the current study was limited to comparisons between the extreme age groups of YAs and OAs and was not replicated when the older age group was split. Thus the advantage of the current study is that it provides a more fine-grained understanding of the effects of advancing older age on emotion recognition ability than research that has only compared YAs and OAs.

To recap, the current findings indicate that OAs are as able as YAs to recognise happy, fear, sad, disgust, and neutral faces; however, OAs are less able to recognise anger from static faces. Furthermore, older-older adults were less able to recognise emotion from faces with particular difficulties for sad faces than YAs, whereas younger-older adults do not appear to have any emotion recognition deficits compared to YAs. These findings are discussed in relation to cognitive and neurological explanations of emotion recognition.

Cognitive aging may provide a possible explanation for the current findings. According to the processing speed hypothesis faster speeds of processing facilitate cognitive performance (Salthouse, 1991). It is feasible that OAs' slower processing speed than YAs may reduce their ability to process and categorise emotion information. Indeed there is some evidence that processing speed may account for some of the age-related deficits in emotion recognition ability in OAs (Horning, Cornwall, & Davis, 2012). However, if processing speed was the only explanation of a decline in emotion recognition ability in OAs then it may be expected that OAs would be less able than YAs to recognise all emotion types, rather than the select deficits reported in this study. Further, fluid abilities have been associated with emotion recognition ability in OAs (e.g., Horning, Cornwall, & Davis, 2012) but other studies suggest fluid intelligence does not account for age-related emotion recognition deficits (e.g., Keightley et al. 2006). In the current study OAs had similar levels of fluid intelligence as YAs, therefore, cognitive aging based on intelligence is unlikely to explain the reported age-related impairment of anger. However, the OAs in the current study may have reduced abilities compared to YAs in unmeasured cognitive skills such as working memory or executive function. In particular lower executive function has been related to lower recognition accuracy for anger (Krendl & Ambady, 2010). Given the omission of a measure of executive function in the current study and the age-related differences in processing speed, then cognitive aging cannot be confidently rejected as an explanation of the current findings.

Furthermore, cognitive aging may help to explain the age-related emotion recognition deficits observed in the older-older adults. The older-older adults in the current study had significantly lower levels of verbal intelligence, fluid intelligence, and general cognitive functioning than younger-older adults. It is, therefore, possible that the demise in cognitive abilities with advancing older age may result in reduced recognition ability for sadness in older-older adults compared to younger-older adults. Although of interest the current older-older adults had similar cognitive abilities to YAs, thus cognitive demise with age is unlikely to fully explain the apparent decline in recognition ability for sadness between these two age groups.

The current emotion recognition findings are somewhat in line with a neurological explanation of emotion recognition ability in OAs (e.g., Ruffman, Henry, Livingstone, & Phillips, 2008). For instance, an age-related deficit in recognising anger in OAs may result from a rapid decline in the orbitofrontal cortex (OFC) compared to other neural areas in older age (Raz et al., 1997), as it has been shown that the OFC is involved in the processing of angry facial expressions (e.g., Sprengelmeyer, Rausch, Eysel, & Przuntek, 1998). Further, the age-related deficit for sad recognition in older-

older adults compared to YAs and younger-older adults may reflect an age-related decrease in the volume of the anterior cingulate cortex in OAs (Resnik, Pham, Kraut, Zonderman, & Davatzikos, 2003), as this brain area is associated with processing of sad faces (Blair, Morris, Frith, Perrett, & Dolan, 1999). Furthermore, the basal ganglia is believed to be spared from aging effects and is related to processing of happy faces (Phan, Wager, Taylor, & Liberzon, 2002) and disgust faces (Calder et al., 2001), hence the preserved neurological functioning may account for the maintenance with age of disgust and happy recognition from faces (Calder et al., 2003). However, a neurological explanation would also suggest that OAs maybe less able to recognise fear compared to YAs as there is evidence that activity in the amygdala declines with age and the amygdala is an important processor of facial displays of fear (Gunning-Dixon et al., 2003; Phillips et al., 1998). However, the current findings suggest that age-related changes in amygdala functioning do not compromise the ability to recognise fear in older age. It is often difficult to relate behavioural outcomes, such as emotion recognition ability, to specific by neurological activity (Hedden & Gabrieli, 2004) but further investigation using modern brain imaging techniques is warranted to increase our understanding regarding the effects of neurological changes on emotion recognition ability in OAs. This will enable research to move beyond correlational associations to establish causation of neurological changes and recognition ability for specific emotions.

Given that OAs and YAs did not differ in levels of empathy, fluid intelligence, and extroversion it is unlikely that these skills and traits may account for the age-related differences in emotion recognition abilities reported here. Furthermore, OAs were not disadvantaged compared to YAs on many characteristics, such as positive and negative affect, anxiety, alexithymia, openness and conscientiousness, that may reduce emotion recognition ability (e.g., Cook, Brewer, Shah, & Bird, 2013; Schmid & Mast, 2010).

Thus, it is unlikely that difficulties for OAs to recognise anger compared to YAs are a function of these abilities. However, it could be argued that the characteristics of the YA participants in the current study for instance, lower positive affect, alongside higher negative affect, neuroticism, and alexithymia compared to OAs, may lower YAs' ability to make accurate emotion recognition judgements. If this were the case then the current findings of largely preserved emotion recognition ability in OAs may reflect difficulties in emotion recognition ability in YAs rather than maintained ability of OAs. However, YAs' ability to recognise happiness appears to be at ceiling suggesting that the YAs had good emotion recognition ability, at least for happiness.

The discussion will now turn to comparing accuracy on the emotion recognition and non-emotion tasks in YAs and OAs. The documented similarities between the emotion and non-emotion tasks allows for confident comparisons between the two. In the current study accuracy was lower on the emotion task than the non-emotion task and OAs and YAs did not differ in accuracy across the two tasks. The latter finding suggests that OAs were as able as YAs to meet the demands of the task. It is likely, therefore, that the age-related decline for anger recognition is not a result of OAs' inability to meet the demands of the task. However, when comparing YAs, younger-older, and older-older adults' accuracy across the emotion and non-emotion tasks, older-older adults were less accurate than both of the younger age groups. Furthermore, the age-related decline in accuracy on the emotion recognition and non-emotion tasks was of a similar magnitude for older-older adults. This finding suggests that the older-older adults had difficulty in meeting the task demands; therefore, any age-related emotion recognition differences that are particular to the older-older adults (i.e., sadness) may be a consequence of task demands rather than emotion processing difficulties. Of interest, despite the apparent difficulty for older-older adults to meet the demands of the task, the older-older adults in the current study did not have emotion recognition deficits across the board. One possible explanation for these emotion specific differences is that older-older adults' difficulty in meeting the demands of the task is detrimental to emotion recognition accuracy only with the most difficult to recognise emotions. For example, in the current study sadness was one of the most difficult emotions to recognise for all age groups. Thus it is possible that selective emotion recognition deficits with advancing older age arise from an interaction of a lower ability to meet the demands of the task and a general difficulty in judging specific emotion types.

To summarise, the current findings demonstrate that OAs with a characteristic profile that is largely supportive of emotion recognition ability, including lower alexithymia than YAs, have limited age-related difficulties in emotion recognition ability. However, OAs are less able than YAs at recognising anger from static faces and this reflects age group differences in emotion processing. Moreover, a general age-related decline for recognising emotion in faces, particularly sadness, is only evident in older-older adults. However, it cannot be stated with confidence that the age-related emotion recognition impairments in older-older adults are a result of emotion processing, as the older-older adults were less able to meet the demands of the task than the two younger age groups.

3.6 Conclusion

Considering the careful task design and the characteristic profiles of the current YA and OA samples it is likely that lower accuracy for anger recognition in OAs is best explained by age group differences in emotion processing. Importantly, the current findings suggest that age-related deficits for sad recognition need to be considered within the context of OAs' ability to meet the demands of the task and the age of the OA sample. Finally, to enable meaningful comparisons the face experiment was designed to be as procedurally similar as possible to the sound and word experiments and these are reported in the next two chapter

Chapter 4 - Experiment 2: The Effect of Age on Emotion Recognition from Non-verbal Affective Vocalisations

4.1 Introduction

Experiment 2 is similar to the other two experiments in Phase 1 except it investigates emotion recognition ability in OAs using auditory non-verbal vocalisations rather than faces or words. The documented evidence suggests that emotion recognition ability from auditory stimuli declines with age (e.g., Lima, Alves, Scott, & Castro, 2014; Mitchell, 2007). Furthermore, the age-related emotion recognition accuracy deficit is reported across different types of auditory stimuli including prosodic sentences (e.g., Mill, Allik, Realo, & Valk, 2009) and non-verbal vocalisations (e.g., Chaby, Boullay, Chetouani, & Plaza, 2015; Orbelo, Testa, & Ross, 2003).

Most of the research in the field, however, does not report performance across discrete emotion types (e.g., Kiss & Ennis, 2001; Raithel & Hielscher-Festabend, 2004). Although findings from studies in the area that do differentiate between emotion types suggest that age-related declines in recognition ability are not uniform across emotions. For example, a study by Chaby, Boullay, Chetouani, and Plaza (2015) found that recognition accuracy for non-verbal vocalisations of fear and anger decline with age, alongside maintenance for recognising neutral, happy, sad, and disgust vocalisations. In contrast, emotion recognition of happiness and sadness from auditory sentences appears to decline in older age, with maintenance for surprise, fear, anger, and disgust (Wong, Cronin-Golomb, & Neargarder, 2005). From the limited research in the field that discriminates between emotion types it appears that emotion recognition may decline in older age and age-related deficits for recognising specific emotions may depend on the stimuli type.

The most commonly used auditory stimuli in the field are semantically neutral sentences spoken in affective prosody (vocal inflections and tone), then non-verbal vocalisations, and finally words spoken in emotion prosody. However, there is evidence that the degree of OAs' emotion recognition impairment depends on the type of stimuli used. For example, Orbelo, Testa, and Ross (2003) measured emotion recognition ability in OAs using auditory information that varied in the length from very short asyllabic (aaaaahhhhh) and monosyllabic (ba ba ba) sounds to spoken prosodic sentences. Compared to YAs, OAs were less able to recognise emotion prosody and the deficit was greater on tasks with short sounds, with less verbal content, than for prosodic sentences. This finding appears to demonstrate that OAs have reduced emotion recognition as the length of verbal emotion information declines. However, Orbelo et al. (2003) did not report performance across emotion types so it is unclear whether OAs simply had a greater general decline with reduced emotion information or if the decline was specific to certain emotion types. Nevertheless, it appears that differences in emotion recognition ability between OAs and YAs may depend on the amount of verbal information in the auditory stimuli.

Furthermore, it is plausible that inconsistencies in the field regarding the extent of emotion recognition decline in older age and which emotions are vulnerable to age-related decline maybe a consequence of between-study methodological differences. For example, the information in Table 2.2 (Appendix 2.1) indicates that emotion recognition tasks using auditory stimuli vary in the number of response options (between two to eight options). The possible implications of between-study variations in task demands including the number of emotion choices and memory load have been extensively explained in previous chapters; particularly in that these inconsistencies make comparisons of findings across studies problematic. The methodological considerations applied to facial expressions also apply to studies using auditory stimuli such as prosodic vocalisations and sentences; thus, further detailed discussion is not necessary here. Suffice to say that the aforementioned factors, including the need to minimise unnecessary task demands, were considered when designing the tasks in Experiment 2.

There is also a need to clarify whether lower accuracy by OAs than YAs on emotion recognition tasks using auditory stimuli can be explained by OAs' ability to meet the demands of the task. Non-emotion tasks, with similar task demands to the emotion task, are required to investigate this possibility. Research in the field that employ non-emotion tasks is scarce; however, when a non-emotion task is included in the experiment the emotion and non-emotion tasks often have methodological disparities. For example, Mitchell and Kingston (2014) used three discrimination tasks, based on pitch; amplitude; and duration, to determine whether OAs were as able as YAs in making non-emotion judgements from sounds. There was no overall difference between the age groups on non-emotion judgements, but OAs were less able than YAs when discriminating sounds by pitch and amplitude. Furthermore, pitch discrimination ability was correlated with prosodic emotion recognition ability. However, the task demands were not equal between the non-emotion and emotion tasks as the discrimination task used short tones, whereas the emotion task used sentences spoken in a happy or sad prosody (Mitchell, Kingston, & Barbosa Boucas, 2011). Obviously sentences and short sounds vary on several aspects: sentences are likely to be more familiar than short sounds of pitch or amplitude, as sentences are typical of real world social interactions; sentences are longer in duration so require more processing; sentences provide more contextual cues than short sound bursts; and processing of sentences, but not short tones, may be influenced by semantic information. In a similar fashion Chaby, Boullay, Chetouani, and Plaza (2015) included a non-emotion task alongside an emotion task but the tasks differed in task demands. Participants in Chaby et al. (2015) completed a short matching sound task using neutral examples taken from the Montreal Affective Voices (MAV; Belin, Filluion-Biloeau, & Gosselin, 2008). However, the non-emotion task was described as short, so it presumably had fewer than the 60 trials used in the emotion task, although the exact number of trials on the non-emotion task is not reported. Moreover, the emotion task required participants to select the appropriate response from six options, whereas for the non-emotion task there appears to be two response options, although this detail is not explicitly stated. Given the methodological differences it is conceivable that the non-emotion task had lower task demands than the emotion task. Taken together between task differences in the emotion and non-emotion tasks make it difficult to draw conclusions regarding OAs' ability to meet the demands of the task. Therefore, accuracy on these non-emotion tasks may not provide an effective explanation of the performance on the emotion task.

In summary, the research to date suggests that OAs are less able than YAs at recognising emotion from auditory information. Moreover, the evidence implies that emotion recognition deficits in OAs, compared to YAs, are not uniform across emotion types. However, there are between-study differences as to which emotions OAs have age-related deficits. Importantly, between-study differences in task demands and the type of auditory stimuli used may provide plausible explanations for the variation in OAs' performance across studies. It is of interest, therefore, to consider the type of auditory information and task demands when interpreting and comparing findings from studies in the field. Moreover, there is a need to understand emotion recognition ability in OAs from tasks that have been specifically designed to reduce unnecessary task demands, and in relation to performance on non-emotion tasks that are closely matched in processing demands to the emotion tasks. In this manner findings should provide a clearer picture of emotion recognition ability in OAs.

In addition to between-study methodological differences the inconstancies in findings in the area may be attributed to differences between the samples. Sample differences can be between groups (i.e., YAs and OAs) or between studies (i.e., the OA sample). The information in Table 4.1 (Appendix 4.1) suggests that cognitive tasks of verbal and fluid intelligence and education status are the most commonly tested sample characteristics (e.g., Hunter, Phillips, & Macpherson, 2010; Kiss & Ennis, 2001; Schaffer, Wisniewski, Dahdah, & Froming, 2009). Of the studies that distinguish recognition accuracy across emotion types, the findings suggest that when OAs and YAs are matched on verbal intelligence and education, then OAs have age-related emotion recognition deficits in recognising either four (Hunter, Phillips, & Macpherson, 2010) or two emotions (Chaby, Boullay, Chetouani, & Plaza, 2015) from non-verbal vocalisations. Similarly OAs, with higher verbal intelligence but lower fluid intelligence than YAs, have emotion recognition deficits for sad and angry non-verbal vocalisations, and sad, fear, anger, and happiness from semantically neutral sentences (Ryan, Murray, & Ruffman, 2010). Therefore, it appears that OAs with verbal intelligence equal to or higher than YAs have emotion recognition deficits. With the exception of a few studies, fluid intelligence is rarely measured in the field when tasks are based on auditory stimuli. A particular gap in the research is whether the pattern of emotion specific age-related deficits in emotion recognition accuracy would be replicated in OAs and YAs matched on fluid intelligence. In summary, OAs with comparable verbal intelligence to YAs have emotion recognition deficits from auditory information. Yet few studies in the area have measured both fluid and verbal intelligence; thus, firm conclusions cannot be made regarding the relationship between intelligence and auditory emotion recognition ability in OAs. To enable more reliable conclusions to be drawn regarding intelligence and emotion recognition from auditory inputs, studies in the field need to measure both fluid and verbal intelligence.

The information in Table 4.1 suggests that, in addition to intelligence, research in the field has sometimes measured affect; this is an important trait to consider given that there appears to be a relationship between current mood and recognition ability of congruent emotions (Schmid & Mast, 2010). Such research reports that OAs tend to have lower negative affect than YAs but the age groups either do not differ in the level of positive affect (Demenescu, Mathiak, & Mathiak, 2014) or OAs have higher positive affect than YAs (Lima, Alves, Scott, & Castro, 2014). Unfortunately, Demenescu, Mathiak, and Mathiak (2014) did not report performance across emotion types, so any impact that mood may have had on recognising emotions of different valance could not be determined. However, Lima, Alves, Scott, and Castro (2014) reported that OAs gave lower ratings than YAs when judging the presence of the target emotion for all of the measured emotions with the exception of sadness. The findings suggest that OAs' lower levels of negative affect than YAs' cannot explain all of the age-related emotion recognition deficits, as OAs and YAs did not differ on sad recognition. Furthermore, OAs were less sensitive to detect happiness than YAs despite OAs having higher levels of positive affect than YAs. There is insufficient evidence, however, to draw firm conclusions regarding the affect of age group differences in affective states on age-related differences in emotion recognition ability from auditory expressions. Given the potential influence of affect on emotion recognition ability it is important that studies in the field can explain any age-related difference, or similarities, in emotion recognition ability within the context of current affect.

In a similar manner to affect, personality may influence emotion recognition ability (e.g., Mayer & Salovey, 1988). Personality has been measured in separate studies using either brief vocalisations or semantically neutral prosodic sentences and the authors reported emotion recognition deficits in OAs compared to YAs (Lima, Alves, Scott, & Castro, 2014; Mill, Allik, Realo, & Valk, 2009). In Lima, Alves, Scott, and Castro (2014) OAs had lower levels of neuroticism and extroversion but higher levels of conscientiousness than YAs. It is possible that age group differences in some personality traits can at least partially explain a decline in emotion recognition ability in OAs. For example, evidence suggests that social activity is positively related to levels of extroversion in OAs (James, Wilson, Barnes, & Bennett, 2011), as such in Lima et al.

the OA participants may experience fewer social interactions than YAs. Thus, YAs relative expertise in social interactions might make them more competent at recognising emotions from sounds than OAs, as social interactions are related to social competence (Sneegas, 1986). Given the potential influence of age-related differences in personality on emotion recognition ability it is important for results from emotion recognition studies to be considered within the context of any differences between OAs with YAs in personality traits.

Aside from intelligence, affect, and personality there appears to be an absence of research that measures other possible confounding sample characteristics alongside emotion recognition ability. Two such factors include cognitive empathy and alexithymia and these are possibly related to emotion recognition ability (Baron-Cohen & Wheelwright, 2004; Lane et al., 2000). Given these potential influences any between-study differences in emotion recognition ability may manifest from age group differences in these emotional and social skills, rather than emotion recognition ability per se. However, the omission in the field for measuring alexithymia and empathy makes it impossible to draw conclusions as to whether any age-related differences in emotion recognition ability can be explained by age group differences in these socio-emotional abilities.

In summary, it is possible that emotion processing per se is not the only factor that contributes to the age group differences in emotion recognition accuracy. Many other skills and characteristics may indirectly lead to age-related differences in emotion recognition ability from auditory information. However, few studies in the area measure these possible confounds; therefore, it cannot be ruled out that age-related differences in emotion recognition ability in OAs may be better explained by age group differences in unmeasured sample characteristics. There is a need for studies in the field to include measures of cognitive abilities, affect, personality, and socio-emotion skills so findings regarding emotion recognition ability in OAs can be discussed within the context of any differences in these characteristics between YAs and OAs. In this manner findings can be more confidently attributed to emotion recognition differences in OAs than studies in the area that do not acknowledge these sample differences.

Finally, any between-study differences in the OA samples may lead to differences in the number of age-related emotion recognition deficits in OAs. The most obvious between-study difference in the field is the age of the OA sample, as the youngest mean age was 54.60 years (Raithel & Hielscher-Festabend, 2004) compared to 74.00 years of age (Orbelo, Testa, & Ross, 2003). As documented in previous chapters cognitive ability and processing, such as fluid intelligence and processing speed, are vulnerable to decline with age and older-older adults are likely to have undergone more changes than younger-older adults (Deary et al., 2009). It is possible that these changes may have a negative impact on OAs' performance on auditory emotion recognition tasks. If this were the case then it would be expected that older-older adults would have broader age-related deficits in emotion recognition ability than younger-older adults. It is apparent that compared to YAs, even younger-older adults experience a general decline in emotion recognition ability from sounds (Raithel & Hielscher-Festabend, 2004). However, neither Raithel and Hielscher-Festabend (2004) nor Orbelo, Testa, and Ross (2003) reported emotion recognition ability across emotion types; therefore, conclusions cannot be made regarding the development of recognition ability for specific emotions with advancing older age. Consequently, there is a need for research to distinguish emotion recognition ability across emotion types between YAs, younger-older adults, and older-older adults. For this reason the current experiment will not only analyse the data between YAs and OAs, in line with much of the research to date, but will also compare the results for older-older and younger-older adults.

To recap, the current experiment aimed to establish emotion recognition ability in OAs from non-verbal vocalisations whilst acknowledging any age-related differences in sample characteristics that may possibly confound the interpretation of results. To achieve this the aims of Experiment 2 were similar to those in Experiment 1 but use non-verbal vocalisations instead of facial expressions.

4.2 Hypotheses

It was predicted that OAs would have lower emotion recognition accuracy than YAs. Particular age-related difficulties were anticipated when recognising anger and fear. When comparing across three age groups it was predicted that older-older adults would have more age-related emotion recognition deficits compared to the YAs and younger-older adults. Finally, it was hypothesised that OAs and YAs would not differ in auditory processing ability or the ability to meet the task demands, as measured by the non-emotion task.

4.3 Method

The experiment comprises of two tasks: an emotion recognition task and a non-emotion task. The general methods, design, and participant information for all of the experiments in Phase 1 have been reported in Chapter 2. Further methodological detail that is specific to Experiment 2 is now given.

4.3.1 Materials.

The auditory database was selected as it fulfilled several criteria: the expressions represented the same emotions types used in Experiment 1, there were sufficient examples to create the task, and the stimuli had evidence of validity. In addition two further aspects were considered: the degree of contextual cues and the need to avoid linguistic content. Regarding the first of these, the degree of contextual information portrayed in the facial expression task was matched, as far as possible, to the stimuli in Experiment 2; the auditory stimuli needed to contain sufficient emotion cues to allow for accurate emotion recognition whilst minimising contextual cues (i.e., no semantic content). To achieve this Experiment 2 used non-verbal vocalisations taken from the Montreal Affective Voices (MAV; Belin, Filluion-Biloeau, & Gosselin, 2008). These audio files have primary communication signals that are believed to be comparable to the innateness associated with facial expressions, as such the emotion expression and judgements from these vocalisations can be compared with emotion facial expression tasks (Belin et al., 2008).

Turning to the need to avoid linguistic content, there is evidence that adults are less accurate when interpreting emotion from prosodic sentences than non-verbal vocalisations (Ryan, Murray, & Ruffman, 2009). Moreover, OAs may process semantic information in sentences to a greater extent than YAs; therefore, it is possible that OAs find emotion recognition from prosodic sentences difficult compared to YAs as semantic information influences the interpretation of prosodic cues (Belin, Fillion-Bilodeau, & Gosselin, 2008; Demenescu, Mathiak, & Mathiak, 2014). Thus, when auditory sentences are used as stimuli in emotion recognition tasks it is difficult to discern whether any age-related differences in OAs are a consequence of emotion or semantic processing. In contrast, non-verbal vocalisations do not contain semantic information; thus, they avoid the semantic-prosody confusion. For this reason the current experiment measured emotion recognition ability from non-verbal vocalisations.

The MAV (Belin et al., 2008) dataset includes 90 non-verbal vocalisations portraying discrete emotions (anger, fear, pain, sadness, surprise, happiness, and pleasure) plus neutral expressions. Ten French-speaking actors created the emotion sounds by stating “Ah” in line with an audio example of the target emotion. The dataset has a high reliability rating (Cronbach’s $\alpha = .98$) (Belin et al., 2008). For the emotions of interest to the current research the lowest rating of intensity (how much of an emotion is displayed with a range between 0 up to 100) for the target emotion (reflecting accuracy rating) was for fearful expressions (average rating = 68) and the highest was for happy expressions (average rating = 81). The sounds varied in length depending on the emotion type (e.g., the mean duration for happiness was 1446 ms and 2229 ms for sadness). For the current experiment the MAV provided the most suitable database for the auditory emotion recognition task as the non-verbal vocalisations avoid any possible processing conflicts between prosodic and semantic information, are low in contextual cues, have evidence for content validity, and are sufficient in number to meet the requirements of the current experiment.

The experiment consisted of 36 experimental trials and eight practice trials giving a total 44 vocalisations (see Appendix 4.2 for a full list of the sound files used). The same vocalisations were used in all five versions of the task and each sound was only heard once with a mean duration of approximately 1.34 (*SD* = 0.59) seconds. Six actors, three males and three females, portrayed one vocalisation for each emotion type (happy, sad, fear, anger, disgust, and neutral). Consequently, there were six trials for each of the six emotion types giving a total of 36 experimental trials. The practice task consisted of one example of each emotion type and three neutral vocalisations produced by four males and four females. The vocalisations in the practice task did not appear in the experimental task.

As detailed when designing the three experiments (face, sound, and word) in Phase 1 several variables (e.g., time for response, number and types of emotions, the number of response options, and the number of trials per category) were matched to create similar procedures across tasks. Further visual similarities were attained across the tasks. To mimic the visual presentation of the laptop screen of the emotion recognition face and word tasks the monitor for the sound task displayed a sound icon in the centre of the screen with the emotion labels underneath in Arial and font size 18 (see Figure 4.3.1).

Figure 4.3.1. An example of the visual presentation during the emotion recognition of affective vocalisations task.

4.3.2 Procedure.

In the emotion recognition task the participants were required to select from the given labels which emotion they thought best represented the emotion heard in the vocalisations. The sequence and the timings of trials are presented in Figure 4.3.2. This continued for all of the 36 trials until the end of the experiment. The order of the trials was randomised for each participant. On each trial a sound icon was presented on the screen and at the same time the auditory vocalisation was heard through external noise reduction Sony headphones. The volume was set at 18 (approximately 65 dBs) on the laptop and was adjusted to a comfortable audible level for each participant during the practice trials as required. The visual display acted as a prompt to participants so they knew when to expect to hear a vocalisation. The vocalisations typically lasted less than 2000 ms but the visual screen remained available until a response was recorded or for a maximum of 4000 ms.

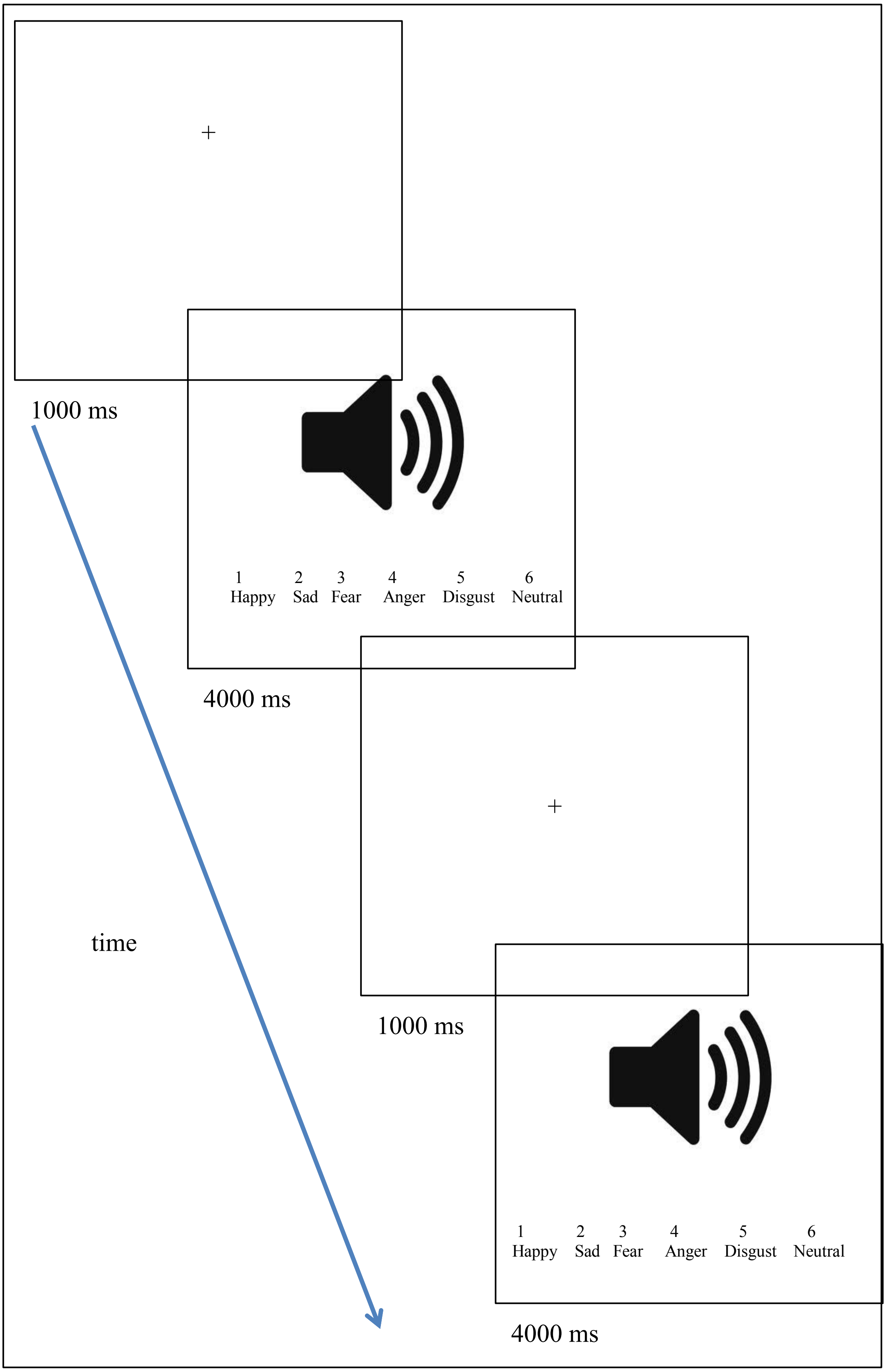


Figure 4.3.2. The order of presentation and duration for each slide in the trials used in Experiment 2.

4.3.3 The non-emotion sound task.

The non-emotion task required the YAs and OAs to select from the given labels which animal they believed had produced the sound (horse, dog, cat, bird, insect) or if the sound was not made by an animal (non-animal). Animal noises are short sound bursts, therefore, make suitable stimuli for the non-emotion task and a comparable alternative to the non-verbal vocalisations in the emotion task. As previously stated, the non-emotion experiment was as visually and procedurally similar to the emotion experiment as possible, except the sounds represented animal noises and non-animal sounds (such as hoover, extractor fan, phone). Specific similarities between the emotion and non-emotion tasks were a computer-based forced-choice task using E prime software, a 4000 ms response time limit, 36 experimental trials, six trials per category, and six response options.

Forty-four sounds were used in the non-emotion task, five of the sounds were taken from Capilla, Belin, and Gross (2012) and the researcher collected the remainder on a voice recorder or recorded on a phone. Audacity software was used to clean the sounds. First the sounds were screened for noise interference by the researcher. Those sounds with audible background noise were excluded from the experiment; thus, there was not a need to remove background noise from the final selection. Next for each of the retained sounds any silent periods before and after the target sound was edited out. To match the sounds used in the MAV (Belin et al., 2008) the sounds were set at 44100 Hz. Finally, the length of the sounds was edited on Audacity software and the emotion and non-emotion sounds were matched for length, $t(70) = .005$, $p = .996$. Each sound was only heard once through Sony sound reduction headphones and the mean duration was approximately 1.34 ($SD = 0.82$) seconds.

To match the emotion task the non-emotion task used stimuli delivered via headphones and run on E prime software, a laptop screen with a sound icon in the centre with the category labels displayed underneath (see Figure 4.3.3), 36 experimental trials (six examples of each animal noise and non-animal sounds), and eight practice trials (one of each animal noise and three non-animal sounds). In total there were 44 trials. All of the trials were randomised across participants to prevent fatigue and practice effects. The procedure on the non-emotion task was the same as the emotion task (i.e., sequence and duration of trials).

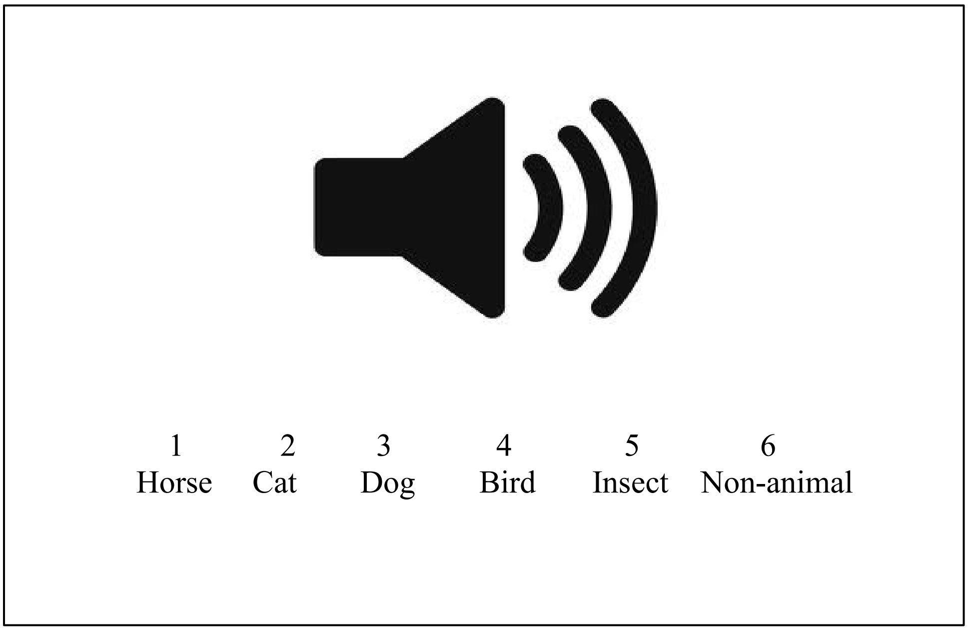


Figure 4.3.3. An example of the non-emotion recognition task using sounds.

4.4 Results

The stages of analysis were similar to Experiment 1. For post hoc tests only significant findings are reported, full results can be found in the appendices (see Appendix 4.3).

4.4.1 Emotion recognition analysis.

Table 4.4.1

Descriptive Statistics Emotion Recognition Accuracy by Emotion Type and Age Group (maximum M = 6)

Emotion	YAs		OAs		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*
Happy	5.97	0.17	5.86	0.36	5.92	0.28
Sad	5.64	0.54	5.34	0.80	5.49	0.69
Fear	4.58	1.68	4.03	1.20	4.31	1.47
Anger	2.64	1.20	2.17	1.25	2.41	1.24
Disgust	4.44	0.96	4.49	0.74	4.46	0.86
Neutral	5.83	0.45	5.17	1.29	5.51	1.01
Total/36	29.11	2.64	27.00	2.75	28.07	2.88

For analysis the data from the five experimental versions were collapsed to create one data set. Descriptive statistics are presented in Table 4.4.1. To analyse emotion recognition ability across the two age groups a mixed factorial 2*6 ANOVA with age group (YAs and OAs) as the between-participants IV and emotion type (happy, sad, fear, anger, disgust, and neutral) as the within-participants IV was conducted with emotion recognition accuracy as the DV. Mauchly's test of sphericity was significant, $\chi^2(14) = 86.37$, $p < .001$, therefore Greenhouse Geisser corrected values are reported. There was a main effect of emotion type, $F(3.50, 241.23) = 123.56$, $p < .001$, $\eta_p^2 = 0.64$. Post hoc paired t-tests, with $\alpha = 1\%$, were conducted to investigate which emotions were more accurately recognised (see Table 4.4.2). All comparisons were significantly different in accuracy scores to each other with only two exceptions (sad and neutral; fear and disgust). In general, accuracy was higher for happy vocalisations than all other emotion types and anger had lower accuracy than all emotion types.

Table 4.4.2

Inferential Statistics for Emotion Recognition Accuracy by Emotion Type in Experiment 2

Comparison	*t*(70)	*p*	95% CI		*d*
			LL	UL	
Happy>Sad	4.88	**< .001**	0.25	0.60	0.80
Happy>Disgust	13.97	**< .001**	1.24	1.66	2.27
Happy>Fear	9.04	**< .001**	0.18	1.96	1.50
Happy>Anger	23.39	**< .001**	3.21	3.81	3.89
Happy>Neutral	3.24	**.002**	0.16	1.56	0.54
Sad> Disgust	8.11	**< .001**	0.78	1.28	1.32
Sad>Fear	6.21	**< .001**	0.80	1.56	1.02
Sad>Anger	18.68	**< .001**	2.76	3.41	3.07
Neutral>Disgust	6.47	**< .001**	-1.36	-0.72	1.12
Neutral>Fear	5.65	**< .001**	-1.62	-0.77	0.95
Neutral>Anger	16.74	**< .001**	-3.47	-2.73	2.74
Anger<Disgust	13.03	**< .001**	-2.37	-1.74	1.92
Anger<Fear	8.47	**< .001**	1.45	2.35	1.39
Fear=Disgust		ns			
Neutral=Sad		ns			

Note. ns = nonsignificant. Lowest nonsignificant value p = .412 (fear-disgust)

There was also a significant main effect of age, $F(1, 69) = 11.00$, $p = .001$, $\eta_p^2 = 0.14$ with YAs having higher emotion recognition accuracy than OAs. However, there was not a significant Age Group* Emotion Type interaction, $F(3.50, 241.23) = 1.37$, $p = .250$, $\eta_p^2 = 0.02$ (see Figure 4.4.1). In summary, compared to YAs, overall emotion recognition accuracy from non-verbal vocalizations was impaired in OAs and the magnitude of the age-related difference was similar across emotion types. This finding suggests that OAs' lower emotion recognition accuracy than YAs was not greater for any specific emotion type.

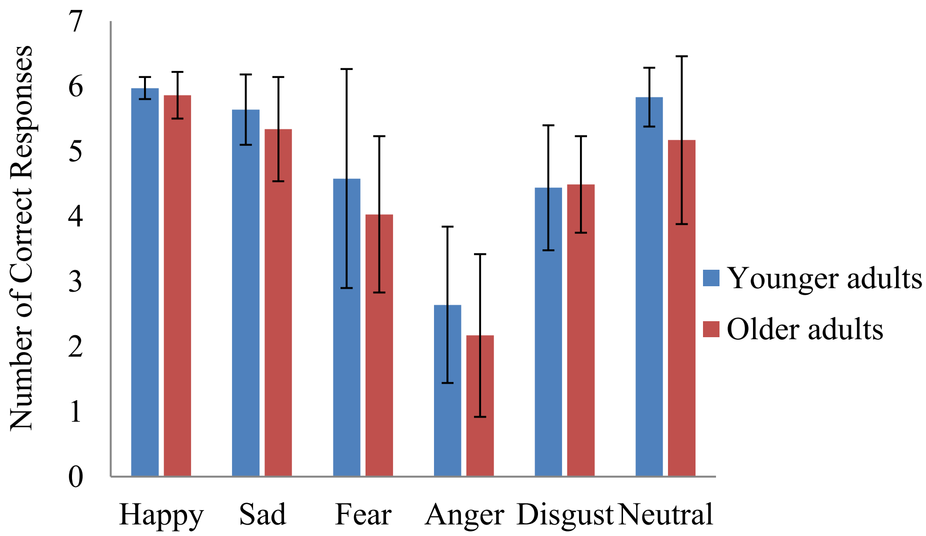


Figure 4.4.1. Emotion recognition accuracy from non-verbal vocalisations by age group (YAs n = 36; OAs n = 35) and emotion type (maximum M = 6).

4.4.2 Comparison of the younger-older and older-older samples.

Table 4.4.3

Descriptive Statistics for Emotion Recognition Accuracy by Emotion Type for Younger-older Adults and Older-older Adults (maximum M = 6)

Emotion	Younger-older Adults		Older-older Adults	
	M	*SD*	*M*	*SD*
Happy	5.83	0.38	5.88	0.33
Sad	5.39	0.70	5.29	0.92
Fear	4.11	0.96	3.94	1.43
Anger	2.33	1.28	2.00	1.22
Disgust	4.22	0.55	4.76	0.83
Neutral	5.22	1.35	5.12	1.27
Total	27.11	2.64	26.88	3.24

The ANOVA analysis was repeated when the OA sample was split into younger-older adults and older-older adults as previously described in Chapter 2. Descriptive statistics are presented in Table 4.4.3. A mixed factorial 3*6 ANOVA with age group (young, younger-older, and older-older adults) as the between-participants IV and emotion type (happy, sad, fear, anger, disgust, and neutral) as the within-participants IV was conducted with emotion recognition accuracy as the DV. Mauchly's test of sphericity was significant, $\chi^2(14) = 87.09$, $p < .001$, therefore Greenhouse Geisser corrected values are reported. There was a significant main effect of emotion type, $F(3.45, 234.79) = 111.75$, $p < .001$, $\eta_p^2 = 0.62$. See Table 4.4.2 for post hoc t tests for investigating the main effect of emotion.

There was a significant main effect of age group, $F(2, 68) = 5.43$, $p = .006$, $\eta_p^2 = 0.14$. Post hoc independent t-tests, with Bonferroni adjustment at $p < .017$, demonstrated that YAs had higher emotion recognition accuracy than both older-older adults, $t(51) = 2.67$, $p = .010$, $d = 0.75$, and younger-older adults, $t(52) = 2.74$, $p = .008$, $d = 0.81$. There was no significant difference in emotion recognition accuracy between younger-older and older-older adults ($p = .810$). Although there was no significant Age Group*Emotion Type interaction, $F(6.91, 234.79) = 1.10$, $p = .363$, $\eta_p^2 = 0.03$ (see Figure 4.4.2). In summary, older-older and younger-older adults did not significantly differ in emotion recognition accuracy. In contrast, compared to YAs, both older-older adults and younger-older adults had lower accuracy for emotion recognition from non-verbal vocalisations. However, the size of the age-related recognition deficits was similar across emotion types.

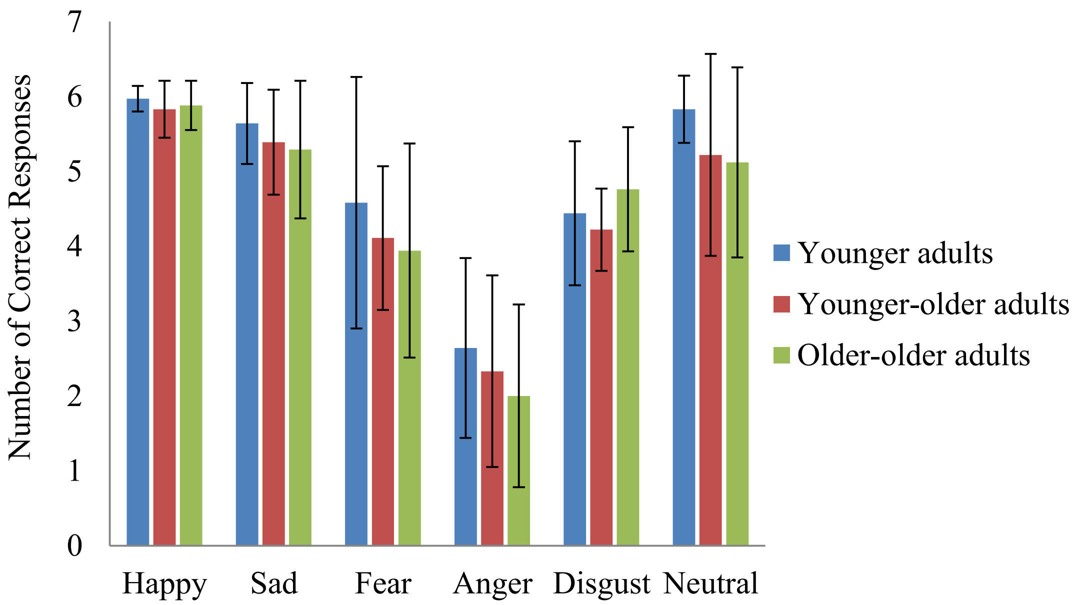


Figure 4.4.2. Emotion recognition accuracy from non-verbal vocalisations by age group (YAs n = 36; Younger-older adults n = 18; Older-older adults n = 17) and emotion type (maximum M = 6).

4.4.3 Comparing accuracy on the emotion and non-emotion sound tasks.

Table 4.4.4

Descriptive Statistics for Total Accuracy on the Emotion and Non-emotion Tasks) by Age Group (maximum M = 36)

	Younger adults		Older adults		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*
Emotion Task	29.11	2.64	27.00	2.75	28.07	2.88
Non-emotion Task	30.89	2.30	28.89	3.20	29.90	2.94
Total/72	60.00	3.94	55.89	4.59		

Since it is not of interest to understand how adults performed on the non-emotion task for the different animal sounds the results were collapsed across categories to give a possible overall score of 36 (see Table 4.4.4 for descriptive statistics). A mixed factorial 2*2 ANOVA with age group (YAs and OAs) as the between-participants IV and content type (emotion and non-emotion) as the within-participants IV was conducted with total accuracy scores as the DV. There was a significant main effect of content type with non-emotion content having higher accuracy than emotion content, $F(1, 69) = 20.25$, $p < .001$, $\eta_p^2 = 0.23$. There was also a significant main effect of age group with YAs having higher accuracy than OAs, $F(1, 69) = 16.48$, $p < .001$, $\eta_p^2 = 0.19$. There was, however, no significant Age Group*Content Type interaction, $F(1, 69) = 0.02$, $p = .895$, $\eta_p^2 = 0 .00$ (see Figure 4.4.3). This finding suggests that the OAs were less accurate than YAs on the emotion task and the non-emotion task and the magnitude of the age-related difference did not differ across tasks. It is possible, therefore, that the emotion recognition deficit in OAs is a consequence of OAs' lesser ability to meet the demands of the task than YAs.

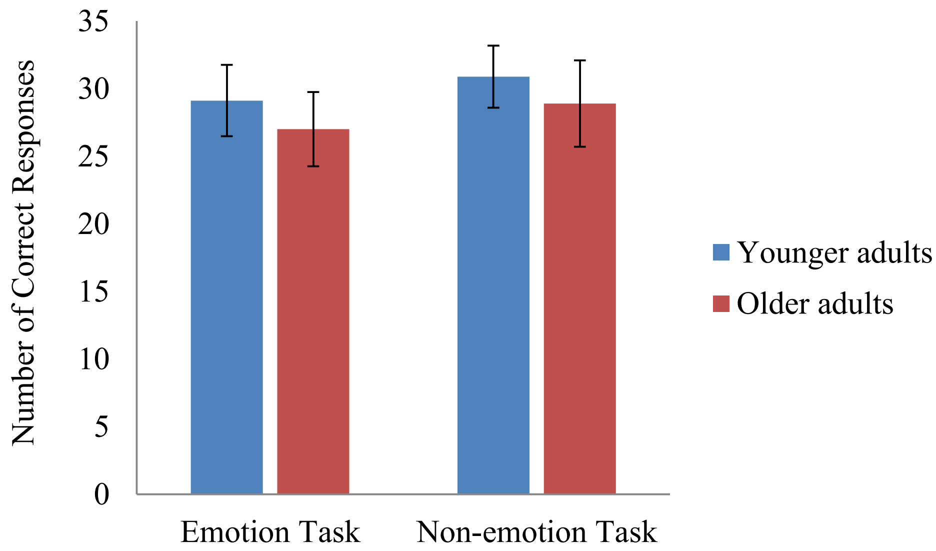


Figure 4.4.3. The total mean accuracy score on the emotion and non-emotion tasks in Experiment 2 (the maximum score on each task = 36) by age group (YAs $n = 36$; OAs $n = 35$).

Table 4.4.5

Descriptive Statistics for Total Accuracy on the Emotion and Non-emotion Tasks by Younger-older and Older-older Adults (maximum M = 36)

	Younger-older adults		Older-older adults	
	M	*SD*	*M*	*SD*
Emotion Task	27.11	2.30	26.88	3.24
Non-emotion Task	30.17	2.68	27.53	3.20
Total/72	57.28	3.59	54.41	5.15

The same analysis was repeated across three age groups (YAs, younger-older adults and older-older adults), see Table 4.4.5 for descriptive statistics. A mixed factorial 3*2 ANOVA with age group (YAs, younger-older adults, and older-older adults) as the between-participants IV and content type (emotion and non-emotion) as the within-participants IV was conducted with total accuracy scores as the DV. There was a significant main effect of content type with non-emotion content having higher accuracy than emotion content, $F(1, 68) = 18.88$, $p < .001$, $\eta_p^2 = 0.22$. There was also a significant main effect of age group, $F(2, 68) = 10.67$, $p < .001$, $\eta_p^2 = 0.24$. Post hoc t tests, with Bonferroni adjustment set at $p < .017$, demonstrated that YAs had higher accuracy than both younger-older adults, $t(52) = 2.46$, $p = .017$, $d = 0.68$[2], and older-older adults, $t(51) = 4.36$, $p < .001$, $d = 1.22$. There was no significant difference on total performance between younger-older and older-older adults ($p = .064$). There was no significant Age Group*Content Type interaction, $F(2, 68) = 2.28$, $p = .111$, $\eta_p^2 = 0.06$ (see Figure 4.4.4).

In summary, accuracy was higher in YAs than both of the older age groups but the size of the age-related difference did not differ across the tasks. It is possible

[2] When controlling for multiple comparisons this is only marginally significant.

therefore, that lower emotion recognition ability in older-older and younger-older adults is a consequence of the older age groups being less able than YAs to meet the demands of the task rather than emotion recognition ability per se. However, of note the interaction shown in Figure 4.4.4 suggests that younger-older adults had reduced emotion recognition ability but similar accuracy on the non-emotion to YAs but this differential trend was not statistically significant.

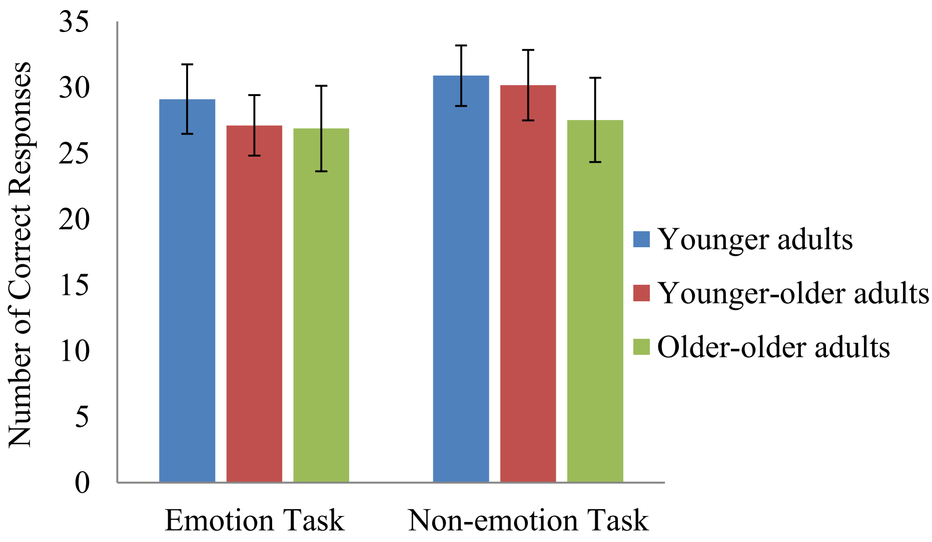


Figure 4.4.4. The total mean accuracy scores on the emotion and non-emotion tasks in Experiment 2 (maximum total score = 36) by age group (YAs n = 36; younger-older adults n = 18; older-older adults n = 17).

4.5 Discussion

The aims of Experiment 2 were essentially the same as the aims of Experiment 1; however, non-verbal vocalisations were used as stimuli instead of static faces. It was hypothesised that OAs would have lower emotion recognition accuracy from affective non-verbal vocalisations than YAs. Furthermore, it was predicted that age-related differences would not be uniform across emotion types, with age-related deficits for anger and fear recognition in OAs. Next it was predicted that older-older adults would have broader age-related recognition impairments compared to younger-older adults.

Finally, it was hypothesised that accuracy on the non-emotion task would be comparable between OAs and YAs. The hypotheses were partially supported, as overall emotion recognition accuracy was lower in OAs than YAs. However, the nonsignificant interaction of the current study suggests that the magnitude of the age-related differences did not significantly differ across emotion types. Thus compared to YAs, OAs did not have lower, or higher, emotion recognition for any specific emotion types. Moreover, the mean scores suggest that accuracy across emotion types were only marginally lower in OAs than YAs. Thus it appears that compared to YAs, OAs were not greatly disadvantaged in the recognition of any specific emotions. Furthermore, against predictions the extent of the emotion recognition deficit did not seem to increase with advanced older age. Finally, OAs were less accurate than YAs on the non-emotion task. Given that older-older adults' emotion recognition accuracy was similar to that of younger-older adults the discussion will focus on comparisons between YAs and OAs.

A general age-related deficit for emotion recognition from non-verbal vocalisations is in line with previous research using the same stimuli (Chaby, Boullay, Chetouani & Plaza, 2015; Hunter, Phillips, & MacPherson, 2010) and those that have used prosodic sentences (e.g., Kiss & Ennis, 2001). However, in contrast to research in the field the current study did not find that OAs and YAs differed in their ability to recognise specific emotions. In particular similar to the current experiment both Chaby, Boullay, Chetouani, and Plaza (2015) and Hunter, Phillips, and MacPherson (2010) measured emotion recognition ability in OAs using sound files taken from the MAV; however, unlike the current study the authors reported age-related deficits in OAs for anger and fear recognition. In the current study OAs appear to be less accurate in recognising fear and anger than other emotion types but the age-related decline for these emotions types was similar in magnitude to the declines in other emotion types. There were, however, methodological differences between the aforementioned studies. For instance, contrary to the imposed 4000ms response time limit in the current experiment the emotion recognition task in Chaby et al. was self-paced and the stimuli was repeated until a response was given. In contrast the task used in Hunter et al. was self-paced and the stimulus was presented once. It is unclear, however, how the self-paced nature and repeated exposure to the stimuli may have resulted in emotion specific deficits in OAs compared to YAs. Thus it is difficult to attribute the disparate findings to these methodological variations; therefore, the findings may be better explained by differences between the samples.

It is conceivable that intrinsic confounding sample differences, rather than methodological dissimilarities, can explain the disparity in findings between the three studies. It is accepted that the different observations between the current study and both Chaby et al. and Hunter et al. are unlikely to manifest from age differences in the OA samples as these were all similar (the mean ages were 70 years, 67.2 years, and 66.96 years respectively). Furthermore, the OAs in all three studies were considered to have good cognitive health and a level of verbal intelligence at least equivalent to the YAs. However, neither Chaby et al. nor Hunter et al. measured other possible confounding variables such as empathy, alexithymia, or personality. Therefore, the findings cannot confidently be attributed to a direct effect of emotion processing of anger or fear in sounds; rather the findings may be an indirect effect of another unmeasured characteristic. It is acknowledged that most relationships observed for emotion recognition ability and socio-emotion skills, traits, affect, and cognitive ability are based on facial experiments; the same relationships are largely yet to be established using auditory information. Nevertheless, the absence of measuring these abilities means that their possible influence on emotion recognition ability cannot be ruled out. In contrast, the current findings suggest that it is unlikely that the age-related decline in emotion recognition ability from non-verbal vocalisations is a consequence of empathy, alexithymia, personality, or intelligence, as the direction of any age-related differences in these traits and skills meant that they were unlikely to hinder OAs' emotion recognition ability. The findings of the present experiment, therefore, can be more confidently stated as representing emotion recognition ability in OAs to a greater extent than experiments that have not applied such rigorous methods.

Together the current findings regarding emotion recognition ability in OAs fail to provide support for some of the proposed explanations regarding why emotion recognition ability may change in older age. First, there is little evidence to support a neurological explanation for age-related decline in emotion recognition per se, as the age-related impairment in recognition ability in OAs was similar across emotion types. A neurological explanation of emotion recognition decline in older age would suggest that emotion recognition ability in OAs would vary across emotion types in line with age-related changes in neurological functioning. For instance, anger and sad sounds are believed to activate the OFC (Hornak et al., 2003; Sander et al., 2005) and this area is thought to decline more rapidly with older age than other frontal regions (Raz et al., 1997). Therefore, it might be expected that OAs' recognition of angry and sad sounds would demonstrate a greater decline than other emotion sounds. Furthermore, it would be expected that any effect on emotion recognition ability from neurological changes would be evident in older-older adults who would presumably have advanced neurological demise than younger-older adults; however, even in this more elderly age group variation in emotion recognition ability across emotion types was not observed. Second, the findings do not appear to support a positivity effect in emotion recognition. A positivity effect would suggest that OAs, compared to YAs, would have either maintained or enhanced recognition ability of positive emotions alongside a reduced ability to recognise negative emotions but this was not found.

In contrast, slowing in processing speed as part of cognitive aging may provide one explanation for OAs' lesser ability to recognise emotions from non-verbal vocalisations than YAs, as OAs had slower processing speed than YAs. It is well documented across different tasks that age-related slowing in processing is related to reduced performance in OAs (Salthouse, 1991). Specific to auditory tasks processing speed may partially account for reduced spoken language comprehension (Pickora-Fuller, 2003). Therefore, slower processing speed with age may have reduced OAs' accuracy in the current task. However, processing speed is unlikely to provide the singular explanation for the current findings as the older-older adults had slower processing speed than the younger-older adults but this was not mirrored by further emotion recognition decline with advancing older age. Thus processing speed cannot account for the maintenance of emotion recognition ability between the older age groups.

Alternatively, it is possible that OAs were less sensitive to the sounds in the task than YAs, due to sensory hearing loss typical of older age (Wingfield, Tun, & McCoy, 2005). The OAs self-reported as having normal hearing and none stated that they were unable to hear the stimuli. However, an objective hearing test was not conducted in the current study thus the effect of any reduced sensory hearing in older age cannot be ruled out. Yet a sensory processing explanation would go against previous reports that sensory hearing does not account for age-related declines in emotion recognition ability (Dupuis & Pichora-Fuller, 2015; Orbelo, Grim, Talbott, & Ross, 2005). Thus the findings are unlikely to be a function of sensory hearing loss in OAs.

An important finding from the current experiment is that OAs were less able to make categorical judgements from non-emotion sounds than YAs. The careful design of the non-emotion task meant that it was as similar as possible in procedure to the emotion task; this enables meaningful conclusions to be drawn. Since the two older age groups (younger-older and older-older adults) did not differ in accuracy on the emotion and non-emotion tasks then further discussion will concentrate on differences between the YAs and OAs. Importantly compared to YAs, OAs were as equally disadvantaged on the non-emotion task and the emotion task. Therefore, OAs do not have an age-related deficit for emotion recognition ability per se, rather OAs have a lesser ability to process and make categorical judgements from short sounds . This observation raises concerns regarding the validity of previous reports of age-related deficits in emotion recognition ability in OAs from sounds, particularly non-verbal vocalisations. Further studies using methodologically similar non-emotion and emotion tasks are essential to replicate these findings; however, it appears that OAs have difficulties in processing short sounds and this is not limited to emotion sounds.

A reduced ability to process sounds with age may be a function of age-related cognitive and neurological changes, and may reflect a central auditory processing deficit; OAs have a cognitive impairment leading to reduced auditory processing that is separate from sensory decline (Atcherson, Nagaraj, Kennett, & Levisee, 2015). Although the mechanisms of a central auditory processing deficit in older age are yet to be firmly established there is evidence that some OAs with hearing within normal thresholds may have difficulty processing sounds (Atcherson, Nagaraj, Kennett, & Levisee, 2015). However, a central processing deficit is usually observed in conditions with background noise, thus may not be a suitable explanation for the findings of reduced auditory processing in the absence of background noise.

Further evidence suggests that the auditory temporal cortex is important in processing and identifying sounds (Arnott, Binns, Grady, & Alain, 2004; Kaiser, Ripper, Birbaumer, & Lutzenberger, 2003). Specifically, the superior temporal gyrus is recruited during the processing of both animal and human vocalisations (Capllia, Gross, Belin, 2012; De Lucia, Clarke, & Murray, 2010; Doehrmann, Naumer, Volz, Kaiser, &

Altman, 2008). Thus, any neurological or processing changes in the temporal regions with age may explain the current findings, that OAs appear to be less able to process and categorise short sounds. Furthermore, neurological research suggests that, compared to YAs, OAs are less proficient at temporal coding of gap detection and duration discrimination, important functions in processing speech, particularly for short sounds than YAs (Schneider & Pichora-Fuller, 2001). Thus any difference in temporal processing between the age groups may explain OAs' deficits in comprehending sounds (Strouse, Ashmead, Ohde, & Grantham, 1998). Of interest, findings suggest that neurological changes in older age account for differences in processing of auditory stimuli over and above that of loss in sensory processing (Martin & Jerger, 2005). Taken together any differences between YAs and OAs in temporal activation and temporal processing of auditory stimuli may explain the age-related difficulties in recognising sounds in the current study. However, further research is required to compare neural activity and recruitment between OA and YA participants whilst performing forced-choice tasks similar to the ones in the current study. In this manner behavioural outcomes can be meaningfully associated to neurological data.

4.6 Conclusion

When OAs were unlikely to be compromised on emotion recognition due to intelligence, empathy, personality, and alexithymia, and emotion tasks were designed to have minimal contextual cues and minimise unnecessary task demands, then OAs had lower emotion recognition accuracy from non-verbal vocalisations than YAs. However, the magnitude of the decline did not vary across emotion types. Moreover, the age-related emotion recognition deficit in OAs did not appear to deteriorate further with advancing older age. However, of central importance to current knowledge is that, compared to YAs, OAs have difficulties in processing sounds regardless of content. Thus, age-related declines in emotion recognition ability from non-verbal vocalisations are better explained by a lower ability in OAs, than YAs, to process sounds rather than a specific emotion-processing deficit. Therefore, the important finding from the current experiment is that emotion recognition deficits in OAs, compared to YAs, do not represent a lesser ability to recognise emotions; rather OAs have a more general deficit for processing and making categorical judgments from short sounds. The findings, therefore, imply that previous observations of age-related emotion recognition deficits in OAs from non-verbal vocalisations that have not used rigorous controls should be interpreted with caution.

Chapter 5 - Experiment 3: The Effect of Age on Emotion Recognition from Single Words

5.1 Introduction

This chapter details Experiment 3 in Phase 1 of the current research programme. As explained in previous chapters all of the three experiments in the series follow similar procedures to investigate emotion recognition ability in OAs. However, the experiments differ by the presentation type. Specifically, Experiment 3 used visual presentations of single words. This communication channel provides an alternative measure of visual processing to facial expressions, thus expanding knowledge of emotion recognition ability in OAs beyond faces. Compared to other presentation types there has been little empirical attention given to investigating age-related emotion recognition from single words (hence a table summarising the research in the area is not necessary). However, evidence does suggest that emotion processing of words may differ between YAs and OAs, as OAs appear to rate emotion related words more positively than YAs (Ready, Santorelli, & Mather, 2017). Given these possible processing differences and that OAs have lower emotion recognition accuracy than YAs in tasks that use facial expressions or various types of prosodic sounds (e.g., Calder et al., 2003; Lima, Alves, Scott, & Castro, 2014) it is conceivable that similar emotion recognition deficits exist when emotion information is conveyed in visual words.

To date the scant evidence in the field appears to be conflicting, as OAs either have a deficit or maintenance in emotion recognition ability from single words, compared to YAs (Grunwald et al., 1999; Keightley, Winocur, Burianova, Hongwanishkul, & Grady, 2006). However, the difference in findings may reflect between study disparities in the design of the task. For example, the studies differed in the number of emotion choices, as in the study by Grunwald et al. (1999) the participants were required to make emotion recognition judgements from eight response options as opposed to three response options in the study by Keightley, Winocur, Burianova, Hongwanishkul, and Grady (2006). Thus, the experiment in Grunwald et al. had higher task demands than the experiment in Keightley et al. (2006); as explained in previous chapters higher task demands might disadvantage OAs more than the YAs due to cognitive decline in older age. It is conceivable, therefore, that the ability of OAs to meet the task demands, relative to YAs, may account for the dissimilar findings between these two studies.

The disparities in findings between Grunwald et al. (1999) and Keightley et al. (2006) may also be explained by between-study sample differences. For instance, the age groups in Grunwald et al. were matched on years in education, general intelligence (assessed by the Information subtest of the WAIS-R; Wechsler, 1981) and mood (as measured by the BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961). In contrast, the OAs in Keightley et al. performed less well than YAs on several cognitive measures including working memory, remembering verbal material, and inhibition ability as measured by a Stroop task. However, the OAs in Keightley et al. had higher verbal intelligence than YAs, and the OAs and YAs were comparable in sequencing and visual search ability. Therefore, age group differences on several characteristics were limited in Grunwald et al. but the OAs had mixed cognitive abilities relative to YAs in Keightley et al. . These between-study sample differences in cognitive abilities may explain the different findings between the two studies. Given that Grunwald et al. found an age-related decline in emotion recognition ability in OAs with comparable intelligence to YAs, it could be argued that these findings are not a result of age group differences in cognitive ability, at least with regards to intelligence. However, cognitive ability is not limited to intelligence and it is unclear how well matched the age groups were on other skills including processing speed, inhibition, or working memory; thus, firm conclusions regarding the relationship between cognitive ability and emotion word recognition cannot be made. An alternative explanation, however, is that superior verbal intelligence in OAs, than YAs, in Keightley et al. may have compensated for age-related declines in other cognitive abilities, resulting in an age-related maintenance of emotion recognition ability in OAs on the words task. Yet, the limited research in the field prevents firm conclusions to be drawn regarding the possible impact of age group differences in cognitive functioning, including verbal intelligence, on emotion recognition accuracy from single words. Given the possibility that age-related differences in cognitive abilities such as processing speed and fluid intelligence may account for emotion recognition decline in older age (e.g., Horning, Cornwall, & Davis, 2012), it is important to discuss findings within the context of age group differences in cognitive ability.

In line with a cognitive aging perspective it is plausible that any age-related differences in emotion recognition ability results from an impaired ability in OAs, compared to YAs, to meet the demands of the emotion task. Interestingly, Grunwald et al. (1999) included a non-emotion task that was procedurally similar to the emotion task (i.e., a forced choice format with eight response options) and the findings suggest that OAs were less accurate than YAs on both the emotion and the non-emotion task. It is conceivable therefore, that any age-related emotion recognition differences result from a lesser ability in OAs than YAs to meet the demands of the task, rather than reduced emotion recognition ability per se. In a similar manner, to assess the ability to meet task demands a non-emotion task was included in the current experiment. The non-emotion and emotion tasks were as procedurally and visually similar to each other as possible to enable confident comparisons between the two.

Further to cognitive abilities, Keightley et al. (2006) found that OAs and YAs did not differ in their levels of alexithymia and personality traits. As documented in Chapter 2 these characteristics may influence emotion recognition ability. It is conceivable, therefore, that similarity between the age groups in these traits may have accounted for maintenance of emotion recognition ability in OAs. In contrast, Grunwald et al. (1999) did not include measures of personality or alexithymia. Thus, it cannot be ruled out that the findings in Grunwald et al. may be better explained by these unmeasured characteristics than by age-related differences in emotion recognition ability. Given the possible implications of differences in sample characteristics on emotion recognition ability there is a need for findings in the current study to be discussed within the context of any age group differences in personality traits, mood, empathy, and alexithymia.

Neither of the aforementioned studies, however, distinguishes recognition ability across emotion types. It is unclear, therefore, whether OAs and YAs differ in recognition ability across emotion types from single words. There is evidence that OAs have emotion specific difficulties in recognising emotion from written sentences and written texts (Isaacowitz et al., 2007; Wieck & Kunzmann, 2017). Isaacowitz et al. (2007) reported that OAs were less able to attribute the correct emotion to the target person in the sentence ("An older man looks at the picture of his recently departed wife" p. 150). On this task OAs were less able to correctly attribute emotions of happiness, fear, anger, disgust, surprise, and neutral states than YAs, there was no age groups difference for attributing sadness to the target. However, it could be argued that attributing emotion to individuals in written scripts relies on somewhat different mechanisms than recognising emotions in words, as the latter relies on attributing the semantic meaning to the target word, whereas emotion identification in scripts may rely on relating the scenario to personal experience and knowledge regarding the situation (Oatley, 1994). In a separate study, OAs were as able as YAs to rate anger and sadness in written texts but the detail of the stimuli is vague and findings are limited to these two select emotion types (Wieck & Kunzmann, 2017). Thus, there is a lack of evidence regarding OAs' emotion recognition ability for specific emotions from single words and findings from other lexical tasks give conflicting results. The current research will, therefore, address a gap in the literature by investigating emotion word recognition in OAs, compared to YAs, and discerning between emotion types.

To recap, the current experiment aimed to investigate emotion recognition ability in OAs from visual single words using tasks designed to minimise the effects of task demands. Furthermore, findings will be discussed regarding between group differences in several sample characteristics that may potentially provide alternative explanations of any age group differences in emotion recognition ability. Hence, any age-related differences in emotion recognition ability in the current study can be more confidently attributed to emotion processing, rather than possible confounds that make interpretation of the results difficult. Thus the aims of Experiment 3 were similar to those of Experiments 1 and 2 but used single words instead of facial expressions or non-verbal vocalisations.

5.2 Hypotheses

It was predicted that general emotion recognition accuracy from words would be lower in OAs than YAs. Given the lack of research in the field using word tasks predictions for the recognition of specific emotions are based on findings from other presentation types; thus it was predicted that age-related impairments in recognition ability in OAs would be particular to words related to anger, fear or sadness, whereas OAs and YAs would not differ in the ability to recognise words related to happiness and disgust. It was also predicted that older-older adults would have more age-related emotion recognition deficits compared to the YAs and younger-older adults. Finally, it was hypothesised that OAs would be less able to categorise non-emotion words than YAs.

5.3 Method

The experiment comprises of two tasks: an emotion recognition task and a non-emotion task. The general methods, design, and participant information for all of the experiments in Phase 1 have been reported in Chapter 2. Further methodological detail that is specific to Experiment 3 is now given.

5.3.1 Participants.

The same participants who undertook the facial expression and sound experiments completed the emotion recognition from word tasks (YAs n = 36; and OAs n = 35). However, due to a technical issue one YA participant could not complete the non-emotion word task so for this condition only n = 35 for YAs.

5.3.2 Materials.

As described in the preceding chapters the three experiments in Phase 1 were carefully designed to match each other, as far as possible, on several variables (e.g., time for response, number and type of emotions, number of response options, and number of trials per category). Single words are an appropriate format to assess visual based emotion recognition as evidence suggests that emotions can be judged from this information (Grunwald et al., 1999). Further, emotion recognition from more complex lexical structures, such as sentences, are likely to be more cognitively demanding than single words; thus tasks based on sentences are perhaps more susceptible to the effects of cognitive changes in older age than tasks based on single words (Grunwald et al., 1999; Isaacowitz et al., 2007). Therefore to avoid any possible disadvantage for OAs in processing sentences and to match, as far as possible, the limited contextual cues in the face and auditory stimuli, the lexical stimuli in the current research used visually presented single words.

At the time of the research the current author was unaware of a suitable database with evidence of reliability, validity, and sufficient words associated with the discrete emotions needed for the task. Hence the researcher created a novel word task. In the current research words that represented the five emotions (happiness, sadness, anger, fear, and disgust) were collated through several sources including the Collins English

Dictionary and Thesaurus (1997) and the DeRose (2005) emotion word list. Neutral words were defined as having a valence rating of four or five on a nine-point scale from happy to sad according to the Affective Norms for English Words (ANEW; Bradley & Lang, 1999). Careful selection of the words included, as far as possible, the exclusion of homographs (a word with several meanings, such as bank) and homophones (words that sound the same but have different meanings such as peace and piece) and the repetitive use of the same stem words (e.g., *revolt*ed and *revolt*ing). A pool of possible words for the stimuli was created. The final words were matched for frequency according to MRC word frequency guide (Coltheart, 1981) and word length across the six emotion categories (see Appendix 5.1 for a full list of the words used and Appendix 5.2 for t-tests).

The emotion recognition task consisted of 36 experimental trials and eight practice trials giving a total 44 trials. As such the experimental trials were made up of 36 words comprising of six words that were semantically related to one of six emotion types (happy, sad, fear, anger, disgust, and neutral). For example, jovial (happy); sorrow (sad); dreaded (fear); fuming (anger); appalled (disgust); and engine (neutral). The practice task consisted of one word in each of the emotion categories and three neutral words. The words used in the practice task did not appear in the experimental task. To mimic the visual presentation of the laptop screen of the emotion recognition face and auditory tasks the word stimulus was displayed in the centre of the screen in Arial Bold font size 35 with the emotion labels underneath in Arial and font size 18 (see Figure 5.3.1).

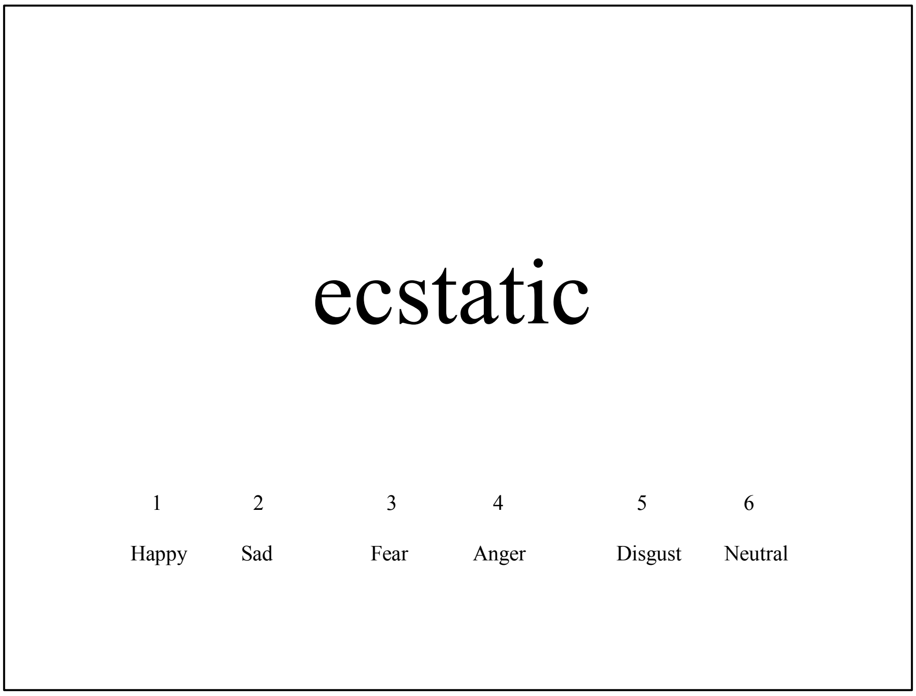


Figure 5.3.1. An example of the emotion word task. In this instance the correct response would be 1 (happy).

5.3.3 Procedure.

In the emotion recognition task the participants were required to select from an array of emotion labels which emotion they thought was closest in meaning to the affective word stimulus. The procedure of the emotion task was similar to the face and auditory task and the sequence and timings for the trials are presented in Figure 5.3.2. This continued for all 36 trials until the end of the experiment. The order of the trials was randomised for each participant.

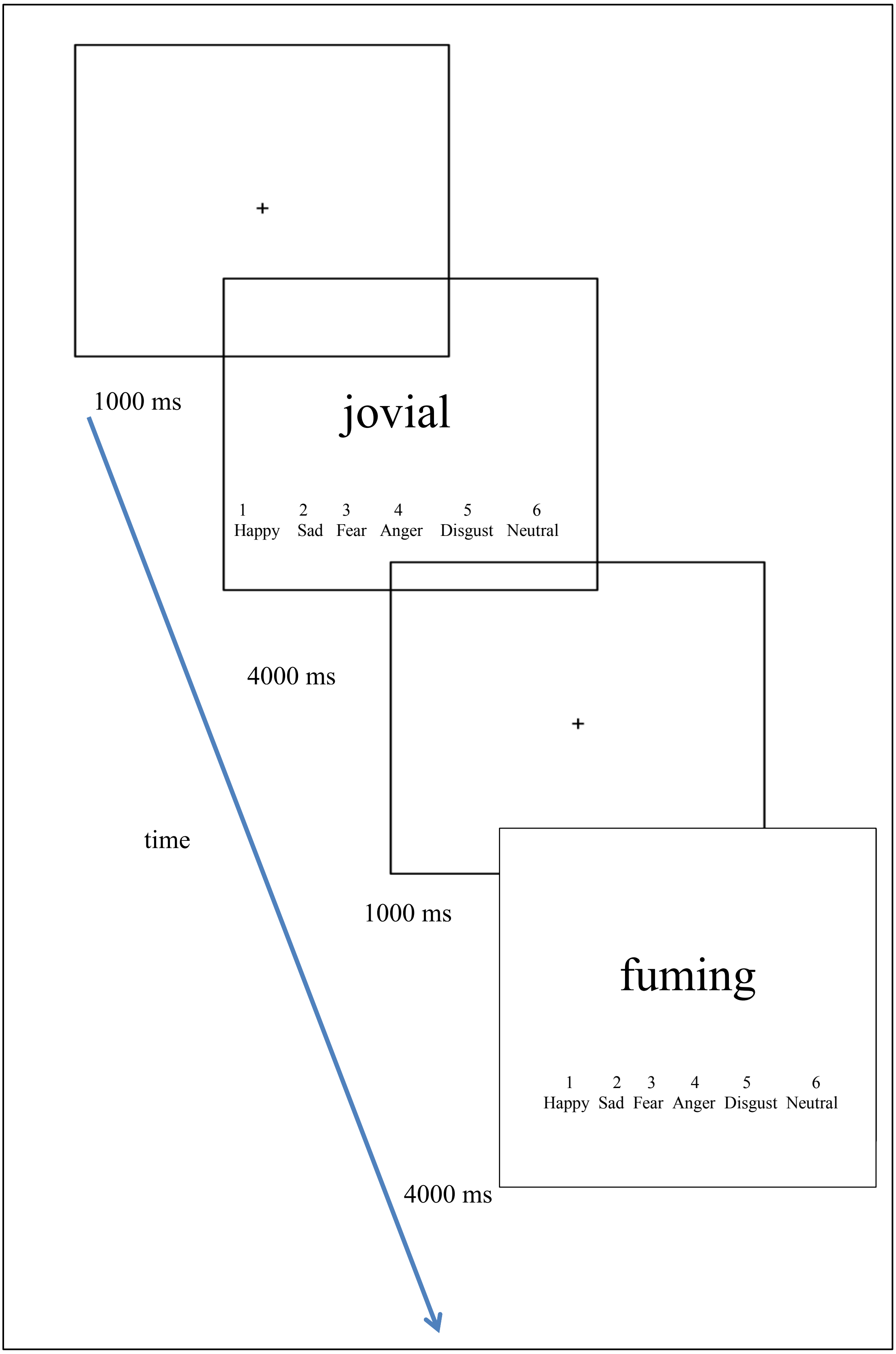


Figure 5.3.2. The order of presentation and duration for each slide in the trials used in Experiment 3.

5.3.4. The non-emotion task.

For the non-emotion task participants were required to decide from the given labels which part of the body the presented word was semantically related to (hand, hair, teeth, body, eyes) or if the word was not related to the body (none). As previously described, as far as possible, the non-emotion task was visually similar and procedurally alike to the emotion task. Specific similarities between the emotion and non-emotion tasks were: a computer-based forced choice task using E prime software, a 4000 ms response limit, 36 words in the experimental trials, six response options, and six trials per category.

To create the word database for the non-emotion task the researcher selected words that were related to parts of the body. For example, finger (hand), sighted (eyes), highlights (hair), rotund (body) and crooked (teeth). Similarly, Grunwald et al. (1999) created a non-emotion task based on "characteristics of people" (p. 229) as these categories were considered to be comparable to the emotion task as they belong to people. The words in the "none" category were non-emotion words which were not related to parts of the body such as "pamphlet" (see Appendix 5.3 for the full word list). The words were matched across categories for length and frequency (MRC; Coltheart, 1981) (see Appendix 5.4). Furthermore, the total word frequency and length did not differ between the emotion and non-emotion tasks (frequency p = .643; length p = .847).

The non-emotion task was similar to the emotion task as there were 36 experimental trials (six examples of each word category) and eight practice trials (one representing each body part category and three none body related words). The trials were randomised across participants. In a similar fashion to the emotion task the words were presented on a laptop with the stimulus word in the centre of the screen in Arial Bold font size 35 with the category labels underneath in Arial Bold font size 18 (see

Figure 5.3.3). The sequence and duration of the slide presentation was the same as the emotion word task.

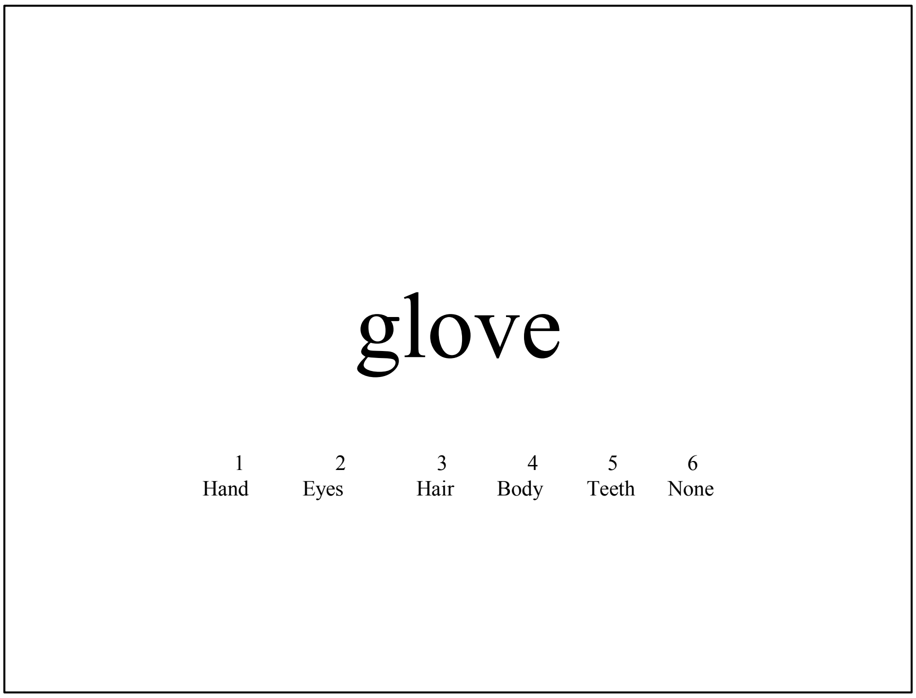


Figure 5.3.3. An example of the non-emotion word task. In this instance the correct response would be 1 (hand).

5.4 Results

The analysis was similar to that in Experiments 1 and 2. In addition mediation analysis was conducted to understand the effect of verbal intelligence on the relationship between age group and emotion recognition ability. For post hoc tests only significant findings are reported, full outputs can be found in Appendix 5.5.

5.4.1 Emotion recognition analysis.

Table 5.4.1

Means and Standard Deviations for Emotion Recognition Accuracy by Emotion Type and Age Group (maximum M = 6)

Emotion	YAs		OAs		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*
Happy	5.53	0.70	5.63	0.49	5.58	0.60
Sad	4.81	0.86	5.43	0.88	5.11	0.92
Fear	4.89	1.04	5.17	0.95	5.03	1.00
Anger	5.50	0.81	5.31	0.80	5.41	0.80
Disgust	4.17	1.16	4.88	1.35	4.52	1.30
Neutral	4.58	1.25	5.14	1.19	4.86	1.23
Total/36	29.80	3.52	31.57	3.24	30.69	3.47

To explore emotion recognition ability across the two age groups a mixed factorial 2*6 ANOVA with age group (YAs and OAs) as the between-participants IV and emotion type (happy, sad, fear, anger, disgust, and neutral) as the within-participants IV was conducted with emotion recognition accuracy as the DV. Descriptive statistics are presented in Table 5.4.1. Mauchly's test of sphericity was significant, $\chi^2(14) = 50.58$, $p < .001$, therefore Greenhouse Geisser corrected values are reported. There was a main effect of emotion type, $F(3.91, 269.99) = 13.97$, $p < .001$, $\eta_p^2 = 0.17$. Post hoc paired t-tests, with $\alpha = 1\%$, were conducted to investigate which emotions were more accurately recognised from words (see Table 5.4.2). It was found that happy words were more accurately classified than all other types of emotion words with the exception of anger. Anger words were recognised more accurately than disgust, fear and neutral words. Disgust words were also less accurately recognised than both sad and fear words. All other comparisons were nonsignificant (all *p*s > .01).

Table 5.4.2

Inferential Statistics for Emotion Recognition Accuracy by Emotion Types in Experiment 3

Comparison	*t*(70)	*p*	95% CI		*d*
			LL	UL	
Happy>Sad	4.56	**< .001**	0.26	0.67	0.60
Happy>Fear	4.45	**< .001**	0.30	0.80	0.67
Happy>Disgust	7.69	**< .001**	0.78	1.33	1.05
Happy> Neutral	4.66	**< .001**	0.41	1.03	0.73
Anger>Fear	2.91	**.005**	-0.12	-2.91	0.42
Anger>Disgust	5.64	**< .001**	0.57	1.20	0.82
Anger>Neutral	3.70	**< .001**	0.25	0.85	0.52
Disgust<Sad	3.96	**< .001**	0.29	0.89	0.52
Disgust<Fear	2.79	**.007**	0.15	0.87	0.44
Anger=Happy		ns			
Anger=Sad		ns			
Disgust=Neutral		ns			
Fear=Neutral		ns			
Sad=Neutral		ns			
Sad=Fear		ns			

Note. ns = nonsignificant; lowest nonsignificant *p* value was $p = .020$, $d = 0.35$ (sad-anger)

There was also a significant effect of age group, $F(1, 69) = 5.91$, $p = .018$, $\eta_p^2 = 0.08$, with YAs having lower accuracy for classifying emotion words than OAs. Finally, there was a significant Age Group*Emotion Type interaction, $F(3.91, 269.99) = 2.98$, $p = .020$, $\eta_p^2 = 0.04$ (see Figure 5.4.1).

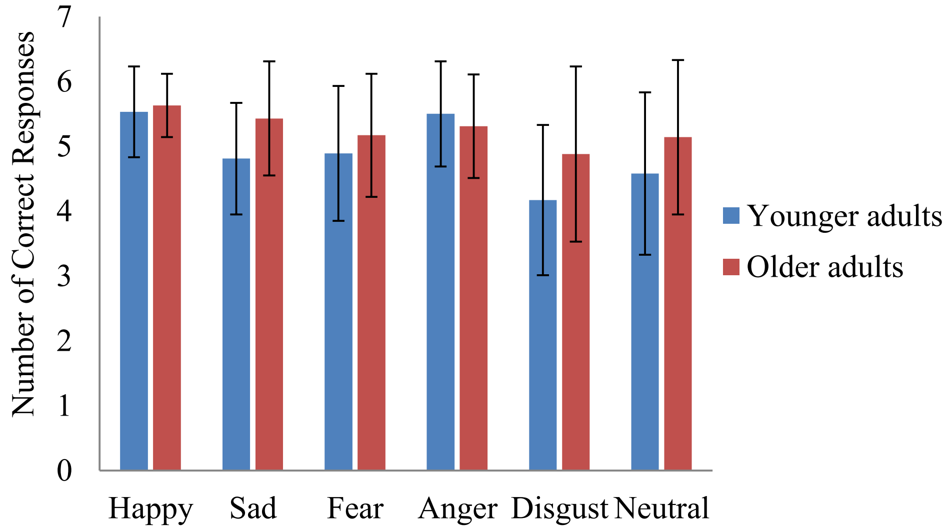


Figure 5.4.1. The mean accuracy for emotion recognition from single words by age group (YAs n = 36; OAs n = 35) and emotion type (maximum M = 6).

Post hoc t tests demonstrated that OAs had higher emotion recognition for sad related words in comparison to YAs, $t(69) = 3.02$, $p = .004$, $d = 0.73$. No other comparisons were significantly different (all *p*s > .01; lowest nonsignificant $p = .018$ for disgust). The interaction can also be explained by the pattern of emotion recognition accuracy across emotion types in each age group.

For the YAs, recognition accuracy was higher for happy related words than all other emotion types with the exception of anger. The recognition of words related to anger had higher accuracy than sad, fear, disgust, and neutral words. Finally, accuracy for recognising words related to disgust was lower than all other emotion types (excluding neutral recognition). All other comparisons were nonsignificant (all *p*s > .01) (see Table 5.4.3).

Table 5.4.3

Inferential Statistics for Emotion Recognition Accuracy from Words in ***Younger Adults***

Comparison	*t*(35)	*p*	95% CI		*d*
			LL	UL	
Happy>Fear	3.49	**.001**	0.27	1.01	0.72
Happy>Sad	5.57	**< .001**	0.46	0.99	0.92
Happy>Disgust	8.78	**< .001**	1.05	1.68	1.42
Happy>Neutral	4.57	**< .001**	0.52	1.36	0.94
Anger>Fear	3.18	**.003**	-1.00	-0.22	0.65
Anger>Sad	5.07	**< .001**	-0.97	-0.42	0.83
Anger>Disgust	8.12	**< .001**	1.00	1.67	1.33
Anger>Neutral	4.76	**< .001**	0.53	1.31	0.87
Disgust<Sad	3.66	**.001**	0.28	0.99	0.63
Disgust<Fear	3.13	**.004**	0.25	1.19	0.65
Anger=Happy		ns			
Disgust=Neutral		ns			
Fear=Neutral		ns			
Sad=Neutral		ns			
Sad=Fear		ns			

Note. ns = nonsignificant; lowest nonsignificant *p* value was $p = .105$ (disgust-neutral)

In contrast, OAs had higher recognition ability for words related to happiness than words related to fear and disgust. All other comparisons were nonsignificant (all *p*s > .01) (see Table 5.4.4). In summary, the interaction can be explained by OAs' higher accuracy for recognising sad related words compared to YAs. Also for YAs, but not OAs, recognition accuracy differed between the negative emotions, for example accuracy was higher when recognising words related to anger than sad, fear, disgust, and neutral words.

Table 5.4.4

Inferential Statistics for Emotion Recognition Accuracy from Words in ***Older Adults***

Comparison	*t*(34)	*p*	95% CI		*d*
			LL	UL	
Happy>Fear	2.76	**.009**	0.12	0.80	0.61
Happy>Disgust	3.40	**.002**	0.30	1.19	0.74
Happy=Sad		ns			
Happy=Neutral		ns			
Anger=Fear		ns			
Anger=Sad		ns			
Anger=Disgust		ns			
Anger=Neutral		ns			
Disgust=Sad		ns			
Disgust=Fear		ns			
Anger=Happy		ns			
Disgust=Neutral		ns			
Fear=Neutral		ns			
Sad=Neutral		ns			
Sad=Fear		ns			

Note. ns = nonsignificant; lowest nonsignificant value was $p = .032$ (anger-happiness)

However, there is evidence of superior performance on word tasks in OAs compared to YAs (Verhaeghen, 2003) and this may be due to their greater vocabulary (Salthouse, 1993). It is possible, therefore, that in the current emotion recognition task better vocabulary knowledge in OAs enabled them to understand the semantics of the word to a greater extent than YAs. This in turn could have supported OAs' performance on the emotion recognition task. Conversely, if the lower vocabulary level in YAs meant that YAs were less able to understand the meaning of a word than OAs then YAs may be disadvantaged on the emotion recognition word task. To investigate this possibility mediation analysis was undertaken in line with Hayes' Processing method (Hayes, 2012; Hayes, 2018).

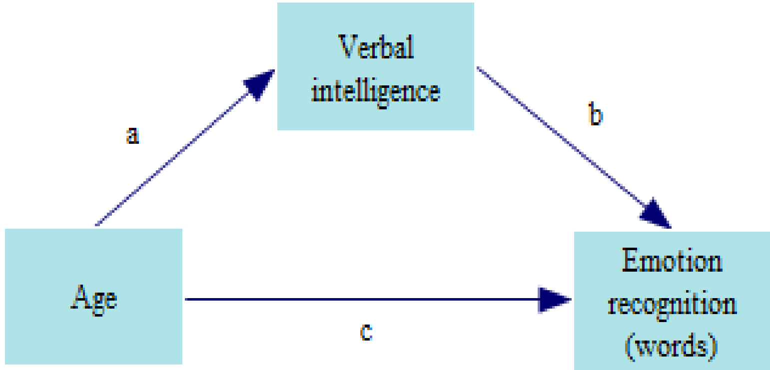


Figure 5.4.2. The mediation model for direct and indirect effects of age and verbal intelligence as predictors of emotion recognition accuracy on the word task.

Mediation analysis was performed to investigate whether the direct effect of age group on emotion recognition ability on the word task was influenced by verbal intelligence. The mediation model is shown in Figure 5.4.2 with age group as the predictor variable, emotion recognition accuracy as the outcome variable, and verbal intelligence as the mediating variable. The findings indicate that there was a direct effect of age group on verbal intelligence (a), $b = 11.11$, $t = 12.94$, $p < .001$, with age group accounting for 71% of the variance in verbal intelligence ($R^2 = 0.71$). There was also a total direct effect (c) of age group on emotion recognition accuracy, $b = 2.10$, $t = 2.43$, $p = .018$, with age group accounting for 8% of the variance in emotion recognition accuracy ($R^2 = 0.08$). However, there was not a mediating effect of verbal intelligence on the relationship between age group and emotion recognition accuracy as the indirect effect was, $b = 2.38$, CIs -0.94 to 5.04. Given that the confidence intervals include zero then it cannot be stated with confidence that there is a mediating effect. The findings suggest that age group is a significant predictor of emotion recognition ability, and verbal intelligence cannot fully account for the age group differences in emotion recognition ability from words.

5.4.2 Comparison of the younger-older and the older-older samples.

Table 5.4.5

Descriptive Statistics for Emotion Recognition Accuracy by Emotion Type for Younger-older Adults and Older-older Adults (maximum M = 6)

Emotion	Younger-older Adults		Older-older Adults	
	M	*SD*	*M*	*SD*
Happy	5.72	0.46	5.50	0.51
Sad	5.61	0.50	5.17	1.15
Fear	5.44	0.86	4.89	0.96
Anger	5.56	0.62	5.00	0.91
Disgust	4.67	1.57	5.00	1.14
Neutral	4.89	1.38	5.22	1.22
Total	31.89	3.43	30.58	3.57

The ANOVA analysis was repeated when the OA sample was split into younger-older and older-older adults as previously described in Chapter 2. Descriptive Statistics are presented in Table 5.4.5. A mixed factorial 3*6 ANOVA, with age group (YAs, younger-older, and older-older adults) as the between-participants IV and emotion type (happy, sad, fear, anger, disgust, and neutral) as the within-participants IV was conducted with emotion recognition accuracy as the DV. Mauchly's test of sphericity was significant, $\chi^2(14) = 51.88$, $p < .001$, therefore Greenhouse Geisser corrected values are reported. There was a significant main effect of emotion type, $F(3.89, 268.42) = 10.57$, $p < .001$, $\eta_p^2 = 0.13$ (see previous analysis). Although, there was no significant main effect of age group, $F(2,69) = 2.60$, $p = .081$, $\eta_p^2 = .07$. There was, however, a significant Age Group*Emotion Type interaction, $F(7.78, 268.42) = 2.52$, $p = .012$, $\eta_p^2 = 0.68$ (see Figure 5.4.3)

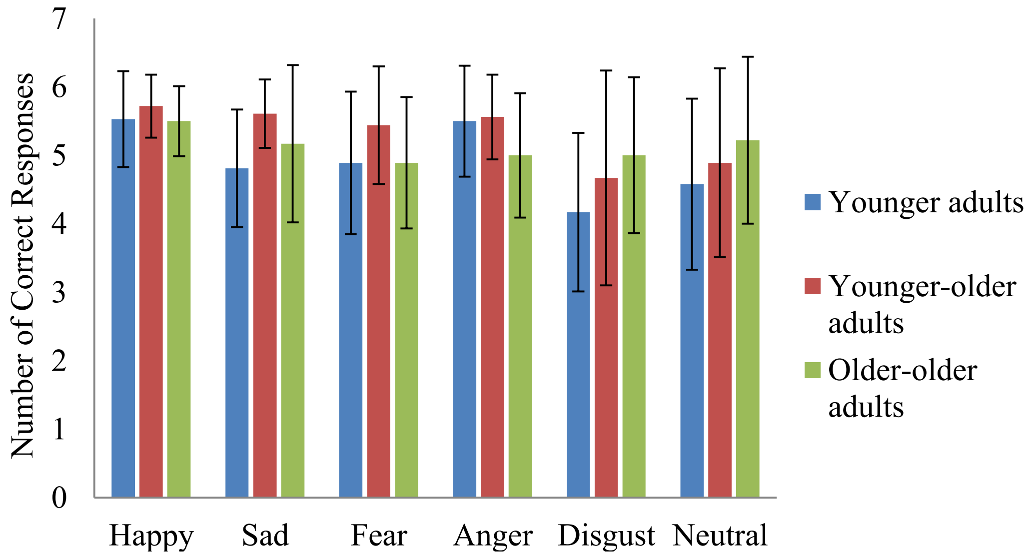


Figure 5.4.3. Emotion recognition accuracy in Experiment 3 by age group (YAs n = 36; younger-older n = 18; older-old adults n = 18) and emotion type (maximum M = 6).

Post hoc t tests, with α = 1%, were performed to investigate the interaction. Younger-older adults were more accurate at recognising sad related words than YAs $t(52) = 3.68$, $p = .001$, $d = 1.02$. However, when accounting for multiple comparisons there were no significant differences between YAs and older-old adults; although higher disgust recognition for older-older adults than YAs was marginally nonsignificant, $t(52) = 2.50$, $p = .015$, $d = 0.72$. All other comparisons between YAs and the two older age groups were not statistically significant (all *p*s > .01; lowest nonsignificant p value was $p = .045$ for anger between younger-older adults and older-older adults). Comparisons between the two older age groups suggest that younger-older and older-older adults do not differ in their emotion recognition ability of specific emotion types (all *p*s > .01; lowest nonsignificant p value was $p = .039$ for anger between younger-older and older-older adults).

The pattern of emotion recognition between the age groups may also explain the significant Age Group*Emotion Type interaction (See Tables 5.4.3 and 5.4.6). As previously discussed YAs were more accurate at recognising words related to happiness and anger and had lowest recognition accuracy for disgust related words (see Table 5.4.3).

Table 5.4.6

Inferential Statistics for Emotion Recognition Accuracy from Words in ***Younger-older Adults***

Comparison	*t*(17)	*p*	95% CI		*d*
			LL	UL	
Happy>Disgust	3.22	**.005**	0.36	1.75	0.91
Sad>Disgust	2.88	**.010**	0.25	1.64	0.81
Happy=Fear		ns			
Happy=Neutral		ns			
Anger=Fear		ns			
Anger=Sad		ns			
Anger=Disgust		ns			
Anger=Neutral		ns			
Disgust=Sad		ns			
Disgust=Fear		ns			
Anger=Happy		ns			
Disgust=Neutral		ns			
Fear=Neutral		ns			
Sad=Neutral		ns			
Sad=Fear		ns			

Note. ns = nonsignificant; lowest nonsignificant value was $p = .016$, $d = 0.83$ for anger-disgust

For younger-older adults accuracy for recognising words related to disgust was lower than words related to happiness. A lower ability to recognise disgust related words than sad related words in younger-older adults was marginally significant (all other *p*s > .01). For the older-older adults, when accounting for multiple comparisons, there was no significant difference in accuracy between emotion types (all *p*s > .01; lowest nonsignificant $p = .030$ for fear-happy).

In summary the interaction is partially explained by higher recognition accuracy for words related to sadness in younger-older adults than YAs. Furthermore, for YAs accuracy for recognising anger was higher than fear, sadness, and neutral words but this was not observed in either of the OA groups when accounting for multiple comparisons. Also the pattern of accuracy for recognising disgust changed across the age groups. Specifically, the two younger age groups had lower accuracy for recognising disgust than happiness. Furthermore, YAs were less able to recognise disgust related words than words related to sadness, fear, and anger. In contrast, for the older-older adults accuracy for recognising disgust was not significantly different to other emotion types. Of interest the interaction graph suggests that mean accuracy for recognising disgust increased with age alongside a decrease in recognition accuracy for all other emotions in older-older adults.

5.4.3 Comparing accuracy on the emotion and non-emotion word tasks.

Table 5.4.7

Means and Descriptive Statistics for Total Accuracy on the Emotion and Non-emotion Tasks by Age Group (maximum M = 36)

	Younger adults		Older adults		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*
Emotion Task	29.80	3.52	31.57	3.24	30.69	3.47
Non-emotion Task	31.88	2.01	34.09	1.69	32.99	2.15
Total/72	61.69	4.62	65.66	3.90		

It is not of interest to understand the accuracy for categorising words as related to different body parts so the scores on the non-emotion task were collapsed across categories to give an overall score (see Table 5.4.7 for descriptive statistics). A mixed factorial 2*2 ANOVA with age group (YAs and OAs) as the between-participants IV and content type (emotion and non-emotion) as the within-participants IV was conducted with total accuracy scores as the DV. There was a significant main effect of content type, $F(1,68) = 32.14$, $p < .001$, $\eta_p^2 = 0.32$, with higher accuracy for non-emotion content than emotion content. There was also a significant main effect of age group, $F(1,68) = 15.12$, $p < .001$, $\eta_p^2 = 0.18$, with OAs having higher accuracy scores than YAs across tasks. There was not a significant Age Group*Content Type interaction, $F(1,68) = 0.28$, $p = .599$, $\eta_p^2 = 0.00$ (see Figure 5.4.4). Whilst OAs were more accurate than YAs when categorising words the magnitude of the age-related difference did not differ across tasks. Thus YAs were less able than OAs to meet the demands of the task regardless of the content type.

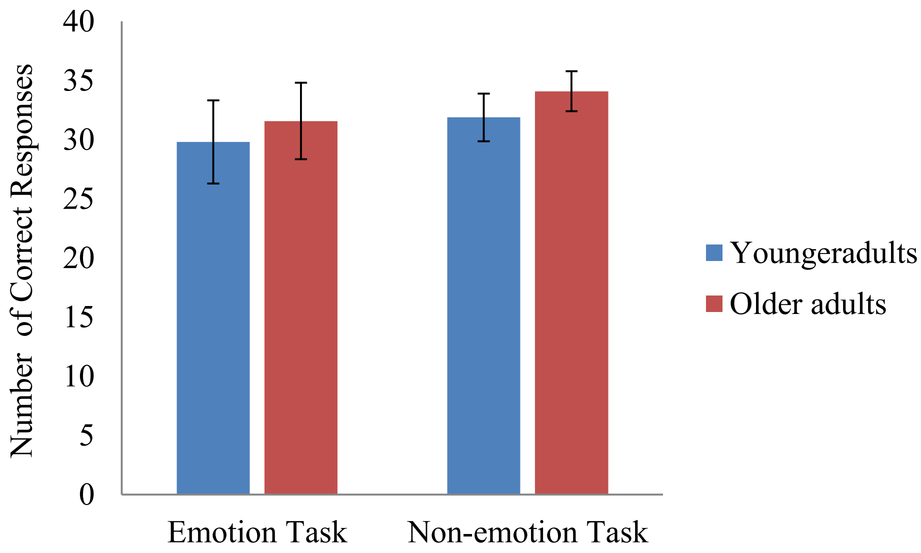


Figure 5.4.4. The total mean accuracy score on the emotion and non-emotion tasks in Experiment 3 (the maximum score on each task = 36) by age group (YAs *n* = 36; OAs *n* = 35).

Next the ANOVA analysis was repeated for the three age groups (YAs, younger-older adults, older-older adults), see Table 5.4.8 for descriptive statistics. A mixed factorial 3*2 ANOVA with age group (YAs, younger-older adults, and older-older adults) as the between-participants IV and content type (emotion and non-emotion) as the within-participants IV was conducted with total accuracy as the DV. There was a significant main effect of content type with non-emotion content (*MM* = 33.20; *SE* = 0.24) having higher accuracy than emotion content (*MM* = 30.82; *SE* = 0.44), $F(1, 68) = 32.01$, $p < .001$, $\eta_p^2 = 0.32$. There was also a significant main effect of age group, $F(2, 68) = 7.39$, $p = .001$, $\eta_p^2 = 0.18$. Post hoc t tests, with Bonferroni adjustment set at $p < .017$, demonstrated that younger-older adults had higher accuracy than YAs, $t(51) = 4.11$, $p < .001$, $d = 1.15$, but accuracy for older-older adults did not significantly differ from the two younger age groups (both *p*s > .017; lowest non-significant *p* value was $p = .043$ between younger-older and older-older adults). There was no significant Age Group*Content Type interaction, $F(2, 68) = 0.50$, $p = .606$, $\eta_p^2 = .02$ (see Figure 5.4.5).

Table 5.4.8

Means and Standard Deviations for Total Accuracy on the Emotion and Non-emotion Tasks by Younger-older and Older-older adults (maximum M = 36)

	Younger-older adults		Older-older adults	
	M	*SD*	*M*	*SD*
Emotion Task	31.89	3.43	30.78	3.57
Non-emotion Task	34.89	1.08	32.83	2.45
Total/72	66.78	3.46	63.61	5.38

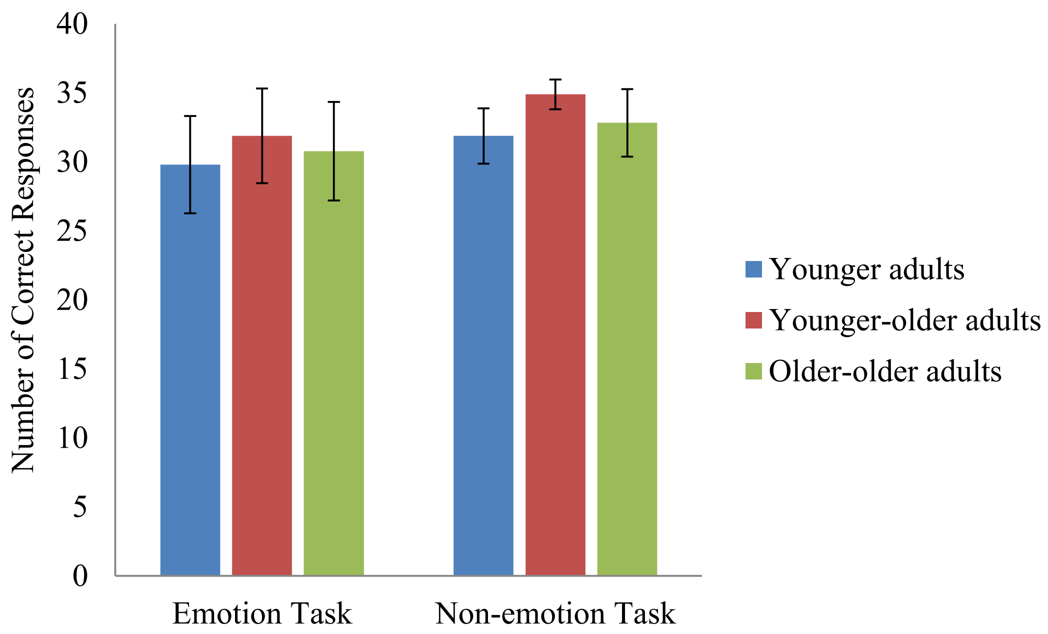


Figure 5.4.5. The total mean accuracy scores on the emotion and non-emotion tasks in Experiment 3 (maximum total score = 36) by age group (YAs $n = 35$; younger-older adults $n = 18$; older-older adults $n = 18$).

In summary, the findings imply that regardless of age the non-emotion task was easier than the emotion task and this was also observed in the pilot study (See Appendix 2.2) suggesting that the non-emotion task was easier than the emotion task. Furthermore, YAs were less accurate than younger-older adults across the tasks but the magnitude of the age-related difference did not differ across tasks. Thus, it is possible that the age-related deficits in emotion recognition ability in YAs compared to younger-older adults is a function of a lower ability in YAs than the younger-older adults to meet the demands of the task.

To recap the findings suggest that accuracy for emotion recognition from words was higher for OAs than YAs, particularly for words related to sadness. Furthermore, the age group difference for sad words appears to be driven by the younger-older adults. Moreover, it is unlikely that any age-related differences may be fully attributed to OAs' higher verbal intelligence than YAs. Of caution however, accuracy on the non-emotion task provides evidence that YAs are less able to meet the demands of the task than OAs and again this age group difference appears to be driven by the younger-older adults. It is likely that YAs' lower accuracy on the emotion task than OAs (and younger-older adults) is due to a lower ability to process and make categorical judgements from words in YAs than OAs, specifically younger-older adults.

5.5 Discussion

The aims of Experiment 3 were the same as those applied to Experiment 1 and 2 but used words instead of facial expressions or non-verbal vocalisations. It was hypothesised that OAs would have lower overall emotion recognition ability than YAs. However, due to the scarcity of research in this area no specific predictions were made regarding age-related differences across emotion types rather it was predicted that any recognition impairments in OAs would be particular to negative emotions. It was also predicted that emotion recognition ability would be further compromised with advancing older age. Finally, it was predicted that OAs would be less accurate than YAs when categorising non-emotion words.

The hypotheses were not supported; indeed emotion recognition accuracy was higher in OAs compared to YAs. Furthermore, OAs were more accurate than YAs in recognising sad related words. Moreover, there was no evidence of a significant deterioration in emotion recognition ability with advancing older age, although the age-related difference in recognition of sad words appears to be driven by the younger-older adults. Finally, the ability to classify words, regardless of emotion content, was higher in OAs, particularly younger-older adults, than YAs.

The current findings are in contrast to Grunwald et al. (1999) as in that study OAs had a general impairment in emotion recognition. A difference between the current and previous studies could be the selection of the words used as stimuli. An absence of a standardised emotion word task limits comparisons across studies, as the words may differ on linguistic aspects, such as word frequency and length, that can influence recognition ability (Larsen, Mercer, & Balota, 2006; Scott, O'Donnell, Leuthold, & Sereno, 2009). Thus there is a need for a suitable standardised emotion word database to allow for comparisons across studies. Recent research by Krause (2014) has established evidence for reliability and construct validity for the lexical tasks used in Grunwald et al. as part of the New York Emotions Battery (NYEB; Borod, Welkowitz, & Obler, 1992). It may be possible that this database will provide a standardised emotion and non-emotion word task for future researchers to use, allowing for cross-study comparisons to be made.

Of interest, in the current study OAs appear to be more accurate than YAs at recognising words related to sadness. To the researcher's knowledge an advantage in older age for recognising a negative emotion, other than disgust, is unprecedented in the field regardless of presentation type. Furthermore, the findings conflict with many of the proposed explanations for age-related emotion recognition differences between YAs and OAs. First the findings do not seem to support a positivity effect (Charles, Mather, & Carstensen, 2003) in emotion processing as OAs appear to have better recognition than YAs for some negative emotions.

Second, age-related reductions in neural activity and structure are unlikely to fully account for the positive trend for OAs' emotion recognition ability from words. It is possible, however, that OAs in the current study used compensatory measures to overcome any neurological changes that may otherwise reduce word recognition ability. The compensatory hypothesis (Cabeza, 2002) suggests that higher functioning OAs may have lower asymmetrical recruitment than YAs and lower functioning OAs (Cabeza, Anderson, Locantore, & McIntosh, 2002). According to this hypothesis the greater range of neural recruitment in higher functioning OAs represents neural activation in areas that are not observed in YAs and are believed to be activated as compensation for the loss of structure or efficiency in brain regions recruited by YAs. This compensation allows OAs to meet the goal, whereas lower functioning OAs do not display compensatory neural recruitment thus task performance is reduced in comparison to higher functioning OAs. This hypothesis may provide a useful explanation for the current findings, as several of the brain areas associated with word reading are thought to be vulnerable to age-related changes. For example, word processing has been associated with activation in several temporal areas including the superior temporal gyrus (Simos et al., 2000). Age-related reduction in white matter volume of the temporal areas is observed in adults from 60 years of age (Allen, Bruss, Brown & Damasio, 2005) and may account for cognitive impairment in older age (Lui et al, 2017). It may be expected, therefore, that due to a reduction in volume in some brain areas associated with word processing that OAs may have difficulties with processing words; however, evidence from the current and previous research suggests that this is not always the case (e.g., Harris, Rogers, & Qualls, 1998). Hence, it is conceivable that the OAs in the current study recruited compensatory brain activation when processing words; however, neurological data during emotion word recognition is required to support this concept.

It is also unclear whether neural changes in older age can explain the current observations regarding OAs' higher recognition accuracy than YAs for word related to sadness. There is yet to be clarification as to the emotion specific neural networks recruited during the processing of affective words. Research that measures neural activity during the processing of affective words typically focus on emotion valance, rather than specific emotion types (e.g., Maddock, Garrett, & Buonocore, 2003). These studies suggest that several brain regions are activated during word processing. For instance, passive viewing of emotion words appear to activate the frontal lobes (Beauregard, Chertkow, Bub, & Murtha, 1997) and different regions of the orbitofrontal cortex (OFC) appear to process positive and negative words (Lewis, Critchley, Rotshtein, & Dolan, 2007). However, the OFC shows signs of structural changes in older age and lower activation in OAs than YAs (Resnick, Lamar, & Driscoll, 2007). It would, therefore, follow that OAs would have lower emotion recognition ability from words than YAs, at least when determining emotion valence. Further evidence suggests that processing of sad related words is related to activation in the superior temporal gyrus and cerebellum (Canli et al., 2004). However, both of these areas are vulnerable to reduction in volume in white matter in older age (Anderson, Gundersun, & Pakkenberg, 2003; Raz, Gunning-Dixon, Head, Williamson, & Acker, 2001) and are associated with reading rather than emotion processing (Fiez & Peterson, 1998; Pons et al., 2014). Given that reductions in white matter volume may account for declines in cognitive functioning then it would be expected that, compared to YAs, OAs would have reduced ability in recognising words related to sadness; however, this is contrary to the current findings. Of interest, the trend for higher recognition of disgust related words in OAs than YAs (although not statistically significant) maybe explained by neural preservation in older age, as processing disgust related words has been associated with activation in the of the anterior insula (Ponz et al., 2014); an area believed to be protected from the effects of aging (Ruffman, 2008).

In summary, it is suggested that neural activation during the processing of emotion words includes brain regions associated with reading and emotion processing. It is important to increase our understanding of neural activation during emotion word processing to tease apart activations related to word processing from activations related to emotion processing. Evidence is scarce regarding neural activations during emotion word processing, particularly for words related to anger and fear; although evidence suggests that the left posterior cingulate gyrus is activated in the processing of words related to threat (Maddock & Buonocore, 1997). Moreover, current knowledge of neural activity in emotion word processing does not appear to explain higher accuracy for recognising sad related words in OAs than YAs. Interestingly disgust related words activate similar brain areas as facial expression of disgust, suggesting some overlap in neural processing of visual information of disgust. Finally, given that there is some evidence for emotion specific neural networks for processing affective words, it would be of interest to collect neurological data during forced-choice emotion word recognition tasks to further explore these associations. Nevertheless, the findings cannot be explained by age-related neural decline per se but higher emotion recognition accuracy from words in OAs than YAs may be a function of OAs' adaptive compensation mechanisms.

An age-related decline in cognitive abilities is also unlikely to provide an adequate explanation for the current findings, as this would suggest that emotion recognition ability would decline rather than improve in older age. Moreover, the older-older adults performed as well as the younger age groups on the emotion recognition task and this is unexpected considering the likely progressive cognitive decline with advancing older age. Furthermore, the OAs were more able than YAs to make judgements from words on the emotion task and the non-emotion task, suggesting that OAs were not compromised in their ability to process words. The findings, therefore, support research suggesting that OAs have either maintained or higher abilities than YAs on word tasks (e.g.,Verhaeghen, 2003). Thus the current findings suggest that OAs' preserved ability for some aspects of word processing is also applicable to word recognition ability for both emotion and non-emotion words. However, the mediation analysis suggests that verbal intelligence cannot fully explain the age-related differences on the emotion word task. Taken together the findings imply that cognitive aging cannot explain the age group differences in emotion recognition ability from words.

The OAs and YAs differed on several sample characteristics including socio-emotional abilities and personality traits and these may provide an alternative explanation for the current findings. For example the OAs in the current study had higher levels of openness to experience than YAs and openness, alongside social activity, has been related to higher verbal ability in OAs (Hogan, Staff, Bunting, Deary, & Whalley, 2012); however, the researchers in that study did not measure emotion word recognition. Regarding the relationship between alexithymia and emotion recognition ability the majority of studies have used affective facial expressions rather than emotion words. However, evidence suggests that individuals with higher levels of alexithymia have lower emotion recognition ability including verbal tasks (Lane et al., 1996). Thus higher levels of alexithymia in YAs, than OAs, may have reduced their ability to recognise emotions from words in the current study. If this is the case then a lower ability to be able to name one's own emotions, as is typical of individuals with higher levels of alexithymia, may reduce the ability to label emotion words (Lane et al., 1996). Thus, the current findings may be explained by age group differences in alexithymia or openness that may reduce emotion recognition ability in YAs, rather than a direct effect of emotion recognition ability in OAs.

5.6 Conclusion

When emotion recognition tasks are designed to reduce unnecessary task demands and contextual cues, and words are carefully selected to minimise linguistic differences across emotion types, then OAs are more accurate at identifying the emotion meaning of a word than YAs. Specifically, OAs had higher accuracy for recognising sad related words than YAs. Of interest higher word recognition both in general and for sad words in older age appears to be driven by the younger-older adults. It is important, therefore, to consider the age of the OA sample when comparing results. The findings may reflect age group differences in alexithymia or openness and further studies are required to enable firmer conclusions to be drawn regarding the relationship between these characteristics and emotion recognition ability from words. Finally, the word task was carefully designed to be as procedurally similar to the face and sound tasks that have been previously reported. Comparisons across these experiments are discussed in the following chapter.

Chapter 6 - The Effect of Age on Emotion Recognition Accuracy across Presentation Types.

6.1 Introduction

To the researcher's knowledge the series of experiments in Phase 1 are the first to report emotion recognition ability in OAs using the same participants across three presentation types (static facial expressions, non-verbal vocalisations, and single words) and to distinguish between several emotion types. Using the same participants in all three experiments means that any differences in emotion recognition ability across the different presentation types are unlikely to result from confounding intrinsic sample differences (e.g., education, verbal intelligence). Likewise, to enable informative comparisons across presentation types the procedures used in all three experiments were as similar to each other as possible. Any differences in emotion recognition ability in OAs across presentation types, therefore, are unlikely to result from methodological differences. Furthermore, the findings will be discussed in relation to the participants' ability to complete the task in the absence of emotion processing as measured by the non-emotion tasks. Hence, the findings from the current experiments arguably provide a clearer picture of emotion recognition ability in OAs across presentation types than research that has not imposed such rigorous controls.

Since, few studies have compared emotion recognition ability in OAs across several presentation types it is unclear whether we would observe a similar pattern of age-related emotion recognition differences when we compare findings across experiments, which are similar in terms of the experimental design and use the same samples. Of those studies that have done so the design typically only includes two presentation types, such as prosodic sentences and facial expressions (Mill, Allik, Realo, & Valk, 2009); visual sentences and facial expressions (Isaacowitz et al., 2007); or cross-modal non-verbal vocalisations with facial expressions (Chaby, Boullay, Chetouani, & Plaza, 2015). Findings from these studies imply that age-related differences in recognition ability in OAs vary across emotion and presentation types. For example, compared to YAs, OAs were less able to recognise facial expressions of anger, sadness, and disgust, whereas the same OAs were less able to recognise fear and anger from non-verbal vocalisations (Chaby et al., 2015). However, researchers rarely run analyses to directly compare emotion recognition ability across presentation types (e.g., are there age-related differences in emotion recognition ability between facial and auditory expressions). Therefore, the influence of presentation type on emotion recognition ability in OAs cannot be determined.

To the researcher's knowledge only Isaacowitz et al. (2007) conducted analysis to directly compare emotion recognition ability across presentation types. In that study participants were more able to accurately recognise emotion from faces than read sentences; however, OAs showed greater differences between the tasks than YAs. The findings suggest that the ability to recognise emotions varies between the presentation types regardless of age and older age may influence the magnitude of these differences. However, the breadth of the age-related emotion recognition differences is not yet understood as the majority of research in the field either focuses on one presentation type, uses different samples between presentation types, or does not include analysis to directly compare across presentation types. Thus to understand the breadth of age-related emotion recognition deficits in OAs it is important to investigate the possible effect of presentation type on age-related emotion recognition ability.

Understanding any developmental differences in emotion recognition accuracy between different presentation types can not only reveal the extent of possible difficulties in emotion recognition with age but can also inform on theories of emotion processing in general. For instance, one theory suggests that emotion is processed by a single, general emotion processing system located in the right hemisphere (Borod et al., 1999). In this manner all emotionally salient information is processed within this singular system, regardless of presentation type and emotion type. If this were the case then any age-related changes in this system should result in similar age-related emotion recognition deficits across presentation types. However, evidence of emotion specific neural systems, as proposed by basic emotion theory (Ekman, 1992), may mean that the concept of a general emotion processor is too simplistic. For example, research findings suggest that disgust maybe processed in the insular and basal ganglia, whereas fear may activate the amygdala more than other emotions, and anger but not sadness may activate the orbitofrontal and anterior cingulate (Adolphs, Tranel, Damasio, & Damasio, 1995; Blair, Morris, Frith, Perrett, & Dolan, 1999; Gray, Young, Barker, Curtis, & Gibson, 1997; Papagno et al., 2016). These observations are arguably more in line with a basic emotion theory, in that discrete emotions are supported by a specific processing system that allows for cross-cultural similarities in emotion processing (Ekman, 1992), than a general processing theory of emotion. However, the majority of research that has identified separate processing systems, such as for disgust and fear, has been based on facial information. It is unclear, therefore, whether similar disassociations occur for communication channels other than faces. Specifically, there is little understanding of the neural basis of emotion processing using auditory stimuli and visual words; however, evidence suggests that damage to the amygdala impairs recognition of auditory signals of anger and fear (Scott et al., 1997), implying that neural networks for processing emotion in auditory information may overlap.

Furthermore, evidence from developmental research suggests that both theories of emotion processing, a general processing system or an emotion specific network, maybe too simple, as age-related differences in emotion recognition accuracy appear to be dependant on both the emotion and the presentation type. For example, Isaacowitz et al. (2007) observed that OAs were less able to recognise happy and angry faces than

YAs, whereas from read sentences OAs were less able to recognise happiness, anger, fear, surprise, and disgust than YAs. Furthermore, the findings of Phase 1 of the current research programme indicate that age-related differences vary across emotion and presentation types, for instance OAs were marginally less able to recognise anger from faces than YAs but are more able to recognise sad words than YAs. In summary, evidence suggests that emotion processing is more complex than a unified general processing system or an emotion specific system; however, the extent of disparate systems across emotion, modality, and presentation types is yet to be established.

Further to a neurological explanation, differences in cognitive skills may also explain variations in the pattern of age-related emotion recognition differences across presentation types. For instance, Baltes' theory of multidimensional and multidirectional cognitive development in older age may explain the variation in pattern (Baltes, 1987). As part of a lifespan development theory Baltes and colleagues made many proposals regarding cognitive changes in older adults, in both performance and strategies for dealing with age-related cognitive decline. Within this model Baltes and colleagues proposed that cognitive changes are not simply a pattern of decline in older age; rather some abilities, such as verbal intelligence and wisdom, may improve or remain stable despite declines in cognitive abilities in other areas, including skills related to fluid intelligence and processing speed (Baltes, Staudinger, & Lindenberger, 1999). In this manner a variation in the pattern of emotion recognition as a function of presentation type may reflect multidirectional development of emotion recognition that differs as a consequence of how the information is presented. The multidirectional nature of the current findings (e.g., OAs were more accurate than YAs when recognising emotion words but were less accurate for non-verbal vocalisations) supports this model and suggests that emotion recognition development into older age is not uniform.

Furthermore, according to Baltes' theory of selectivity, compensation, and optimisation when faced with a decline in processing ability OAs may adopt strategies to either ensure success in a task or to avoid tasks that may prove to be too challenging (Baltes, 1997; Baltes & Carstensen, 2003). For example, to compensate for cognitive decline OAs may adopt different strategies to YAs, including recruiting skills that are less vulnerable to age-related decline, to achieve their goal. Taken together Baltes' theories of aging may provide useful explanations regarding the diversity in OAs' ability to recognise emotions across emotion and presentation types. For example, the OAs' disparate abilities for emotion recognition across presentation types suggest that emotion recognition may be a multidimensional concept and findings from the current research suggest that development maybe multidirectional. In addition, OAs may use compensating strategies to enhance emotion recognition ability in some tasks, such as relying more on wider vocabulary knowledge when making emotion recognition judgements from words than from faces. However, it is difficult to ascertain whether emotion recognition ability from words is supported by verbal knowledge in OAs as research investigating age-related differences in emotion recognition ability from words in older age is scarce. Furthermore, the mediation analysis discussed in Chapter 5 indicated that verbal knowledge did not fully account for higher emotion recognition accuracy for words in OAs than YAs. Thus, other compensatory strategies may have supported this finding. Nevertheless, given Baltes' theory of a multidimensional and multidirectional approach to cognitive aging and possible adaptive strategies used by OAs to achieve their goals it is possible that OAs' performance may significantly differ across tasks.

The pattern of emotion recognition ability for the experiments reported in Chapters 3, 4, and 5 are summarised in Table 6.1.1. Further analysis, reported below, compared emotion recognition ability in OAs, and YAs, across the presentation types.

The absence of research in the field that has directly compared emotion recognition accuracy across presentation types means that predictions for the current analysis are based on the means for emotion recognition accuracy reported in the previous three chapters. It was predicted that regardless of age overall emotion recognition would be higher on the word task and lowest on the face task. However, compared to YAs, OAs would have lower accuracy for recognising emotion in non-verbal vocalisations but higher accuracy for recognising emotion meaning in words. Furthermore, it was predicted that OAs would have an age-related deficit for recognising anger. In contrast OAs would have higher accuracy for recognising disgust than YAs. Further age-related declines in emotion recognition ability were expected in the older-older adults.

Table 6.1.1

Age-related Differences in Emotion and Non-emotion Recognition Ability between YAs and OAs Across Three Presentation Types

Presentation Type	**Emotion Type**						**Total**	**Non-emotion**
	Happy	**Sad**	**Fear**	**Anger**	**Disgust**	**Neutral**		
Faces	ns	ns	ns	**L**	ns	ns	**ns**	**ns**
Sounds	ns	ns	ns	ns	ns	ns	**L**	**L**
Words	ns	**H**	ns	ns	ns	ns	**H**	**H**

Note. H = OAs have higher accuracy than YAs; L = OAs have lower accuracy than YAs; ns = nonsignificant

6.2 Results

Initially emotion recognition accuracy for each presentation type was treated as three separate DVs so MANOVAs were conducted with follow up Discriminant Functions Analysis (DFA), as suggested by Field (2012) DFA is a suitable analytical method for investigating a significant MANOVA (see Appendix 6.1). A single function was positively related to sounds and faces and negatively related to words. As a reminder, OAs compared to YAs had a trend for lower emotion recognition ability from faces (although this was nonsignificant) and non-verbal vocalisations alongside higher accuracy from words. Given the similarity in the pattern between the variable in the DFA and emotion recognition ability it is logical to assume that the variable is emotion recognition. Thus it is reasonable to replace the MANOVAs with an ANOVA, as the DVs appear to be measuring the same construct (see Appendix 6.1). Furthermore, Isaacowitz et al. (2007) compared emotion recognition ability across presentation types using ANOVA analysis with emotion recognition as the DV. This precedence suggests that using emotion recognition as a single DV is acceptable practice.

Therefore, to compare emotion recognition accuracy across the three experiments in Phase 1 a 2*3*6 ANOVA was run with age group (OA and YA) as the between groups IV and presentation (face, non-verbal vocalisations, and words) and emotion type (happy, sad, fear, anger, disgust, and neutral) as the two within groups IVs. To be in line with the three experiments in Phase 1 the initial analysis was repeated to compare emotion recognition accuracy between younger-older and older-older adults.

The 2*3*6 ANOVA comparing emotion recognition accuracy between OAs and YAs revealed significant findings of a main effect of presentation type, $F(2, 138) = 36.27$, $p < .001$, $\eta_p^2 = 0.36$; Presentation*Age Group interaction, $F(2, 138) = 10.24$, $p < .001$, $\eta_p^2 = 0.13$; main effect of emotion, $F(5, 345) = 76.09$, $p < .001$, $\eta_p^2 = 0.52$; Emotion*Age Group interaction, $F(5, 345) = 4.44$, $p = .001$, $\eta_p^2 = 0.06$; and Presentation*Emotion interaction, $F(10, 690) = 40.14$, $p < .001$, $\eta_p^2 = 0.37$. There was not, however, a significant Age Group*Presentation*Emotion interaction, $F(10, 690) = 1.46$, $p = .148$, $\eta_p^2 = 0.02$. There was also a nonsignificant main effect of age group, $F(1, 69) = 0.46$, $p = .500$, $\eta_p^2 = 0.01$. The significant findings are discussed in turn in the following sections but only those statistics that reveal significant differences are reported in full; see Appendix 6.2 for full outputs.

6.2.1 Presentation type.

Post hoc t-tests, with Bonferroni corrections set at $p = .017$, revealed that participants were more able to recognise emotion from words than non-verbal vocalisations, $t(70) = 4.81$, $p < .001$, $d = 0.73$. Furthermore, accuracy was higher for both words and non-verbal vocalisations than facial expressions, $t(70) = 7.29$, $p < .001$, $d = 1.05$, and, $t(70) = 3.42$, $p = .001$, $d = 0.47$, respectively (see Table 6.2.1).

6.2.2 Presentation*Age Group interaction.

Table 6.2.1

Descriptive Statistics for Total Emotion Recognition Accuracy by Age Group and Presentation Type (maximum M = 36)

Presentation Type	Younger adults		Older adults		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*
Face	27.03	3.77	25.74	4.38	26.39	4.10
Non-verbal vocalisations	29.11	2.64	27.00	2.75	28.07	2.88
Words	29.47	3.99	31.57	3.24	30.51	3.76

Descriptive statistics for total emotion recognition accuracy within the different presentation types in YAs and OAs are presented in Table 6.2.1. The Age Group *Presentation Type interaction (see Figure 6.2.1) can be explained by the previously reported findings (see Chapters 3, 4, and 5) that emotion recognition accuracy for OAs and YAs did not differ for facial expressions, was lower in OAs than YAs for non-verbal vocalisations, and OAs had higher accuracy than YAs from words. Furthermore, post hoc t-tests, with Bonferroni corrections set at $p = .017$, suggest that YAs had higher emotion recognition accuracy from words and non-verbal vocalisations than facial expressions, $t(35) = 3.00$, $p = .005$, $d = 0.63$, and, $t(35) = 3.03$, $p = .005$, $d = 0.64$, respectively but there was no difference between non-verbal vocalisations and words (*p*

= .573). For OAs emotion recognition from words was higher than both non-verbal vocalisations and facial expressions, $t(34) = 7.40$, $p < .001$, $d = 1.52$, and, $t(34) = 8.65$, $p < .001$, $d = 1.51$, respectively but there was no difference in emotion recognition accuracy between non-verbal vocalisations and facial expressions ($p = .083$).

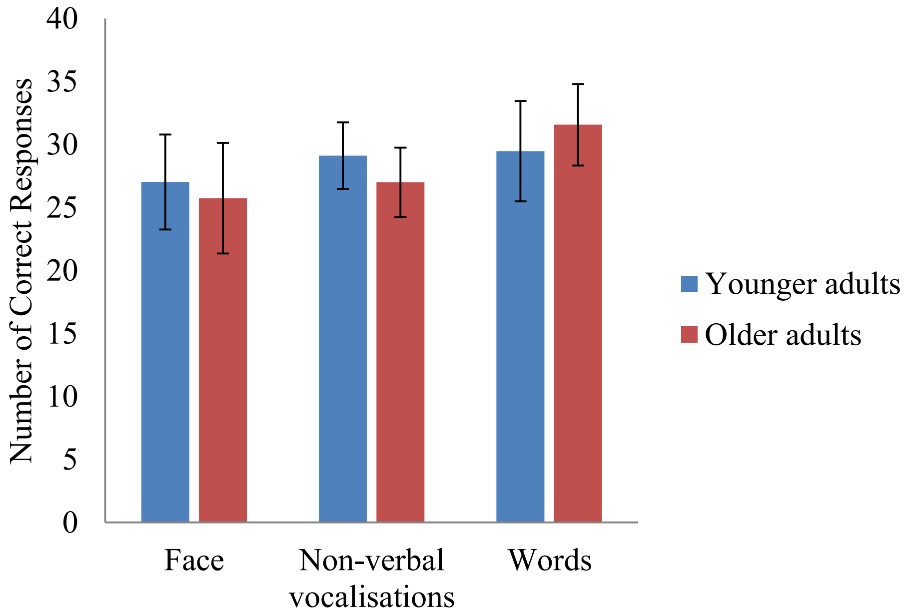


Figure 6.2.1. The mean accuracy for total emotion recognition by age group (YAs $n = 36$; OAs $n = 35$) and presentation type (maximum $M = 36$).

6.2.3 Main effect of emotion.

Post hoc t tests, with alpha = 1%, were run to investigate the main effect of total emotion type (summed accuracy across the presentation types). The findings indicate that participants were more able to recognise happiness but were less able to recognise anger than all other emotion types (see Tables 6.2.2 and 6.2.3).

Table 6.2.2

Inferential Statistics Investigating the Main Effect of Emotion.

Comparison	*t*(70)	*p*	95% CI		*d*
			LL	UL	
Happy>Sad	11.36	**< .001**	2.51	3.59	1.82
Happy>Fear	11.98	**< .001**	3.47	4.86	1.87
Happy>Disgust	14.67	**< .001**	3.22	4.24	2.19
Happy>Neutral	8.50	**< .001**	1.49	2.40	1.42
Happy > Anger	18.52	**< .001**	5.39	6.69	2.71
Anger<Fear	4.68	**< .001**	1.07	2.67	0.65
Anger<Disgust	5.62	**< .001**	-3.13	-1.49	0.92
Anger<Neutral	11.40	**< .001**	-4.81	-3.38	1.96
Anger<Sad	8.59	**< .001**	2.29	3.68	1.20
Sad>Fear	3.04	**.003**	0.38	1.84	0.42
Sad<Neutral	3.23	**.002**	-1.80	-0.42	0.62
Disgust<Neutral	5.88	**< .001**	-2.39	-1.18	0.88
Fear<Neutral	5.31	**< .001**	-3.06	-1.39	0.97
Disgust=Sad		ns			
Disgust=Fear		ns			

Note. ns=nonsignificant; lowest nonsignificant *p* =.033 (disgust-sad)

6.2.4 Emotion*Age Group interaction.

Post hoc t tests, with alpha = 1%, were run to investigate the Emotion*Age Group interaction (see Figure 6.2.2). Regarding differences between the two age groups for each emotion type OAs were marginally more able to recognise disgust than YAs, $t(69) = 2.65$, $p = .010$, $d = 1.52$, whereas OAs were marginally less able to recognise anger than YAs , $t(69) = 2.62$, $p = .011$, $d = 1.52$. All other comparisons were nonsignificant (lowest non-significant *p* value was for fear, $p = .264$) (see Table 6.2.3 for descriptive statistics).

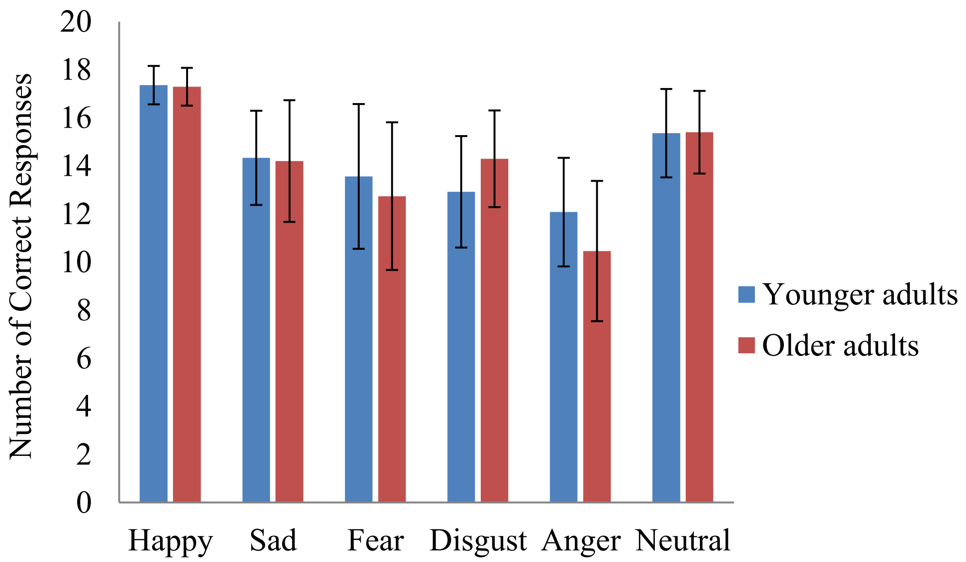


Figure 6.2.2. The mean accuracy for total emotion recognition by age group (YAs *n* = 36; OAs *n* = 35) (maximum *M* = 18).

Table 6.2.3

Descriptive Statistics for Total Accuracy for Emotion Recognition by Emotion Summed across the Three Presentation Types (maximum M = 18)

Emotion Type	Younger adults		Older adults		Total	
	M	*SD*	*M*	*SD*	*M*	*SD*
Happy	17.36	0.80	17.29	0.79	17.32	0.79
Sad	14.33	1.96	14.20	2.53	14.27	2.24
Fear	13.56	3.01	12.74	3.07	13.15	3.05
Disgust	12.92	2.32	14.29	2.01	13.59	2.27
Anger	12.08	2.26	10.46	2.92	11.28	2.72
Neutral	15.36	1.84	15.40	1.72	15.38	1.77

The interaction can also be explained by the pattern of emotion recognition accuracy within each age group. Post hoc t tests suggest that for YAs accuracy was higher for happiness compared to all other emotion types and anger had the lowest accuracy (see Table 6.2.4). In a similar manner OAs had higher accuracy for happiness than all other emotion types and accuracy was lowest for anger (see Table 6.2.5). However, OAs had higher accuracy for disgust than fear and anger but these comparisons were not significantly different for YAs. Therefore, the differences appear to be driven by OAs' higher accuracy for disgust than some other emotion types and this was not observed in YAs.

Table 6.2.4

Inferential Statistics for Emotion Recognition Accuracy in ***Younger Adults*** *by Emotion Type and Summed Across Presentation Types*

Comparison	*t*(35)	*p*	95% CI		*d*
			LL	UL	
Happy>Sad	9.69	**< .001**	2.39	3.66	2.02
Happy>Fear	7.75	**< .001**	2.81	4.80	1.73
Happy>Disgust	13.02	**< .001**	3.75	5.14	2.56
Happy > Anger	13.14	**< .001**	4.46	6.09	3.11
Happy>Neutral	6.54	**.001**	1.38	2.62	1.41
Anger<Fear	2.71	**.010**	0.37	2.58	0.56
Anger<Sad	4.70	**< .001**	1.28	3.22	1.06
Anger<Neutral	6.94	**< .001**	-4.24	-2.32	1.59
Fear<Neutral	3.14	**.003**	-2.97	-0.64	0.72
Disgust<Neutral	5.92	**< .001**	-3.28	-1.61	1.16
Disgust<Sad	3.85	**< .001**	0.67	2.16	0.66
Disgust=Fear		ns			
Anger=Disgust		ns			
Sad=Fear		ns			
Sad=Neutral		ns			

Note. ns = nonsignificant. The lowest nonsignificant *p* value was *p* = .041 (sad-neutral)

Table 6.2.5

Inferential Statistics for Emotion Recognition Accuracy in ***Older Adults*** *by Emotion Type and Summed Across Presentation Types*

Comparison	*t*(34)	*p*	95% CI		*d*
			LL	UL	
Happy>Disgust	8.81	< **.001**	2.31	3.69	1.96
Happy>Sad	6.92	< **.001**	2.18	3.99	1.65
Happy>Fear	9.22	< **.001**	3.54	5.54	2.03
Happy > Anger	14.00	< **.001**	5.84	7.82	3.19
Happy>Neutral	5.47	< **.001**	1.18	2.59	1.41
Anger<Fear	3.88	< **.001**	1.09	3.48	0.76
Anger<Sad	7.82	< **.001**	2.77	4.72	1.37
Anger<Neutral	9.66	< **.001**	-5.98	-3.90	2.06
Fear<Neutral	4.35	< **.001**	-3.90	-1.42	1.07
Disgust<Neutral	2.63	**.013**	-1.98	-0.25	0.55
Disgust>Fear	2.84	**.008**	-2.64	-0.44	0.68
Disgust>Anger	7.09	< **.001**	-4.93	-2.73	1.53
Sad=Fear		ns			
Sad=Neutral		ns			
Disgust=Sad		ns			

Note. ns = nonsignificant. The lowest nonsignificant *p* value was *p* = .015 (sad-fear)

Of note, it is conceivable that rather than OAs being more able to recognise disgust than YAs, OAs may have had a response bias for disgust. Indeed, when looking at the pattern of response errors across the different experiments, when judging facial expressions of anger, fear, and sadness OAs appear to be more likely to respond as disgust than YAs. However, this possible response bias was not evident on the sound or word tasks. To investigate a possible response bias for facial expressions of disgust in OAs a Signal Detection Analysis was conducted (see Table 6.2.6). Signal Detection Theory (Green & Swets, 1966) suggests that the probabilities of correct or incorrect outcomes depend upon the strategies used by the participants when making a decision, especially when there is an element of uncertainty or risk in the decision-making process (Lynn & Feldman Barrett, 2014). In simple terms analysis based on this theory accounts for the proportion of hits (correctly deciding that disgust is present in the stimuli), misses (deciding that disgust is not present in the stimuli when it actually is), false alarms (deciding that disgust is present when it is not), and correct rejections (deciding that disgust is not present in the absence of disgust). In this manner response bias can inform on the sensitivity for the target, in this case disgust recognition.

Table 6.2.6

The Scores and Proportion of Signal to Noise (in brackets) for Older Adults Responses in the Presence or Absence of Disgust

Reality	Decision	
	YES	NO
Signal (Disgust) Present	HIT 172 (0.82)	MISS 39 (0.18)
Signal (Disgust) Absent	FA 116 (0.11)	CORRECT REJECTION 934 (0.89)

The Signal Detection analysis (Gaetano, Lancaster, & Tindle, 2015) suggests that OAs were able to distinguish the signal (disgust) from noise (no disgust) as $d' = 2.14$ which represents the distance (in SDs) between the noise and signal distributions, although there were a few errors. Furthermore, the OA participants were marginally conservative responders as the response bias was positive $c = 0.16$, meaning that OAs had a slight tendency to respond that disgust was not present regardless of whether disgust was present or not. Thus, the signal detection analysis suggests that OAs did not have a response bias for disgust. It can be concluded, therefore, that OAs, are more sensitive to recognising disgust than YAs.

6.2.5 Comparing younger-older and older-older adults.

A 3*3*6 ANOVA was run with age group (YAs, younger-older adults, and older-older adults) as the between groups IV and presentation (face, non-verbal vocalisations, and words) and emotion type (happy, sad, fear, anger, disgust, neutral) as the two within groups IVs. There were significant findings for a main effect of presentation type $F(2, 136) = 44.02$, $p < .001$, $\eta_p^2 = 0.39$; Presentation*Age Group interaction, $F(4, 136) = 6.40$, $p < .001$, $\eta_p^2 = 0.16$; main effect of emotion, $F(5, 340) = 76.46$, $p < .001$, $\eta_p^2 = 0.53$; Emotion*Age Group interaction, $F(10, 340) = 4.18$, $p < .001$, $\eta_p^2 = 0.11$; Presentation*Emotion, $F(10, 680) = 36.01$, $p < .001$, $\eta_p^2 = 0.35$. There was not, however, a significant Age Group*Presentation*Emotion interaction, $F(20, 680) = 1.26$, $p = .199$, $\eta_p^2 = 0.04$. There was also a nonsignificant main effect of age group, $F(2, 68) = 1.26$, $p = .292$, $\eta_p^2 = 0.04$. Those effects that do not include age as a variable are identical to what has been discussed above. For those effects that do include age, the findings will be discussed in more detail in the following sections.

6.2.5.1 *Presentation Type* Age Group interaction.* The descriptive statistics for the three age groups for emotion recognition accuracy when summed across the three presentation types are presented in Table 6.2.7. Post hoc t tests, with Bonferroni corrections set at $p = .017$, were run to investigate the Presentation Type* Age Group interaction (see Figure 6.2.3).

Table 6.2.7

Descriptive Statistics for Total Emotion Recognition Accuracy by Age Group and Presentation Type (maximum M = 36)

Total accuracy	Younger adults		Younger-older adults		Older-older adults	
	M	*SD*	*M*	*SD*	*M*	*SD*
Face	27.03	3.77	27.17	3.90	23.61	5.01
Non-verbal vocalisations	29.11	2.64	27.11	2.30	26.88	3.24
Words	29.47	3.99	31.89	3.43	30.78	3.57

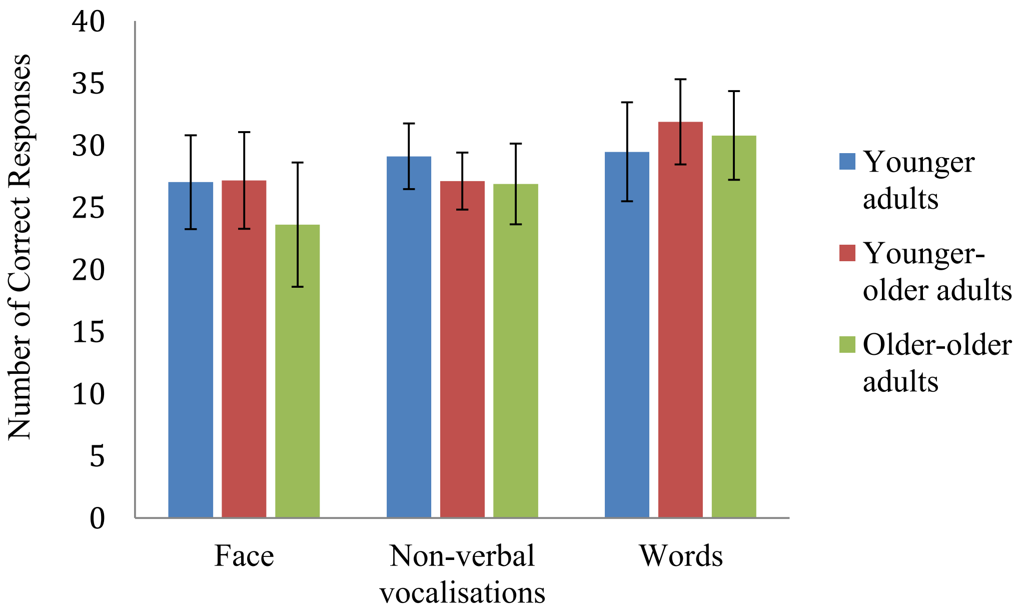


Figure 6.2.3. The mean accuracy for total emotion recognition by age group (YAs n = 36; Younger-older adults n = 18; Older-older adults n = 18) and presentation type (maximum score = 36).

The findings for age group differences have been detailed in previous chapters and suggest that YAs were more accurate than older-older adults when recognising emotion from faces and non-verbal vocalisations. However, YAs were only more accurate than younger-older adults at recognising emotions from non-verbal vocalisations. All other comparisons between YAs and the older age groups were nonsignificant (all $ps > .017$, lowest nonsignificant p value was $p = .033$, for words between YAs and younger-older adults). After accounting for multiple comparisons there were no significant differences for emotion recognition accuracy for any presentation types between younger-older adults and older-older adults (lowest nonsignificant *p* value was $p = .024$, for faces).

The pattern of YAs' accuracy was as reported for the ANOVA comparing YAs and OAs. Younger-older adults were more accurate at recognising emotion from words than either non-verbal vocalisations or faces, $t(17) = 4.71$, $p < .001$, $d = 1.64$, and, $t(17) = 5.68$, $p < .001$, $d = 1.29$, respectively. However, younger-older adults did not significantly differ in their recognition accuracy when emotions presented via faces or non-verbal vocalisations ($p = .951$). Similarly, older-older adults were more accurate at recognising emotion from words than both faces and non-verbal vocalisations, $t(17) = 7.33$, $p < .001$, $d = 1.62$, and, $t(16) = 6.11$, $p < .001$, $d = 1.14$, respectively. However, older-older adults did not differ in their ability to recognise emotion from faces and non-verbal vocalisations ($p = .020$)

6.2.5.2 *Emotion Type*Age Group interaction.* Post hoc t tests with, alpha =1%, were run to investigate the Emotion Type*Age Group interaction (see Figure 6.2.4 and Table 6.2.8). There were no age-related differences for recognising emotions of happiness, fear, or neutral stimuli. However, YAs were more accurate at recognising anger than older-older adults, $t(51) = 2.91$, $p = .008$, $d = 0.89$, and younger-older adults were marginally more accurate at recognising sadness than older-older adults, $t(33) = 2.67$, $p = .012$, $d = 0.90$. Furthermore, older-older adults had higher accuracy for recognising disgust than YAs, $t(51) = 2.83$, $p = .007$, $d = 0.86$. No other comparisons reached significance (all other *p*s > .01; lowest nonsignificant $p = .056$, sad). There were no significant comparisons for emotion accuracy by emotion type between the two younger groups (all *p*s > .01; lowest nonsignificant *p* value was $p = .136$, fear).

Table 6.2.8

Descriptive Statistics for Total Accuracy for Emotion Recognition by Emotion Summed across the Three Presentation Types (maximum M = 18)

Emotion Type	Younger adults		Younger-older adults		Older-older adults	
	M	*SD*	*M*	*SD*	*M*	*SD*
Happy	17.36	0.80	17.39	0.78	17.18	0.81
Sad	14.33	1.96	**15.22**	**2.24**	**13.12**	**2.42**
Fear	13.56	3.01	13.50	2.83	11.94	3.19
Anger	**12.08**	**2.26**	11.16	2.75	**9.71**	**3.00**
Disgust	**12.91**	**2.32**	13.83	1.98	**14.76**	**1.99**
Neutral	15.36	1.84	15.06	1.63	15.76	1.79

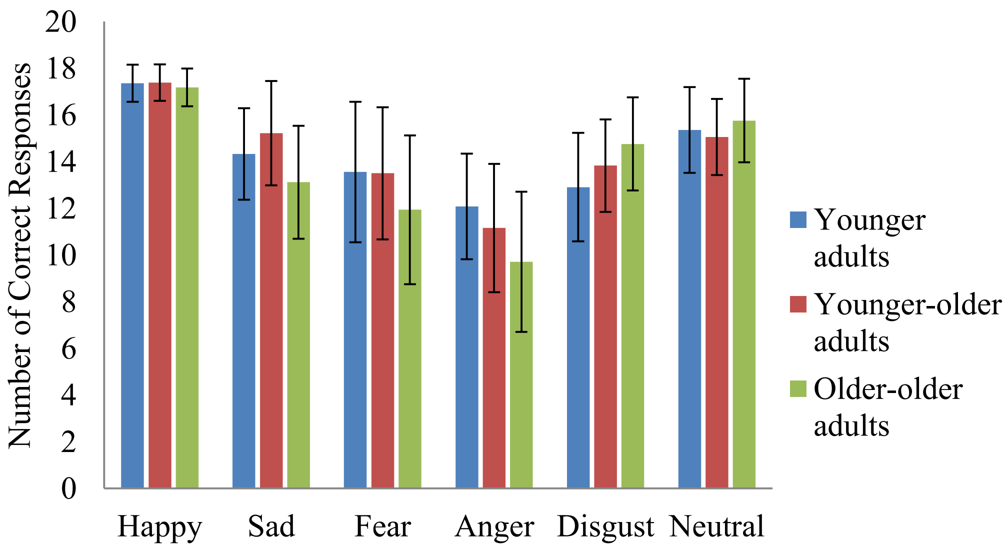


Figure 6.2.4. The mean accuracy for total emotion recognition by age group (YAs *n* = 36; Younger-older adults *n* = 18; Older-older adults *n* = 18) (maximum score = 18).

The interaction can also be explained by the pattern of emotion recognition accuracy within each age group (see Tables 6.2.9 and 6.2.10). Post hoc t tests suggest that for all three age groups happiness was recognised more accurately than other emotion types (with the exception that happiness and neutral emotion did not significantly differ in older-older adults). Anger was recognised less well than other emotions types for all age groups, with the exception that anger and disgust did not differ for YAs, and for older-older adults recognition accuracy for anger and fear did not differ. Further differences were observed as older-older adults had higher recognition accuracy for disgust than fear, and lower recognition of sadness than neutral information; neither of these findings was observed for the other age groups.

Table 6.2.9

*Inferential Statistics for Emotion Recognition Accuracy in **Younger-Older Adults** by Emotion Type and Summed Across Presentation Types*

Comparison	*t*(17)	*p*	95% CI		*d*
			LL	UL	
Happy>Sad	3.98	**.001**	1.01	3.31	1.29
Happy>Disgust	8.59	**< .001**	2.68	4.43	2.37
Happy>Fear	6.17	**< .001**	2.55	5.22	1.87
Happy > Anger	9.97	**< .001**	4.91	7.54	3.08
Happy>Neutral	5.45	**< .001**	1.43	3.24	1.82
Anger<Fear	2.76	**.013**	0.55	4.11	0.84
Anger<Sad	6.35	**< .001**	2.71	5.40	1.61
Anger<Neutral	5.45	**<. 001**	-5.39	-2.38	1.72
Anger<Disgust	4.06	**.001**	-3.23	0.12	1.11
Fear=Neutral		ns			
Disgust=Neutral		ns			
Disgust=Fear		ns			
Sad=Fear		ns			
Sad=Neutral		ns			
Disgust=Sad		ns			

Note. ns = nonsignificant. The lowest nonsignificant p value was $p = .025$ (sad-disgust)

Table 6.2.10

Inferential Statistics for Emotion Recognition Accuracy in ***Older-Older Adults*** *by Emotion Type and Summed Across Presentation Types*

Comparison	*t*(16)	*p*	95% CI		*d*
			LL	UL	
Happy>Disgust	4.62	**<.001**	1.31	3.52	1.59
Happy>Sad	6.24	**< .001**	2.68	5.44	2.25
Happy>Fear	7.03	**< .001**	3.66	6.82	2.25
Happy > Anger	10.05	**< .001**	5.90	9.05	3.41
Anger<Sad	4.69	**< .001**	1.87	4.95	1.25
Anger<Neutral	9.32	**<. 001**	-7.44	-4.68	2.46
Anger<Disgust	6.50	**< .001**	-6.71	-3.41	1.99
Fear<Neutral	4.39	**< .001**	-5.67	-1.98	1.48
Sad<Neutral	4.55	**< .001**	-3.88	-1.41	1.24
Disgust>Sad	2.90	**.010**	-2.85	-0.44	2.46
Disgust>Fear	3.99	**.001**	-4.33	-1.32	1.06
Happy=Neutral		ns			
Disgust=Neutral		ns			
Anger=Fear		ns			
Sad=Fear		ns			

Note. ns = nonsignificant. The lowest nonsignificant *p* value was *p* = .018, *d* = 0.52 (fear-anger and happy-neutral)

6.2.6 Summary.

The findings indicate that regardless of age, accuracy was higher for words then non-verbal vocalisations and lowest for faces for total emotion recognition. The pattern differed slightly between the OAs and YAs, as OAs had higher emotion recognition accuracy for words than both non-verbal vocalisations and faces, but emotion recognition accuracy for words was only higher than faces in YAs.

Regarding emotion recognition accuracy by total emotion type, as measured by the summed totals of the presentation types, YAs were more accurate than OAs for recognising anger. In contrast OAs had higher accuracy for recognising disgust than YAs. The findings from the three age groups suggest that the older-older adults drive the age group differences for disgust and anger recognition. Further, younger-older adults were marginally more accurate at recognising sadness than older-older adults. There were no age differences for emotion expressions of happiness, fear, or neutral stimuli. Finally, the pattern of age-related differences in emotion recognition accuracy for discrete emotions did not significantly differ across presentation types.

6.3 Discussion

One of the main aims of Phase 1 was to enable meaningful comparisons across presentation types by carefully designing three emotion recognition tasks, which differed by presentation type, but were as methodologically similar to each other as possible. Furthermore, the same participants completed all three experiments, thus any differences in emotion recognition accuracy across the presentation types is unlikely to result from sample differences. The findings from Phase 1 suggest that as predicted, regardless of age, emotion recognition accuracy was highest for words and lowest for faces. Also OAs were less able to recognise emotions from non-verbal vocalisations but more able from single words than YAs. Furthermore, as predicted OAs were less able than YAs to recognise anger across presentation types, conversely across presentation types OAs were more able than YAs to recognise disgust; both of these findings appear to be driven by the older-older adults. Finally, older-older adults were marginally less able to recognise sadness across presentation types than younger-older adults. Thus, the pattern of the age-related differences in emotion recognition ability did not significantly differ between different presentation types.

The current findings suggest that total emotion recognition accuracy for each presentation type differed between the YAs and OAs. Of importance the developmental trajectory of emotion recognition appears to depend upon how the information is presented; OAs are equally as able as YAs to recognise emotions from faces, are less able than YAs to recognise emotions from non-verbal vocalisation but are more able than YAs to recognise emotions from words. This finding appears to be in contrast to research that suggests that OAs are less able to recognise emotions regardless of presentation format. For example, OAs were less able than YAs to recognise emotions from faces and vocalisations (Mill, Allik, Realo, & Valk, 2009) and faces and read sentences (Isaacowitz et al., 2007). However, Mill, et al. (2009) measured different emotions between the tasks making between task comparisons difficult. The advantage of the current study was that the tasks were as similar to each other as possible in procedure and level of contextual cues in the stimuli, thus meaningful comparisons can be made.

To the author's knowledge this is the first study to take a developmental approach to assessing emotion recognition ability in OAs across three presentation types. Non-developmental research, however, has investigated emotion recognition across three different communication channels. Similar to the current research, Borod et al. (1998) measured emotion recognition across static faces, words, and prosodic sounds. The researchers found that the participants were less able to recognise emotion in prosodic sounds than both faces and words. These findings are somewhat in contrast with the current findings as we report that accuracy was lower for affective faces than words and non-verbal vocalisations, whereas accuracy for non-verbal vocalisations was lower than accuracy for words. There are many methodological differences between the study by Borod et al. and the current study: the older study used black and white images as the face stimuli rather than coloured images; word clusters were used rather than single words; and there were only three examples of eight emotion types for the word and prosody tasks and four examples in the face task compared to six examples for all six emotions in each presentation type in the current study. Thus it is likely that the difference in the pattern of emotion recognition accuracy between the presentation types in the current study and Borod et al. arise from these methodological differences. Nevertheless, Borod et al. explained that the differences in emotion recognition between the different presentation types in their study were probably due to specific stimuli effects rather than any differences in processing systems. It is feasible that this is also the case in the current study and this is particularly likely given the robust methodology used to make the tasks in the present study as procedurally similar to each other as far as possible; thus, differences between the tasks were limited to the stimuli type.

It is feasible that the differences in overall emotion recognition ability across presentation types, particularly for faces and non-verbal vocalisations, results from variations in the ability of the actors to accurately encode the emotion, as emotion recognition accuracy relies on both the ability of the individual to encode the emotion as well as the ability of the receiver to decode it (Brunswik, 1956). Facial and auditory expressions can vary in intensity and can be influenced by many encoder factors, such as wrinkles in the face, and these may increase the ambiguity of the emotion expression making it more difficult to decode (Riediger, Voelke, Ebner, & Lindenberger, 2011). In contrast, a specific word is largely structurally unambiguous, for example the graphemes or letters that make up a word are consistent. Therefore, the participants' ability to accurately recognise emotion in words more than from faces and sounds may be due to these ambiguity and encoder effects.

The discussion now turns to age-related differences in recognising emotion across the different presentation types. In line with a general processing theory of emotion it would be expected that OAs, and YAs, would perform in a similar manner across the different presentation types (Borod et al., 2000). According to this theory, regardless of presentation type or emotion valence, emotion information is processed in the right hemisphere (Borod et al., 1998). Therefore, any age-related impairment in the general emotion processor should lead to similar changes in emotion recognition across presentation types. Indeed, findings from research based on clinical (patients with either left or right hemispheric damage) and non-clinical adults suggest that those adults with damage to the right hemisphere are less able to recognise emotions across presentation types (lexical, faces, and prosody) than non-clinical adults (Borod et al., 1998). Furthermore, emotion recognition accuracy across different presentation types is correlated suggesting that the ability is related and not variable across presentation channels (Borod et al., 2000). However, the current findings suggest that results from clinical samples do not generalise onto older age populations, as OAs did not have age-related emotion recognition impairments across all three presentation types. Specifically emotion recognition accuracy in OAs was lower than YAs from non-verbal vocalisations, whereas OAs were equally as proficient as YAs in recognising affective faces but were more accurate than YAs for emotion words. Therefore, the current research does not support a general processing system of emotion; rather the findings imply a more delineated system that underlies emotion development in older age.

It is also possible that emotion is processed by emotion specific systems as would be proposed by basic emotion theory (Ekman, 1992). The current findings may provide some support for this approach, as there was a trend for higher disgust recognition and lower anger recognition in OAs than YAs, and the magnitude of the age-related differences did not differ across presentation types. These two emotion specific findings seem to be particularly true for older-older adults who also had lower recognition ability for sadness than younger-older adults. Furthermore, the age groups did not differ in their ability to recognise happiness, fear, and neutral expressions across the different presentation types. These findings will be discussed in turn.

The current findings demonstrate that OAs have a particular impairment for processing anger regardless of how the information is presented. Lower accuracy for recognising anger in OAs, compared to YAs, across several presentation types is in line with some previous research (e.g., Chaby, Boullay, Chetouani, & Plaza, 2015; Isaacowitz et al., 2007). It appears from these studies that age-related recognition deficits in OAs for anger have been observed across several different presentation formats including faces, non-verbal vocalisations, visual sentences, and audio-visual presentations. There are a few exceptions to this finding as Wong, Cronin-Golomb, and Neargarder (2005) reported that age-related deficits in OAs for recognising anger were particular to faces and were not observed when presented in heard sentences. Nevertheless, the majority of studies suggest that OAs are less able to recognise anger than YAs. However, these studies have typically only measured anger recognition across one or two separate presentation types. Therefore, to the author's knowledge the current research is the first to suggest that the magnitude of an age-related decline for recognising anger does not change across three presentation types. However, it is important to note that when the analysis was conducted on the individual presentation types (as presented in Chapters 3, 4, and 5) anger was only statistically significant for faces, and this was marginal given the strict alpha level, and only demonstrated a trend for a decline from non-verbal vocalisations and words. It is feasible that the non-verbal vocalisation and word tasks lacked the sensitivity to detect age-related differences for anger recognition. Nevertheless, the findings in the current chapter imply that OAs with a characteristic profile that should be supportive of emotion recognition ability such as, levels of intelligence at least equal to YAs; similar levels of extraversion and higher levels of openness than YAs; and aspects of socio-emotional functioning at least equal to YAs, still appear to have difficulties for recognising anger. This is an important finding as a lower ability to read threatening emotion cues may have detrimental consequences in real world social interactions, as anger signals serve as a cue to avoid negative interactions; if this is misread then OAs may approach rather than avoid a threatening or aversive situation (Marsh, Ambady, & Kleck, 2005).

An age-related impairment for recognising anger regardless of how the information is presented may reflect changes to neurological structure, activation, or neurotransmitters in older age. For instance, the orbitofrontal cortex (OFC) is believed to be involved in the processing of angry facial expressions (e.g., Sprengelmeyer, Rausch, Eysel, & Przuntek, 1998) and has evidence of decline in older age (Raz et al., 1997; Resnick, Lamar, & Driscoll, 2007). Thus age-related changes in the OFC may result in lower anger recognition ability. Further, the dopamine hypothesis may provide another explanation for a decline in anger recognition ability regardless of presentation type, as a decline in dopamine levels and functioning in older age has been related to age-related decline in cognitive abilities such as processing speed and executive functioning (Bäckman, Lindenberger, Li, & Nyberg, 2010; Frank & Kong, 2008). Furthermore, the loss of dopamine function may accelerate with advancing older age (e.g., Ma et al., 1999). Specifically regarding anger recognition, administering sulphate to participants, thus preventing dopamine binding to receptors, resulted in a temporary reduction in ability to detect anger (Lawrence, Calder, McGowen, & Grasby, 2002). Given that reduced ability to recognise anger in the current study appears to be a function of the older-older adults' performance then this finding maybe explained by the evidenced accelerated reduction in dopamine function with advancing older age. However, research is required to directly test the hypothesis that reduced dopamine activity across older age is related to reduced anger recognition across presentation types.

In relation to the dopamine hypothesis, activity in the ventral striatum, an area associated with the release of dopamine, may be lower in OAs and YAs in different tasks (e.g., Mell et al., 2009). Changes in activity in the ventral striatum may account for reduction in anger recognition in older age, as patients with damage to the ventral striatum are less able than controls to recognise anger regardless of presentation type (static and dynamic faces, prosodic, and non-verbal vocalisations) (Calder, Keane, Lawrence, & Manes, 2004). Whilst our knowledge of a specific neural network for anger recognition appears to be incomplete (Calder et al., 2004), the possible age-related changes in the ventral striatum, the OFC, and dopamine levels warrant further investigation in relation to age-related decline in anger recognition across several presentation types.

Whilst some research has identified possible neural substrates for processing anger, less is known about a specific neural pathway for processing sadness. In the current study older-older adults had a marginal age-related difference for recognising sadness to younger-older adults. Given the limited knowledge of a processing system for sadness it is difficult to explain this finding in relation to age-related neurological changes. However, processing of sad facial expressions has been related to activation in the left amygdala and the right inferior and middle temporal gyri (Blair, Morris, Frith, Perrett, & Dolan, 1999). Given that the temporal areas including the amygdala are vulnerable to volume reduction in older age (Allen, Bruss, Brown & Damasio, 2005) then it is feasible that the current finding of reduced sad recognition in older-older adults are a reflection of smaller temporal volume with advancing older age. However, further investigation regarding the neural networks involved in emotion recognition of sadness across presentation types is required to give further support to this possibility.

An experience perspective may provide an alternative explanation for the age-related differences for specific emotions, as emotion experience may be related to emotion recognition. Adolphs et al. (2000) suggest that detecting emotion states in others instigates congruent emotion responses within the perceiver that leads to the identification of the emotion. It is feasible that in the current sample OAs' apparent greater regulation of negative emotions (as measured by negative affect) than YAs may have reduced their ability to recognise anger. However, self-reported negative affect did not differ between older-older adults and YAs. Given that the age-related emotion recognition deficits for anger and sadness were observed specifically in relation to older-older adults, this undermines the extent to which the emotion experience argument is plausible. Of note however, the measure of negative affect in the current study is based on a summation of self-reported experience of emotion valence rather than specific, discrete emotions. Future research may provide more revealing findings for an association between emotion recognition and emotion experience by mapping experience onto emotionally congruent recognition abilities across discrete emotions. For example, OAs are reported to experience sadness more intensely than YAs, whereas YAs experience more anger than OAs (Blanchard-Fields & Coats, 2008; Seider, Shiota, Whalen, & Levenson, 2011); thus an experience perspective would predict that, compared to YAs, OAs would have lower ability to recognise anger alongside an increased ability to recognise sadness. In this manner findings may be more informative than the present research that uses affective valence as a measure of emotion experience.

In contrast to evidence of a decline with age in the recognition ability of some negative emotions, OAs, and particularly older-older adults, are more able to recognise disgust than YAs. The findings corroborate with some research suggesting that OAs are more able to recognise disgust than YAs in facial expressions (e.g., Suzuki, Hoshino, Shigemasu, & Kawamura, 2007). However, the current research also suggests that this enhanced ability is not restricted to facial expressions of disgust but is evident across presentation types including faces, non-verbal vocalisations, and words. Furthermore, Calder et al. (2003) state that the advantage for disgust recognition in OAs relative to YAs is possibly a consequence of YAs' underdeveloped ability to recognise disgust rather than an increased ability with advancing age. The current findings do not necessarily support this stance. Whilst accepting that it is likely that maturation of disgust recognition ability may not be complete in YAs, it appears that the ability to recognise disgust increases with advancing older age, at least up until the ninth decade.

An alternative explanation for an apparent superior sensitivity to disgust in OAs than YAs is that OAs may have a response bias for disgust. However, signal detection analysis demonstrated that OAs did not have a response bias for disgust; therefore, OAs are more sensitive at detecting disgust than YAs.

The apparent improvement with age for the ability to recognise disgust in the present study is possibly a function of neurological preservation. Specifically, the insula and basal ganglia are believed to be spared from aging effects and are related to processing of disgust in faces (Calder et al., 2001; Phillips et al., 1998.). However, the experiment by Phillips et al. (1998) was not a developmental study; therefore, the findings from the current study suggest that preservation in the insula and basal ganglia is maintained into older-older age as these adults appear to drive the age-related benefit of disgust recognition in the current study.

Of interest whilst there were age-related differences for recognition of disgust and anger, the age groups did not differ in recognition ability for fear, happiness, and neutral stimuli. As discussed neurological explanations may account for the observed age-related differences in disgust and anger recognition; however, it is unlikely that a neurological explanation can account for the findings for fear. There is some evidence that the amygdala is activated when processing fearful faces and this area is vulnerable to decline in activation with age (Calder, Lawrence, & Young, 2001; Gunning-Dixon et al., 2003). However, OAs were as able as YAs to detect fear across all presentation types. Therefore, an aging brain explanation of age-related changes cannot fully account for all of the current findings.

A pattern of maintained recognition ability for happiness across presentation types in OAs alongside age-related declines in recognising anger across presentation types and sadness in older-older adults is suggestive of a positivity effect (Charles, Mather, & Carstensen, 2003). According to the theory of a positivity effect in older age, OAs' seemingly lower ability to recognise anger and sadness in older-older adults may result from changes in processing of negative stimuli in that OAs either pay less attention to negative stimuli or that they are slower to detect it (Mather & Knight, 2006). However, this concept does not singularly focus on attention to cues representing anger or sadness, rather it suggests that attention to affective cues of negative valence is the same. If this were the case then it would be expected that a reduction in attending to negatively valenced stimuli with older age would result in lower recognition ability in OAs than YAs across a range of negative emotions. The current findings do not support a broad spread of recognition deficits across negative emotions; rather any age-related impairment in processing negatively valenced stimuli appears to confined to anger and sadness. Therefore, the current findings suggest that, with the exception of anger and sadness in older-older adults, any age-related differences in processing negative emotions do not extend to processing difficulties for fear and disgust in older age. Rather than a positivity effect, the pattern of findings including the preservation in the ability to recognise happiness may reflect the task design. Essentially the ease in identifying a single positive emotion from an array of negative emotions may result in a maintained ability to recognise happiness and difficulties in distinguishing between negative emotions leads to errors. This issue will be addressed in Phase 2 of the current research.

The current findings do not tend to support a theory of cognitive aging (Salthouse, 2000). The OAs in the present study were at least matched to YAs on levels of intelligence and education and the OAs were considered to be highly educated in comparison with some previous research (e.g., Grainger, Henry, Phillips, Vanman, & Allen, 2015a). However, OAs had slower processing speed than YAs and this may have led to some of the age-related to declines in emotion recognition ability. Yet it is unlikely that any age-related deficits can be attributed to age differences in cognitive abilities of intelligence and education. Furthermore, a decline in cognitive functioning in older age would suggest that OAs should have a broad range of emotion recognition deficits. Yet, OAs were only less accurate than YAs in emotion recognition for anger. Moreover, OAs tended to be more able than YAs to recognise disgust and this suggested enhanced ability with age does not fit with the view of emotion recognition decline being due to demise in cognitive abilities with older age.

In contrast, the current findings of differing developmental trajectories in emotion recognition accuracy between the presentation types seem to support a multidirectional and multidimensional approach to cognitive aging (Baltes, 1987). Furthermore, the OAs may have used compensatory strategies to form their emotion recognition judgements. The OAs in the current study had equal levels of fluid intelligence and more years in education, higher verbal intelligence than YAs but slower processing speed. There is some evidence that slower processing is related to lower emotion recognition accuracy in OAs (e.g., Horning, Cornwall, & Davis, 2012). However, despite slower processing the OAs in the current study were as able as the YAs to recognise emotion from faces, and more able to recognise emotion from words than YAs. The success on these tasks in the face of a slowing in processing suggests that OAs may have adopted compensatory strategies on the emotion tasks. Whilst it was not the focus of this research to identify these strategies, it is possible that the performance on the non-emotion tasks might serve to inform on these. For example, it is conceivable that to achieve successful emotion recognition OAs rely on their general ability to process information from faces and words. However, OAs were less able than YAs to process auditory information, thus OAs could not utilise auditory processing strategies as a compensation mechanism for slower processing speed resulting in an age-related emotion recognition impairment.

With regards to other possible influences on emotion recognition ability the findings are unlikely to be explained by socio-emotional abilities as OAs had higher levels of alexithymia than YAs and the age groups did not differ on empathy. Furthermore, the detection of stimuli related to threat maybe greater in those with higher anxiety (Mogg, Bradley, De Bono, & Painter, 1997). In the current study YAs had higher levels of state and trait anxiety than OAs; therefore, it is possible that higher anxiety enabled YAs to detect anger more than OAs rather than OAs having reduced recognition ability for anger per se. However, for both YAs and OAs accuracy was relatively low for anger compared to other emotions suggesting that higher anxiety in YAs did not increase recognition ability in comparison to other emotion types. Thus it is unlikely that YAs' higher recognition ability for anger than OAs was a consequence of enhanced processing of threatening stimuli due to levels of anxiety. Of note, OAs were as able as YAs to recognise when no emotion was present, neutral, and this did not differ across presentation types.

6.4 Conclusion

When OAs have a characteristic profile that is supportive of emotion recognition, for example, OAs have good socio-emotional skills; have higher levels of openness; and similar levels of extroversion when compared to the YAs, and tasks are used that are procedurally similar across presentation types, OAs still experience some difficulties in emotion recognition relative to YAs. Age-related impairments were observed for processing emotion from non-verbal vocalisations regardless of emotion type, as well as for specific emotions of anger, and sadness in older-older adults regardless of presentation type. However, there was a trend for disgust recognition to improve with older age and the magnitude of this did not differ across the presentation types. Furthermore, OAs were more able to relate emotion meaning to words than YAs. Of interest is that the age-related differences in the recognition of specific emotions (anger, sadness, and disgust) appear to be a result of older-older adults' emotion recognition ability.

In general the findings provide a more positive picture of emotion recognition ability than previously detailed as OAs did not have age-related emotion recognition impairments for several emotion types. Importantly, the current findings highlight that some of the previously observed age-related emotion recognition impairments may be a function of the method used in the task, differences between the age groups in sample characteristics, or the ability to meet the task demands, rather than differences in emotion recognition ability per se. Furthermore, age-related differences in emotion recognition ability between younger-older and older-older adults provide a more fine-grained understanding of development and highlight the importance of considering the age of the OAs when interpreting results.

6.5 Overall Summary of Phase 1 and Future Research.

The findings from Phase 1 suggest that OAs were as able as YAs to recognise emotions in faces but were less able than YAs to recognise some emotion specific facial expressions including anger, and sadness for older-older adults. However, a general ability to recognise emotions from faces in OAs appears to decline with advancing older age. Furthermore, OAs were less able than YAs to recognise emotion from non-verbal vocalisations and this may be a reflection of a lower ability to process short sounds yet this ability does not appear to decline further with advancing older age. However, OAs did not have any age-related emotion specific deficits from non-verbal vocalisations. Finally, OAs were more able to recognise emotion in visual words than YAs and this was particularly true for sad related words and this ability seems to be maintained into older-older age.

Despite findings in Chapters 3 to 5 suggesting that age-related deficits for recognising some specific emotions, such as anger, are not consistently reported across the presentation types, the observations reported here in Chapter 6, did not reveal a significant Age Group*Presentation Type*Emotion Type interaction effect. Thus the pattern of age-related differences in emotion recognition ability did not differ across presentation types. Given that the tasks were carefully designed to be as procedurally similar as possible then this reduced the chance of between task methodological differences leading to a variation in the pattern of emotion recognition ability. Thus the findings can be more confidently stated as reflecting emotion recognition ability than studies that have not applied such methodological control.

When recognition accuracy was summed across emotion types OAs were as able as YAs to recognise affective facial expressions, less able to recognise non-verbal vocalisations, and more able to recognise emotion meaning in words than YAs. It is possible that findings of disparate emotion recognition accuracy across presentation types in experiments that do not include similar non-emotion tasks maybe interpreted as a variation in emotion processing as a function of how the emotion is presented. However, the current study had the advantage that it included non-emotion tasks to understand age-related differences in processing information from faces, sounds, and words without emotion content. Performance on the non-emotion tasks suggest that the age-related differences between the presentation types on the emotion tasks might reflect age-related differences in general processing ability across specific presentation types rather than a result of emotion processing ability per se. This finding demonstrates that, where possible, to discern between the effects of emotion processing and processing of the stimuli (i.e, static faces, short sounds, or single words) non-emotion tasks should be incorporated into emotion recognition research.

However, OAs were less able to recognise anger when recognition accuracy was summed across the presentation types and this is a function of the older-older adults Furthermore, older-older adults were less able to recognise sadness than younger-older adults. In contrast to these age-related impairments OAs were more able to recognise disgust than YAs. Also of importance is that OAs were as able as YAs to recognise happiness, fear, and neutral stimuli across all tasks. The maintenance for recognising happiness alongside declines for certain negative emotions is somewhat supportive of a positivity effect in emotion processing.

In light of these findings it is important to further investigate certain observations. For instance, the stimuli used in Phase 1 were specifically selected to replicate most of the existing research in the field, which meant that they had low ecological validity (e.g., static faces). It is, therefore, important to understand whether the age-related decline for recognising anger and sadness are observed in tasks that use more ecologically valid stimuli, or whether this finding is particular to laboratory tasks, that may not tap into processing used in naturally occurring social interactions. Therefore, Phase 2 of the current research programme measured emotion recognition ability in tasks that use cross-modal information, comprising actors dynamically expressing emotion whilst speaking prosodic nonsense sentences. Furthermore, the pattern of age-related emotion recognition differences in Phase 1 may be suggestive of a positivity effect but this could also be a result of the task design in that only one positive emotion was included in the emotion choices. It is of interest to further investigate these two explanations for the pattern of findings and this will be tested using especially designed tasks in Phase 2.

Phase 2

Chapter 7- The Effect of Age on Emotion Recognition Ability from Unimodal and Cross-modal Presentations of Dynamic Faces and Prosodic Sentences

7.1 Introduction

This chapter details two experiments that were specifically designed to address some of the methodological limitations of the traditional emotion recognition tasks used in Phase 1 of the current research and elsewhere in the field. Phase 1 used tasks which have been typically used in the emotion recognition literature (e.g., which have employed discrete static images, short sound bursts, or single words). Such an approach was taken in order to allow direct comparisons to be made between current findings and those previously reported. Furthermore, age-related differences on these tasks are informative of changes in emotion processing in older age. As detailed in previous chapters, findings from these studies typically suggest that emotion recognition ability declines in older age. Specifically, the findings from Phase 1 suggest that OAs have comparable emotion recognition ability to YAs with a few particular and notable exceptions. First, the OAs in Phase 1 appear to have a general age-related deficit for recognising anger and emotion in non-verbal vocalisations, and specifically OAs were less able than YAs to recognise facial expressions of anger. Furthermore, older-older adults were less able to recognise affective facial expressions than YAs, and this was particularly true of sad expressions. Importantly, the age-related findings for reduced ability to detect emotion in non-verbal vocalisations in OAs and faces in older-older adults are a consequence of a general reduced ability to process short sounds and facial information regardless of emotion content.

However, it should be acknowledged that the tasks used in Phase 1 and elsewhere can be said to lack the multiple channels of information and dynamic cues which are relied upon when we recognise the emotions of others in more naturalistic settings (Isaacowitz & Stanley, 2011). It is, therefore, unclear whether age-related emotion recognition impairments are a consequence of a lesser ability in OAs to make accurate judgements of emotion recognition per se or arise from impoverished cues in the stimuli. Phase 2 sought to address this issue by using stimuli which were richer sources of information in terms of being dynamic and involving more than one modality. Therefore, it is of interest to further investigate OAs' lesser ability to recognise anger and auditory information using stimuli with higher levels of ecological validity than those used in Phase 1 to see whether the findings are replicated when emotion information is presented in unimodal and cross-modal (simultaneously presented audio and visual information) dynamic faces and prosodic sentences.

As discussed findings from Phase 1 indicate that OAs have an age-related deficit for recognising anger, and this seems to be particularly true for static facial expressions. An age-related deficit for anger from static faces and morphed faces are often, but not consistently, reported in the field (see Ruffman, Henry, Livingstone, & Phillips, 2008). However, there is evidence to suggest that this impairment may still exist when anger is displayed in cross-modal presentations of static faces and non-verbal vocalisations (Chaby, Boullay, Chetouani, & Plaza, 2015). Possible neurological explanations for an age-related decline in recognition ability for anger have been discussed in Chapter 6 including the dopamine hypotheses and age-related changes in the OFC. However, evidence for these neurological changes is often based on static or morphed faces (e.g., Lawrence, Calder, McGowan, & Grasby, 2002); thus may not apply to cross-modal or acted dynamic expressions of anger. For instance, evidence suggests that different neural networks are recruited for dynamic and static faces of anger and it is possible that these networks may differ in the degree of neural degradation with age (Kilts, Egan, Gideon, Ely, & Hoffman, 2002). Furthermore, it is feasible that the deficit for recognising anger from static faces may be a consequence of the stimuli; as static faces lack the unfolding cues of dynamic expressions that OAs may rely on to make emotion judgements (Isaacowitz & Stanley, 2011). Taken together the possible differences in neurological networks and facial cues between static and dynamic stimuli may mean that OAs' ability to recognise anger in static and dynamic expressions differ. However, if OAs are less able than YAs to recognise anger from acted, dynamic faces then this would further support findings from Phase 1 that OAs have a general age-related impairment for recognising anger.

Furthermore, the research in Phase 1 purposefully used stimuli low in ecological validity including unimodal displays. It is possible that OAs are disadvantaged more than YAs on such tasks and the findings may not be replicated in tasks that utilise stimuli with higher levels of ecological validity such as cross-modal presentations. Dynamic, cross-modal information is more representative of real life interactions than unimodal presentations, as real life social interactions often involve integrating inputs from multiple channels and adapting interpretations in line with evolving information (Sze et al., 2012). In a similar manner, successful processing of cross-modal information in laboratory tasks involves the integration of inputs from two or more information streams (Stein et al., 2010). Findings from various types of cross-modal tasks suggest that cross-modal information is often more efficiently processed than unimodal information, including faster reaction times or enhanced accuracy (Barutchu, Spence, & Humphreys, 2018; Kreifelts, Ethofer, Grodd, Erb, & Wildgruber, 2007; De Gelder & Vroomen, 2000). The additional benefit for cross-modal processing compared to unimodal presentations is perhaps due to effective integration of the information in neural areas including the superior temporal sulcus and the posterior parietal cortex (Driver, & Noesselt, 2008; Laurienti, Burdette, Maldjian, & Wallace, 2006; Stein & Stanford, 2008).

Of interest, recruitment of compensatory mechanisms may further support enhanced cross-modal processing. For example, when processing cross-modal information evidence suggests that the brain is adaptive, shows neural plasticity, in individuals with sensory loss, such as vision or hearing; thus recruitment of compensatory neural mechanisms may overcome the loss of sensory input (Merabet & Pascual-Leone, 2010). It is possible that this finding generalises onto OAs, as OAs are susceptible to a reduction in sensory sensitivity (Brooks, Chan, Anderson, & McKendrick, 2018; Cavazzana et al., 2018). For example, fMRI data indicates that reduced hearing sensitivity to high frequencies in OAs was related to enhanced cross-modal interconnectivity, which may increase cross-modal integration (Puschmann & Thiel, 2017). Thus, OAs may benefit when information is presented in cross-modal formats than unimodal tasks despite age-related sensory, cognitive, and neurological changes.

Indeed, both YAs and OAs tend to perform better on non-emotion based cross-modal tasks than unimodal tasks; however, OAs appear to benefit to a greater extent than YAs from visual-somatosensory or audio-visual inputs as measured by reduced reaction times (Laurienti et al., 2006; Mahoney, Li, Oh Park, Verghese, & Holtzer, 2011; Peiffer, Mozolic, Hugenschmidt, & Laurienti, 2007). It is possible that a greater enhanced benefit for cross-modal information over unimodal information in OAs than YAs may reflect age-related neurological changes, such as volume reduction and neural recruitment, which may reduce effective processing of unimodal stimuli in OAs (Dieuleveult, Siemonsma, Erp, & Brouwer, 2017). Moreover, it is feasible that when processing cross-modal information OAs use compensatory mechanisms to overcome any declines in processing of unimodal information. For example, according to the Scaffolding Theory of Aging (STAC; Parks & Reuter-Lorenz, 2009) neural overactivation in OAs compared to YAs may act as a compensatory mechanism to achieve task demands (Parks & Gutchess, 2004). Indeed, fMRI data suggests that OAs have earlier detection and overactivation in the inferior parietal and medial prefrontal regions than YAs in response to cross-modal stimuli; this was related to a greater benefit, shorter RTs, for OAs than YAs on cross-modal tasks (audio-visual) compared to unimodal tasks (Diaconescu, Hasher, & McIntosh, 2013). Thus, an enhanced processing advantage in cross-modal information for OAs maybe a consequence of compensatory neural recruitment as measured by overactivation in prefrontal areas.

An alternative account of compensation in OAs is Baltes' theory of successful cognitive aging; this theory suggests that OAs use cognitive strategies of compensation, selectivity, and optimisation to achieve goals (Baltes, 1997). Essentially in the face of decline in many cognitive abilities and changes in processing with age, OAs may select to conduct tasks that are not too cognitively demanding, attend to goals in which they can demonstrate competence, and use skills that are resilient to the effects of cognitive aging to achieve successful performance (Baltes, 1997). When applied to processing cross-modal information, OAs may use the extra cues from a second sensory modality to support and compensate for any difficulties in processing information from unimodal presentations (Isaacowitz & Stanley, 2011). Furthermore, due to their longevity, OAs are often expert in processing and integrating multiple information streams and this experience may compensate for changes in sensory, neural, or cognitive domains when processing cross-modal information (Grossman et al., 2010; Isaacowitz & Stanley, 2011; Kensinger & Gutchess, 2017). This is perhaps important regarding emotion recognition tasks as some research findings imply that expertise, shaped by experience, is used to form social judgements (Hess, Osowski, & Leclerc, 2005). It is conceivable, therefore, that to compensate for sensory, cognitive, and neurological changes OAs use their greater expertise than YAs to process and integrate cross-modal information when making emotion judgements; thus OAs may be more proficient on cross-modal tasks than unimodal tasks.

However, only a few studies have investigated emotion recognition ability in OAs using cross-modal tasks based on simultaneously presented visual and auditory information (e.g., Chaby, Boullay, Chetouani, & Plaza, 2015; Horning, Cornwell, & Davis, 2012; Lambrecht, Kriefelts, & Wildgruber, 2012). These tasks tend to follow the format of the traditional emotion recognition task in that participants select from a given array of emotion labels which emotion they believe best describes the emotion presented in the stimuli. In such tasks emotion recognition accuracy increases on the cross-modal task (static faces and non-verbal vocalisations) compared to the unimodal task for both YAs and OAs (Chaby, Boullay, Chetouani, & Plaza, 2015; Hunter, Phillips, & MacPherson, 2010). Indeed, overall emotion recognition accuracy from cross-modal presentations is similar for OAs and YAs despite age-related declines in OAs on the unimodal tasks (e.g., Chaby, Boullay, Chetouani, & Plaza, 2015; Hunter, Phillips, & MacPherson, 2010). However, these studies have used static faces as the visual stimuli thus lack the unfolding cues in dynamic expressions. In a different study Sze et al. (2012) used movies of interactions between couples as stimuli, and participants rated the emotion valence of the target individual. OAs were more able to recognise the valence of emotion within these interactions than YAs despite an age-related decline in emotion recognition ability from static faces. However, this study tells us little about how OAs and YAs recognise discrete emotions from movies. More recently, OA females with age-related emotion recognition impairments from dynamic faces and prosodic non-linguistic verbalisations (but not lexical, written texts), as measured by accuracy for identifying anger and sadness, benefited to a greater extent than YA females from cross-modal presentations including face-prosody and lexical-prosody tasks (Wieck & Kunzmann, 2017). However, this study used a restricted number of emotions and further understanding of emotion recognition from cross-modal presentations from a wider set of emotions is needed. Taken together there is evidence that OAs and YAs have improved emotion recognition accuracy on cross-modal tasks than unimodal tasks and OAs appear to benefit to a greater extent than YAs.

Despite improvements in emotion recognition ability from cross-modal tasks, compared to unimodal tasks, OAs still appear to be less able to recognise certain emotions than YAs. For example, on the cross-modal task of simultaneously presented static faces and non-verbal vocalisations in Chaby, Boullay, Chetouani, and Plaza (2015) OAs, compared to YAs, were as able to recognise happiness, fear, sadness, and disgust but had a recognition deficit for anger. Also Lambrecht, Kreifelts, and Wildgruber (2012) used film clips of actors speaking a word in an emotion tone whilst displaying an emotionally congruent facial expression, and reported linear declines with age for all of the measured emotion types (happy, alluring, anger, and neutral) with the exception of disgust, which remained stable. However, the two studies measured slightly different emotions, thus, it is difficult to draw firm conclusions regarding the pattern of age-related emotion recognition deficits in OAs from cross-modal tasks. Further research is, therefore, required to establish whether certain emotions do or do not benefit from cross-modal presentations.

Differences in OAs' ability to recognise discrete emotions in cross-modal tasks may reflect differential age-related changes in emotion specific neural networks. For instance, fMRI data collected during the processing of cross-modal information suggests that the posterior cingulate, fusiform gyrus, and the cerebellum are activated during presentations of anger, whereas the parahippocampal gyrus, hippocampus, claus-cingulate amongst others are activated during displays of happiness (Park et al., 2010). However, this study only investigated neural networks whilst processing anger and happiness and understanding of the neural networks that are recruited during processing of cross-modal presentations of other basic emotions is less clear. Nevertheless, there may be a disparity in how age-related neurological changes affect processing of cross-modal information of anger and happiness. For instance, studies have revealed age-related reductions in the volume of white matter of 26 % in the cerebellum and 30% in the anterior lobe, alongside a reduced number of neural cells (Anderson, Gundersen, & Pakkenberg, 2003). Further fMRI data suggests that there are age-related shrinkages of around 20% alongside possible neuron cell loss in the hippocampus (Schuff et al., 1999). Thus, greater demise in the cerebellum than the hippocampus with age may lead to differential recognition ability of cross-modal presentations of anger and happiness in OAs. Furthermore, accelerated changes with advancing older age are observed in the cerebellum and hippocampus (Raz et al., 2005); thus, emotion recognition deficits from cross-modal displays of anger or happiness may be more readily detected in older-older than younger-older adults. Thus the current study will compare emotion recognition accuracy between younger-older (60-70 years of age) and older-older adults (70 years and over).

Given that the majority of cross-modal research in the field has used static faces as visual stimuli the current study will use dynamic facial expressions (video clips of actors displaying certain emotions). This is because most social interactions involve recognising emotions from moving and unfolding facial expressions, therefore, dynamic facial displays are more ecologically valid than static facial expressions (Kilts, Egan, Gideon, Ely, & Hoffman, 2003). It is, therefore, important to understand whether the select age-related emotion recognition deficits in OAs, specifically for anger, are observed using dynamic stimuli. One method of researching dynamic emotion recognition ability is to use morphed faces (one expression transitions to another expression). Findings from such tasks report similar patterns of age-related differences in emotion recognition accuracy (maintained happiness and disgust alongside impairments in select negative emotions) as those observed for static faces (e.g., Calder et al., 2003; Kessels, Montagne, Hendriks, Perrett, & de Haan, 2014). However, morphed faces are often the result of computerised transitions from one expression to another, therefore, may lack some of the cues that are evident in naturally unfolding dynamic expressions. Therefore, an alternative method for measuring dynamic expressions is to use film clips of acted, moving expressions. Findings from such research indicate that emotion recognition accuracy is comparable between OAs and YAs (Krendl & Ambady, 2010). This study, however, only measured two emotion types, thus the results may reflect the relative simplicity of the task compared to tasks that include multiple emotion types. Indeed, another study did explore emotion recognition ability from dynamic faces when participants made decisions from several emotion choices and OAs were less accurate in overall emotion recognition than YAs (Grainger, Henry, Phillips, Vanman, & Allen, 2015). Thus, it could be that when the task is more difficult, has several emotion choices, OAs have lower emotion recognition accuracy than YAs despite the unfolding cues in the dynamic expressions. However, none of the studies that use dynamic faces distinguish between emotion types; therefore, there is a need to explore whether OAs have emotion specific age-related recognition deficits from acted dynamic expressions.

Regarding the auditory stimuli, prosodic sentences were used in the current experiments. Findings from Phase 1 suggest that OAs are less able to recognise emotion, and non-emotion information, from short sounds; however this maybe a consequence of the brevity of the stimuli. Evidence suggests that OAs' age-related emotion recognition difficulties from auditory stimuli increase as the length of the vocalisation is reduced (Orbelo, Testa, &Ross, 2003). If this is the case then OAs may perform as well as YAs on emotion recognition tasks when longer prosodic sentences are used. On the other hand, OAs may have a generalised difficulty in recognising emotion from auditory stimuli irrespective of its duration. To date evidence suggests that OAs are less able than YAs to recognise emotion from prosodic sentences but research rarely distinguishes this ability across discrete emotion types (Kiss & Ennis, 2001; Raithel, & Hielscher-Festabend, 2004). One study that did differentiate recognition ability from semantically neutral prosodic sentences by the six basic emotion types reported that, compared to YAs, OAs had select emotion recognition impairments, with specific deficits for happiness and sadness (Wong, Cronin-Golomb, & Neargarder, 2005). However, evidence suggests that OAs may rely more on semantic information than affective prosodic information, whereas YAs may use affective prosody more than semantic information to form emotion recognition judgements (Dupuis & Pichora-Fuller, 2010). Thus it is unclear as to what extent age-related emotion recognition impairments in OAs from prosodic sentences is a function of semantic information interfering with emotion processing. It is, therefore, important to understand emotion recognition ability in OAs from prosodic sentences devoid of sematic information.

Besides from exploring specific findings from Phase 1, the research in the current study also aims to address some more general methodological limitations in the field such as a research focus on basic emotions (e.g., Chaby, Boullay, Chetouani, & Plaza, 2015; Hunter, Phillips, & MacPherson, 2010). It is possible that OAs have age-related impairments for recognising non-basic emotions. Indeed, Lambrecht, Kriefelts, and Wildgruber (2012) observed that in unimodal and cross-modal tasks, using dynamic faces and prosodic words, accuracy for the recognition of the non-basic emotion of alluring declines with age. This finding suggests that differences in emotion recognition accuracy between YAs and OAs may not be restricted to the basic emotions. However, other emotions including amusement and pride have been rarely measured in the field; thus, OAs' ability to recognise these emotions has not been understood within unimodal and cross-modal dynamic displays. To address this, one experiment in Phase 2 included expressions of pride and amusement to further our understanding regarding OAs' recognition ability of non-basic emotions

The typical pattern of OAs' emotion recognition accuracy across different emotion types, particularly for facial expressions, is suggestive of an age-related positivity effect and was observed on the face task in Phase 1 as evidenced by the finding that OAs were as able as YAs to recognise of happiness but OAs had an age-related deficit for recognising anger. Evidence suggests that OAs prioritise attention to positively valenced information and process positive information over negative information to a greater extent than YAs (Carstensen & DeLiema, 2018). Thus, in relation to emotion recognition ability an age-related positivity effect would be observed if OAs are more able to recognise positive emotions than negative emotions and this is to a greater extent than YAs. However, an alternative explanation for the pattern of findings reported for static faces in this and other research is that it is easier to select a positive emotion from one positive option than it is to select a negative emotion from several negative options (Isaacowitz & Stanley, 2011). One experiment in Phase 2 will attempt to tease apart these possible explanations, as the valence of the emotions included in the task are the reverse of the valence of the emotions typically included in emotion recognition tasks. Therefore, this task will measure recognition accuracy for joy, amusement, pride, surprise, and anger in unimodal and cross-modal presentations of dynamic faces and prosodic sentences. The logic of this task is that if OAs have a higher ability to recognise positive emotions than negative emotions to a greater extent than YAs then this will be suggestive of a positivity effect. However, if anger is recognised more accurately than the positive emotions then this is likely to reflect the ease of selecting an emotion of the opposite valence to the other emotions in the task; an effect of task design.

Further, as explained in previous chapters, and observed on the static face task in Phase 1, emotion recognition ability may differentiate between younger-older adults and older-older adults. Therefore, performance on the experiments in Phase 2 will not only be compared between YAs and OAs but also between younger-older and older-older adults. In this manner any progressive decline in emotion recognition ability with advancing older age may be detected.

Finally, despite very few age-related emotion recognition impairments reported in Phase 1 it appears that OAs do have some select deficits. It is unclear, however, to what extent age-related demise in recognising emotions is a reflection of a general decline in social functioning (Phillips & Slessor, 2011). As explained in Chapter 1 there is limited, if any, research in the field that includes measures of social functioning; thus the current research investigates whether OAs and YAs differ on three measures of social competence.

Hence the aims of the current research are to understand whether:

- an age-related decline for anger recognition in OAs is observed in tasks with higher levels of ecological validity than those used in Phase 1.
- OAs perform as well as YAs on emotion recognition tasks using cross-modal information based on dynamic facial expressions and prosodic sentences.
- OAs have age-related emotion recognition impairments from prosodic sentences when presented alone.
- OAs have age-related emotion recognition deficits for non-basic emotions.
- The typical pattern of emotion recognition ability in OAs is a function of a positivity effect or task design.
- OAs have global difficulties in social functioning compared to YAs.

7.2 Hypotheses

For specific presentation types it was expected that emotion recognition accuracy would be higher on the cross modal task than the unimodal tasks for both age groups. Furthermore, age-related differences would be limited to the unimodal tasks and were expected on the prosodic sentence tasks, however, OAs will perform as well as YAs on the cross-modal tasks. It was also predicted that, compared to YAs, OAs would be less able to recognise anger across the three presentation types (unimodal and cross-modal presentations of dynamic faces and prosodic sentences). Further OAs would be less able than YAs to recognise non-basic emotions. Furthermore, given the findings in Phase 1 emotion recognition accuracy will differ between older-older and younger-older adults, particularly on the dynamic face task.

The research will also explore a possible positivity effect in emotion recognition. Specifically one task will measure several positive emotions and one negative emotion (anger); if OAs are more able to detect anger than the positive emotions then this implies that it is easier to detect an emotion of different valence to the other emotion options, therefore, the pattern of findings generally reported using the traditional format is likely to arise from task design rather than a positivity effect. Conversely, a positivity effect would be observed if OAs are more able to recognise positive emotions than anger and if this is evident to a greater extent in OAs than YAs. Finally, OAs and YAs may differ on measures of social functioning.

7.3 Method

7.3.1 Design.

Two emotion recognition experiments were conducted at the same sitting and these are hitherto referred to as the positive experiment (predominately measuring positive emotion types) and the negative experiment (predominately measuring negative emotion types) (see Figure 7.3.1). Within both of these experiments emotion recognition ability was measured across three different presentation types (unimodal and cross-modal presentations of dynamic faces and prosodic sentences). As such each experiment followed the same 3*2*5 mixed factorial design with age group (YAs and OAs) as the between-participants IV and emotion type as the within-participants variable. The DV was emotion recognition accuracy.

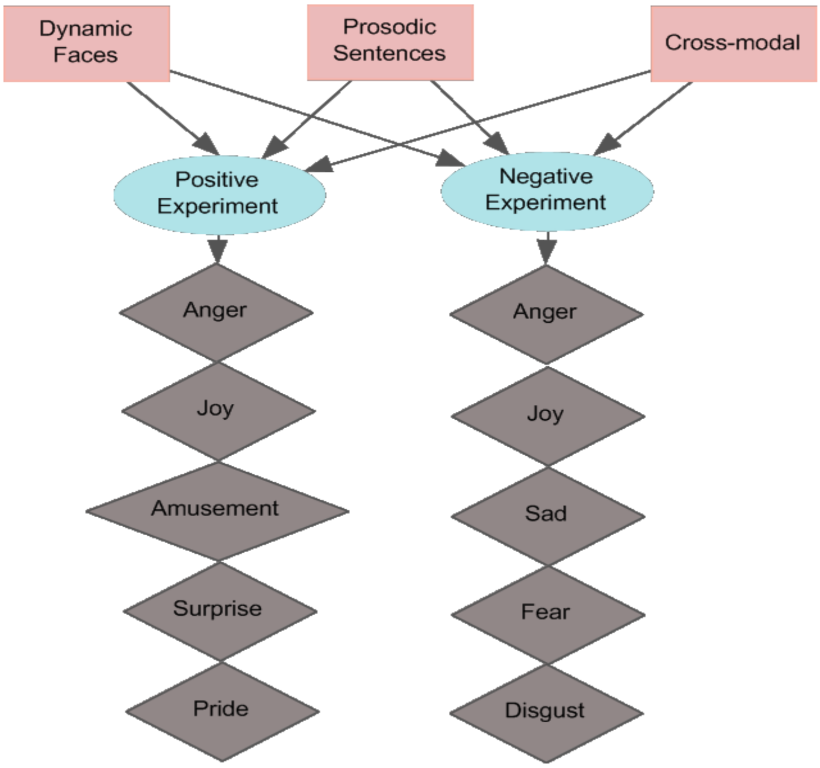


Figure 7.3.1. The presentation types and emotion types that were measured in the emotion recognition experiments.

7.3.2 Design choices.

In a similar manner to the careful design of the tasks in Phase 1, it was as equally important to reduce methodological disparities, such as task demands, between the tasks within the two experiments in Phase 2. Furthermore, to reduce the influence of individual differences the same OAs and YAs completed all six tasks.

7.3.2.1. ***The choice of presentation and stimuli types***. The stimuli used in Phase 2 were carefully selected as having a higher degree of ecological validity than those used in Phase 1. Specifically, dynamic facial expressions were used instead of static face and prosodic nonsense sentences were used instead of non-verbal vocalisations. It is accepted that nonsense sentences are devoid of meaningful semantic information and thus may lack ecological validity compared to semantic sentences; however, nonsense sentences were preferred to semantic sentences as evidence suggests that OAs base emotion recognition decisions on semantic information more than prosodic information when the two are presented together (Dupuis & Pichora-Fuller, 2010). Therefore, to reduce any influence of semantic information on emotion recognition decision-making in OAs the current study used prosodic nonsense sentences, as the interest in the current study is the influence of auditory information rather than the language itself.

There are several databases available that include unimodal and cross-modal representations of dynamic facial expressions and prosodic nonsense sentences. The final selection of the database was based on several criteria. First, to control for possible differences in encoding ability the same actor must portray each emotion across the three conditions (unimodal and cross-modal presentations). Thus, any variation in recognition ability across emotion types and presentation types cannot be attributed to differences in encoding ability between actors. Further, to reduce between-task differences, such as sentence structure and facial expressions, the same prosodic and face exemplars were presented in the unimodal and cross modal tasks. Thus any variations in emotion recognition ability between the cross-modal task and unimodal tasks are unlikely to result from differences in the stimuli and can be more confidently attributed to differences in processing between presentation types. Furthermore, to fulfil the experimental requirements the database needed to have examples of discrete basic emotions, several positive emotion types, and non-basic emotions. Finally, the database needed to include expressions from adults other than YAs to avoid a possible own-age processing bias (Anastasi & Rhodes, 2005).

Only the Geneva Multimodal Emotion Portrayal Core Set (GEMEP-CS; Bänziger, Mortillaro, & Scherer, 2012) (see Table 7.1, Appendix 7.1) met these stringent criteria. This database includes dynamic facial expressions and prosodic nonsense sentences that can be displayed separately or simultaneously and are produced by actors representing a spread of ages (25 to 57 years of age). Furthermore, the database includes 17 different emotions; thus, the GEMEP-CS contains the range of emotions necessary to create the tasks. Moreover, the actors portrayed elicited emotion expressions, which are more representative of real world expressions than posed, prototypical expressers (Bänziger, Mortillaro, & Scherer, 2012; Ruffman, 2011). The validation data for the GEMEP-CS demonstrates that overall emotion recognition accuracy was highest for cross-modal presentations and lowest for audio presentations. The most accurately recognised emotions were amusement and anger, whereas accuracy for recognising sadness was the lowest. Recognition accuracy was particularly low for prosodic expressions of sadness and pride. However, all emotions across all presentations were recognised above that of chance (Bänziger, Mortillaro, & Scherer, 2012).

In Phase 1 non-emotion tasks were run alongside the emotion tasks to measure whether the OAs, and YAs, were able to meet the processing demands of the task. Non-emotion tasks were not used in the current study as to the researcher's knowledge there are no tasks available that are similar in procedure, task demands, and stimuli to the emotion tasks. Furthermore, it was not possible to create a task, as it was difficult think of a non-emotion task using dynamic and cross-modal information that would equate to the emotion recognition tasks.

7.3.2.2 *Number of trials.* The number of available examples in the dataset that met the study criteria restricted the number of trials for each emotion type. Specifically the same example needed to be available across all presentation types (i.e., the cross-modal information could be presented without the visual or auditory information) and each actor needed to be represented across all emotion types. However, there were only four examples of disgust in the GEMEP-CS that met the study criteria; thus four trials were used for all emotion types in the negative experiment. Four trials have been used in previous research (e.g., Mill, Allik, Realo, & Valk, 2009; Phillips, MacLean, & Allen, 2002; Ruffman, Sullivan, & Dittrich, 2009); thus, evidence suggests that this number of trials is sufficient to detect variations in accuracy across emotion types. There were, however, more available examples of the emotions used in the positive experiment (joy, amusement, pride, surprise, and anger); thus, five trials for each emotion type were used in the positive experiment.

7.3.2.3. *The choice of emotions types.* The tasks in the two experiments included slightly different emotion types. The negative experiment included a range of basic emotions (joy, sadness, fear, anger, and disgust) to allow for comparisons with previous research (e.g., Chaby et al., 2015). In contrast, the positive experiment reversed the valance of the emotion types used in the negative experiment, so the task measured one negative emotion alongside four positive emotions (joy, amusement, pride, surprise, and anger). Anger was chosen as the negative emotion as OAs were less able than YAs to recognise angry faces in Phase 1 and OAs appear to have a deficit for recognising anger from cross-modal tasks (Chaby et al., 2015). The positive emotions were: joy (to measure happiness, an emotion commonly included in emotion recognition tasks), amusement (to determine OAs and YAs ability to distinguish between emotion smiles), pride (this emotion is readily recognised especially with face and body gestures [Tracy & Robins, 2004; Tracy & Robins, 2007]), and positive surprise (this emotion is often considered to be a basic emotion [Ekman & Cordaro, 2011] and is sometimes included in emotion recognition research [e.g., Mill et al., 2009; Schaffer, Wisniewski, Dahdah, & Froming, 2009]).

7.3.3 Materials.

Some of the standardised measures used in Phase 1 were also used in Phase 2 including: MMSE-2 (Folstein, Folstein, White, & Messer, 2010) for processing speed and cognitive health, Raven's Progressive Matrices (RPM; Raven, 2008) and the Mill Hill Vocabulary Scale (Raven et al., 1998a) for fluid and verbal intelligence, and the PANAS (Watson et al., 1988) to measure affect. However, Phase 2 also included measures of social and emotional functioning, such as social activity; quality of and attitude to friendships; and emotion intelligence, as socio-emotional measures are largely absent in the field (Phillips & Slessor, 2011). The measures that were unique to Phase 2 are discussed in turn.

7.3.3.1 *Emotion intelligence.* Emotion intelligence has been theoretically considered as either a personality trait (Petrides, Pita, & Kokkinaki, 2007) or a measure of intelligence (Salovey & Mayer, 1990). One intelligence model explains emotion intelligence as a number of related abilities including emotion recognition in others; understanding emotion in self and others; emotion control in self and others; and using emotion to aid thoughts, decisions, and behaviours (Mayer, Salovey, Caruso, & Sitarenios, 2003; Salovey & Mayer, 1990). In contrast, trait emotion intelligence is conceptualised as a set of related emotion characteristics that can be seen as the emotion aspects of personality (Petrides, Pita, & Kokkinaki, 2007). The two different theories do share some commonalities regarding what constitutes emotion intelligence; specifically emotion expression, emotion recognition, and emotion control. However, the trait theory also suggests that factors such as self-esteem and trait happiness need to be considered (Petrides & Furnham, 2001). Further, Salovey and Mayer have acknowledged the possible relationship in emotion intelligence and personality and this has led to a mixed modal of emotion intelligence (Mayer, Salovey, & Caruso, 2000).

Emotion intelligence was included in the test battery as it is associated with levels of satisfaction with social relationships, such as positive relationships (positively related) and negative interactions (negatively related); thus, can be considered an important aspect of social intelligence and functioning (Lopes, Salovey, & Strauss, 2003; Salovey & Mayer, 1990). Furthermore, emotion intelligence may facilitate emotion recognition ability. For example, adults with higher trait emotion intelligence are faster to accurately recognise emotions from morphed faces than adults with lower emotion intelligence (Petrides & Furnham, 2003). Furthermore, evidence suggests that emotion intelligence may decline from middle age (32-44 years) into older age (44-75 years) (Cabello, Sorrell, Fernández-Pinto, Extremera, & Fernández-Berrocal, 2016). Thus, any age-related emotion recognition deficits in OAs are perhaps related to age group differences in emotion intelligence.

There are several different tools available to measure emotion intelligence and these appear to reflect the theoretical basis of emotion intelligence. For example, self-report measures are in line with the trait theory, whereas performance based tests are akin to the intelligence or cognitive ability theory of emotion intelligence. One of the most commonly used measures of emotion intelligence is the Mayer, Salovey, and Caruso Emotional Intelligence Test (MSCEIT; Mayer, Salovey, & Caruso, 2002) but this has been criticised as lacking the ability to tap into emotion experience (Petrides, Pita, & Kokkinaki, 2007).

The Schutte Self Report Emotional Intelligence Scale (SSEIT; Schutte et al., 1998) was used in the current study because it is a self-report measure based on the model of emotion intelligence forwarded by Salovey and Mayer (1990). An advantage of the self-report method of emotion intelligence is that it may capture emotion experience to a greater extent than performance-based tasks such as the MSCEIT (2002). Whilst there are other self-report measures available, such as the Bar-on Emotional Quotient Inventory (Bar-on, 1996a), the SSEIT has been endorsed as a suitable tool to capture global emotion intelligence (Perez, Petrides, & Furnham, 2005). Furthermore, the SSEIT (Schutte et al., 1998) is simple and quick to administer and this was important to avoid participant fatigue given the large test battery. Moreover the test has evidence of good reliability, $\alpha = .90$ (Schutte et al., 1998). Responses to 33 statements are recorded on a five-part Likert scale (1 = strongly agree to 5 = strongly disagree). For example, "*I know when to speak about my personal problems to others*" and "*I am aware of the non-verbal messages I send to others*". The scores are then summed.

7.3.3.2 *Quality of and attitude to friendships.* Quality of and attitude to friendships was measured in the current study to explore whether OAs' emotion recognition ability could be explained as part of a broader decline with age in social functioning. Quality of friendships is an important aspect of social functioning (Baron-Cohen & Wheelwright, 2003). The Convoy Model of social relationships suggests that an individual carries some supportive relationships throughout their lifespan with some relationships being more valuable than others (Antonucci, Ajrouch, & Birditt, 2014). Importantly, regardless of age, friendships are generally considered as social relationships based on reciprocal support (Hartup & Stevens, 1999). However, not all friendships achieve this in equal levels; thus, there maybe some variation in the types of friendships. Those friendships that are characterised as supportive, close, and involve disclosure are typically considered as being high quality friendships, whereas friendships that involve negative emotionality and conflict are typically considered as low quality (Berndt, 2002). The types of interactions and the individuals chosen as friends, however, may change across the lifespan. For example, in adolescence friendships are based on shared social activities and disclosure, in YAs friendships evolve from contacts made through work and parenting, whereas in OAs friendships are based on support and companionship (Hartup & Stevens, 1999). It could be that these differences reflect a disparity in the quality of and attitude to friendships between YAs and OAs. For example, YAs may utilise friendships not only as a support network but also as deflection from their responsibilities, whereas OAs may use friendships as a barrier to loneliness (D'Agostino, Kattan, & Canli, 2018; Dykstra, 1995). However, OAs appear to be more selective than YAs in their friendships as OAs are more likely to end negative social relationships (Huxhold, Miche, & Shüz, 2014). Given that OAs may elect to end negative friendships more than YAs then it may be expected that the quality of friendships is higher for OAs than YAs (Carstensen, Isaacowitz, & Charles, 1999).

There are several tools available for measuring friendships. Those based on the Convoy Model of social relations (Antonucci, 2001) were not considered to be a suitable measure for the current study as these instruments measure relationships that may not be applicable to the current participants, such as spouse and parents (Antonucci, Akiyama, & Takahashi, 2004). An alternative measure of friendship quality is the McGill Friendship Questionnaire-Friend's Functions (MFQ-FF, short form; Mendelson & Aboud, 1999). This tool uses 30 statements that are designed to tap into six factors of friendships including companionship, support, closeness, reliability, self-validation, and emotion security. However, this measure appears to assess the relationship quality of one particular friend rather than friendships in general; thus, was not suitable for the current research.

The Cambridge Friendship Questionnaire (Baron-Cohen & Wheelwright, 2003)[3] was deemed to be a suitable measure as it assesses both quality of friendships and

[3] downloaded from ARC free access

attitude towards relationships (such as the importance of friendships and wanting social interaction with relevant others). For conciseness, whilst acknowledging the differential facets that are measured in this instrument, discussion of administration and results of this measure will be referred to as quality of friendships. Possible scores range from 135 to zero, with high scores suggesting that the individual has empathetic and close friendships that are valued interactions (Baron-Cohen & Wheelwright, 2003). The questionnaire consists of 35 questions including eight filler questions, the maximum score for most questions is 5 and the lowest is zero and scores are summed to give a total rating.

7.3.3.3 ***Social activity.*** Social contact tends to change over the lifespan with adolescents and OAs spending more time with friends than middle aged adults (Larson, Zuzanek, & Mannell, 1985). However, it has been reported that the number of social relationships declines with age but this may not necessarily lead to social isolation as incidences of social activity tends to increase in older age (Cornwell, Laumann, & Schuum, 2008). Moreover social activity, social competence, and emotion recognition ability may be related (Mueser et al., 1996; Sneegas, 1986). To determine the level of social activity in the YAs and OAs in the current study the social activity subtest of the Social Functioning Scale (Birchwood, Smith, Cochrane, Wetton, & Copestake, 1990) was administered. For this task participants are required to state how often over the past three months they have participated in a number of social activities (never, rarely, sometimes, and often). There is also an option to add activities to the list. Scoring was weighted depending upon the frequency of the activity (i.e., never = 0, rarely = 1, sometimes = 2, often = 3). The frequency definitions were standardised: if in the last three months participation in an the activity was once or twice then “rarely” was selected, more than once or twice but less than weekly was “sometimes”, and weekly/daily was “often”. Scores were then summed.

7.3.3.4 Emotion recognition tasks.

In total across both experiments there were 135 trials. For the positive experiment all three tasks contained 25 trials comprising of five examples of each emotion type (joy, anger, surprise, pride, and amusement) (see Appendix 7.2 for details of trials used). The adult actors were three males (one younger, one middle-aged, and one older) and two females (one younger and one middle-aged). For the negative experiment each of the three tasks contained 20 trials comprising of four examples of each emotion type (joy, sad, fear, anger, and disgust) (see Appendix 7.3 for details of trials used). The adult actors were three females (two younger and one older) and one younger male actor.[4].

All of the experiments were run on E prime 2 software (Psychology Software Tools, Pittsburgh, PA). The emotion recognition tasks were forced-choice between five emotion types. Each task followed the same order of presentation commencing with an instruction page asking participants to respond as accurately and quickly as possible. Following this, participants conducted a practice task of four trials before commencing onto the experimental task; the stimuli in the practice trials did not appear in the experimental tasks. For all of the tasks a fixation cross (+) was shown in the middle of the screen for 1000 ms before each trial. The stimuli were presented in the centre of the screen (a sound icon was used as a prompt in the audio conditions) with the emotion labels underneath in Arial and font size 18 (see Figure 7.3.2). The position of the emotion labels was counterbalanced between participants to avoid response bias. All responses were time limited to 6000 ms and entered via a response box. This time limit was set to allow sufficient time to make an emotion judgement and enter a response but at the same time forcing participants to record their automatic response. The procedure

[4] Due to the limited number of examples of emotion expressions it was not possible for an equal representation of actors across sex and age groups.

continued for all of the trials and the order of the trials was randomised for each participant.

A pilot experiment confirmed that the stimuli included in both experiments had good content validity with an acceptability rate set at 50%, which is above that of chance. The data in the pilot study was gained from 11 volunteers (three males and eight females; mean age = 42.81 years [SD = 16.48]). See Appendix 7.4 for further details of the pilot study.

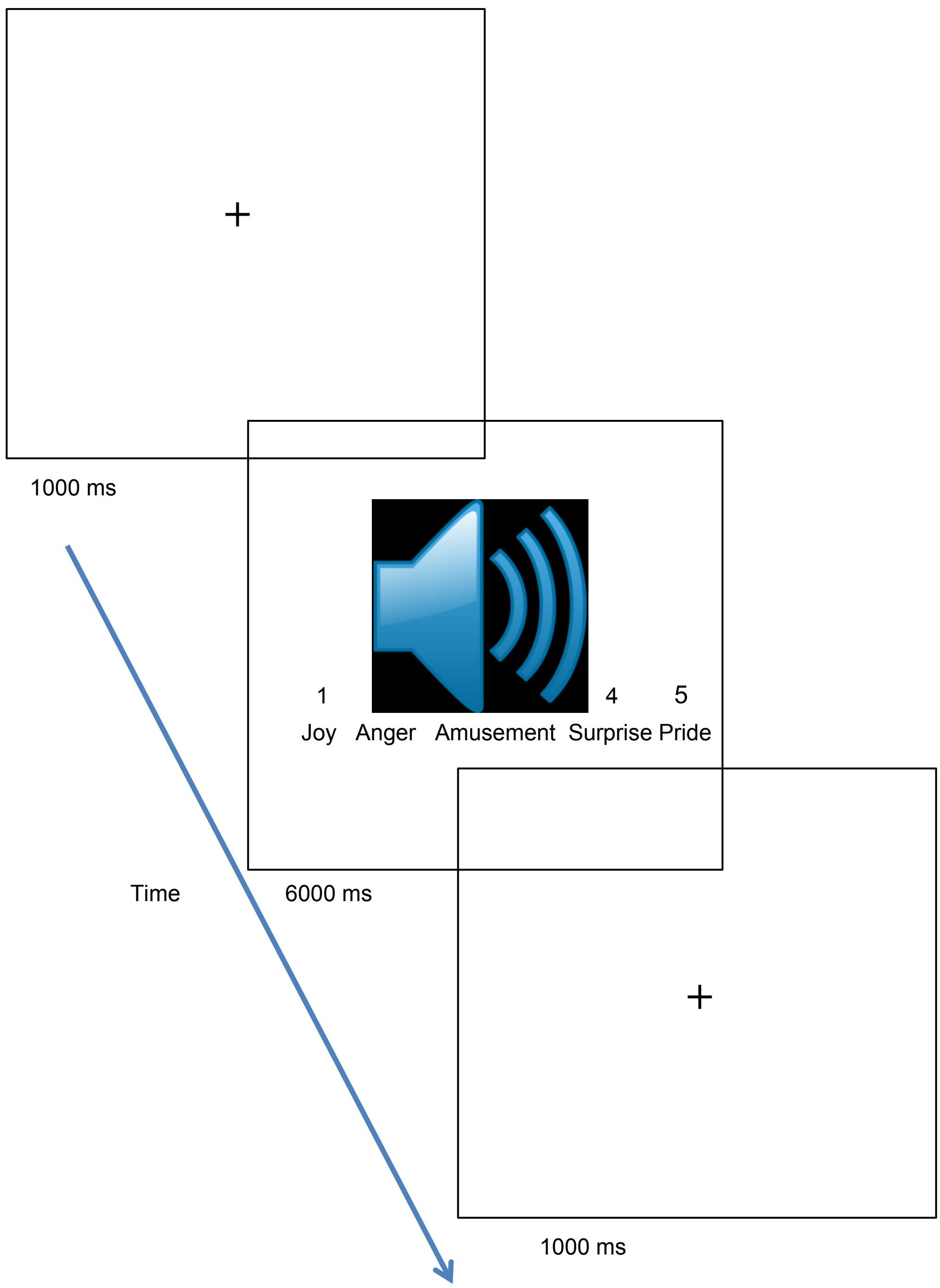


Figure 7.3.2. The order and duration of the slides presented in the positive prosody tasks. The same procedure was followed for all of the tasks but the emotion labels changed depending on the experiment and the sound icon was replaced by a video clip on the visual tasks.

7.3.4 Participants.

The samples used in Phase 1 and Phase 2 were recruited separately; however, six OAs participated in both phases of the research programme. Seventy-one adults volunteered to participate in the experiments: thirty-three OAs (10 men and 23 women, *M* age = 69.70 years, age range 60-80 years) were recruited from a local social group and 38 YAs (two males and 36 females, *M* age = 18.53 years, age range 18-22 years) who were university students. Participants self-reported as having good health, and vision and hearing were reported as normal or adjusted to normal. All participants either received course credits or a £10 high street voucher in compensation for their time. Table 7.3.1 presents a summary of the sample characteristics for both YAs and OAs. In summary, OAs had significantly more years in education, higher levels of verbal intelligence and positive affect, and were more socially active than YAs. However, OAs and YAs did not significantly differ on fluid intelligence, negative affect, emotion intelligence, or quality of friendships. In contrast, OAs had slower processing speed than YAs.

To determine whether the samples were representative of the general population the mean scores for each characteristic were compared with normative data where available. Compared to mean scores in normative data the adults in the current study had similar mean scores on the friendship questionnaire (*M* = 80.15), emotion intelligence (*M* = 117.40), and positive affect (*M* = 31.31) but levels of negative affect were markedly lower than those observed in the normative data (*M* = 16.00) (Baron-Cohen & Wheelwright, 2003; Crawford & Henry, 2004; Schutte, 1998). Turning to intelligence, the OAs appear to be on the 90th percentile and between 25th to 50th percentiles for YAs on fluid intelligence (Raven, 2008). However, there is no normative data available for the multiple-choice section of the Mill Hill for verbal intelligence.

Table 7.3.1.

Descriptive and Inferential Statistics for the Sample Characteristics by Age Group (N = 71)

Measure	Younger Adults		Older Adults				95% CIs		
	M	SD	M	SD	*t*(69)	*p*	*LL*	*UL*	*d*
Education (years)	14.32	1.02	16.15	3.09	3.45	**.001**	-2.90	-0.78	0.83
MMSE (16)	15.50	0.73	15.30	0.85	1.06	.295	-0.18	0.57	*ns*
Processing Speed (35)	21.84	3.49	16.88	3.56	5.92	**< .001**	3.29	6.64	1.43
Positive Affect (50)	28.50	6.15	33.18	6.64	3.08	**.003**	-7.71	-1.65	0.74
Negative Affect (50)	10.74	1.74	11.03	1.79	0.47	.622	-0.68	1.13	*ns*
Fluid Intelligence (30)	17.42	2.00	17.42	3.36	-0.01	.996	-1.29	1.29	*ns*
Verbal Intelligence (44)	25.21	2.86	34.82	3.63	12.47	**< .001**	-11.14	-8.07	3.00
Emotion Intelligence (165)	117.61	10.65	117.12	13.99	0.17	.869	-5.36	6.33	*ns*
Social Activity	23.89	6.76	29.15	5.79	3.49	**.001**	-8.26	-2.25	0.84
Friendship Questionnaire (135)	83.24	19.56	80.73	17.17	0.57	.570	-6.27	11.29	*ns*

Note. ns = nonsignificant; CI = Confidence Interval; LL = Lower Level; UL = Upper Level. For all measures higher means are seen as positive with the exception that lower scores are more desirable for negative affect. (x)= maximum score

To understand the affect of advancing older age on emotion recognition accuracy the analysis was re-run when the OAs sample was split at the age of 70 years. Thus two older aged groups were created: the younger-older (*N* = 16; *M* age = 65.00 years; *SD* =

3.01; age range 60 years to 69 years) and older-older age group (*N* = 17; *M* age = 74.12 years; *SD* = 3.53; age range 70 years to 80 years). The two older age groups did not differ to each other on many of the measured characteristics such as years in education, levels of affect, and measures of social functioning. However, older-older adults had lower levels of verbal intelligence, slower processing, and performed marginally less well on the MMSE than younger-older adults (see Appendix 7.5 for t tests).

Given that many of the findings in Phase 1 appear to be driven by the older-older adults it may seem unnecessary to conduct the analysis between the YAs and OAs and only run the analysis between the three age groups (YAs, younger-older, and older-older adults). However, the extreme group analysis (between YAs and OAs) is vital for two reasons. First, it allows for comparisons to previous research as most research in the field compares emotion recognition ability between YAs and OAs (e.g. Chaby et al., 2015). Second, the spilt OA age groups (younger-older and older-older adults) consist of small samples so there may be a lack of power to reveal significant findings. Indeed, in Phase 1 OAs were more able than YAs to recognise emotions from words but when the analysis was run across the three age groups (YAs, younger-older, and older-older adults) there was no effect of age group on the emotion word task. This finding may reflect a lack of power to detect age group differences and highlights the importance of running both sets of analysis (extreme groups and across the three age groups) to clarify our understanding of age-related emotion recognition differences in OAs.

7.3.5. Procedure.

Participants were tested individually in a university laboratory. All participants received a participant information form detailing the aim, task, and procedure of the research and gave informed consent (see Appendix 7.6 and 7.7). The researcher administered the MMSE-BV to measure cognitive status and all adults achieved a score ≥ 13, a cut-off used in previous research (i.e., Finger et al., 2011). Next the participants completed a demographic questionnaire (see Appendix 2.4) followed by the emotion recognition experiments. During the computer-based-tasks participants were seated a comfortable distance, approximately 40 cm, from the laptop. The order in which the two experiments were undertaken was counterbalanced across participants. Furthermore, the three tasks within each of the emotion recognition experiments were counterbalanced to avoid order effects. Before each experimental task the researcher gave standardised verbal instructions to the participant (see Appendix 7.8) and answered any questions relating to the task. Participants were required to decide as accurately as possible which emotion label best represented the emotion portrayed in the stimuli. There was further opportunity for the participant to raise any queries after the practice task. Participants could also repeat the practice task if they scored below 50% or if they so wished to do so. For the tasks that included prosodic sentences the volume was pre-set at 18 (approximately 60 dBs) on the laptop and adjusted if necessary. The sound tasks were heard through Sony headphones with reduced interference from external sound. Following the six emotion recognition tasks participants completed the measures of affect, emotion intelligence, and cognitive and social functioning. These tasks were counterbalanced across participants, with the exception of the Raven's Progressive Matrices (RPM), which was always the penultimate task, and the final task was the speed of processing task. To reduce the chances of fatigue participants only answered every other question (even numbered pages) on the RPM. Participants were debriefed and thanked for their time at the end of the session (see Appendix 7.9), which lasted for approximately two hours. Breaks and refreshments were offered throughout the session to avoid fatigue. The data was treated and prepared for analysis in the same manner as the data in Phase 1 (see Appendix 7.10). Tables depicting the number of missed responses due to time outs are presented in the appendices (Appendix 7.11). In summary most of the incorrect answers were due to incorrect responses rather than timeouts but OAs had more timeouts for all presentation types than YAs

7.3.6 Instruments. The instruments used in Phase 2 were the same as Phase 1 with the exception that in Phase 2 a five-button response box was used rather than a six-button response box.

7.4 Results

The positive and negative tasks were run in the same sitting but the findings are reported separately. The initial analysis investigated OAs' and YAs' emotion recognition across different emotion and presentation types. Furthermore, the effects of advancing age in the OAs may influence findings; hence, emotion recognition ability in older-older adults was compared to that of younger-older adults and YAs. For post hoc tests only the significant findings are reported in full, outputs can be found in the corresponding appendices Appendix 7.12 for positive experiment and 7.13 for negative experiment).

7.4.1 Positive experiment.

To investigate the influence of age, emotion, and presentation type on emotion recognition ability a 2*5*3 factorial ANOVA was run with Age Group (YAs and OAs) as the between participants IV, and emotion type (anger, joy, amusement, pride, surprise) and presentation type (unimodal and cross-modal dynamic faces and prosodic sentences) as the within participants IVs. The DV was emotion recognition accuracy.

There was a nonsignificant main effect of age group, $F(1,69) = 1.31$, $p = .256$, $\eta_p^2 = 0.02$. However, there was a significant main effect of presentation type, $F(2,138) = 74.16$, $p < .01$, $\eta_p^2 = 0 .52$ but a nonsignificant Age Group*Presentation Type interaction effect, $F(2,138) = 1.04$, $p = .357$, $\eta_p^2 = 0 .02$. There was also a significant main effect of emotion type, $F(4,276) = 122.42$, $p < .01$, $\eta_p^2 = 0 .64$. This was qualified by a significant Age Group*Emotion Type interaction, $F(4,276) = 2.71$, $p = .031$, $\eta_p^2 = 0.04$. There was also a significant Presentation Type* Emotion Type interaction, $F(8,552) = 11.91$, $p < .01$, $\eta_p^2 = 0.15$, although findings for this are not reported as it is not central to the research question as we are interested in the interaction with age. There was not, however, a significant Age Group* Presentation Type* Emotion Type interaction, $F(8,552) = 1.34$, $p = .223$, $\eta_p^2 = 0.02$. Descriptive statistics for emotion recognition accuracy by YAs and OAs for each emotion and presentation type are presented in Table 7.4.1 and the descriptive statistics for total accuracy, summed across the age groups, for each emotion and presentation type are given in Table 7.4.2.

7.4.1.1 Presentation type. Post hoc t tests, with Bonferroni corrections set at $p = .017$, were run to investigate the main effect of presentation type. Regardless of age, emotion recognition accuracy was higher for cross-modal presentations than either dynamic faces, $t(70) = 4.36$, $p < .01$, $d = 0.44$, or prosodic sentences, $t(70) = 11.43$, $p < .01$, $d = 1.33$. Furthermore, emotion recognition accuracy was higher when emotions were presented in dynamic faces than prosodic sounds, $t(70) = 7.80$, $p < .01$, $d = 0.88$. The nonsignificant Age Group*Presentation Type interaction suggests that the pattern was the same between the YAs and OAs.

Table 7.4.1

Descriptive Statistics for Emotion Recognition Accuracy by Age Group, Emotion Type, and Presentation Type (Maximum M = 5)

Emotion	Faces				Sentences				Cross modal				Total/15			
	Younger		Older		Younger		Older		Younger		Older		Younger		Older	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Anger	4.68	0.62	4.30	0.77	4.16	0.92	3.52	1.33	4.87	0.34	4.67	0.69	13.71	1.16	12.48	1.94
Joy	2.34	1.28	2.58	1.28	2.11	1.11	1.55	1.18	2.63	1.24	2.58	1.25	7.08	2.62	6.70	2.88
Amusement	3.37	1.22	3.82	1.21	3.76	1.42	3.91	1.16	4.02	1.44	4.18	1.04	11.16	3.35	11.91	2.80
Pride	3.11	1.23	2.45	1.28	1.16	1.00	0.94	1.12	3.00	1.27	2.48	1.42	7.26	2.62	5.88	2.85
Surprise	2.55	1.43	2.39	1.32	2.39	1.26	2.27	1.04	3.05	1.11	3.24	1.35	8.00	2.80	7.91	2.64
Total/25	16.05	3.68	15.55	3.23	13.58	3.17	12.18	2.94	17.58	3.64	17.15	3.50	47.21/75	9.20	44.89/75	7.75

Table 7.4.2

Descriptive Statistics for Total Emotion Recognition Accuracy for Each Emotion Type by Each Presentation Type (maximum M = 5)

Emotion	Faces		Prosodic sentences		Cross-modal		Total/15	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Anger	4.51	0.71	3.86	1.16	4.77	0.54	13.14	1.68
Amusement	3.58	1.23	3.83	1.30	4.10	1.27	11.51	3.11
Surprise	2.48	1.37	2.33	1.16	2.76	1.36	7.96	2.71
Joy	2.45	1.27	1.85	1.17	2.61	1.24	6.90	2.73
Pride	2.80	1.28	1.06	1.05	2.76	1.36	6.62	2.80
Total/25	15.82	3.46	12.93	3.12	17.38	3.56		

7.4.1.2 Emotion type. Post hoc t tests, with α = 1%, were run to investigate the main effect of emotion type (see Table 7.4.3). Accuracy was higher for recognising anger than all other emotion types, whereas accuracy was lower for recognising joy than all other emotion types with the exception of pride and surprise.

Table 7.4.3

Inferential Statistics Comparing Recognition Accuracy Between Emotion Types

Comparison	*t*(70)	*p*	95 % CI		*d*
			LL	*UL*	
Anger>Joy	17.48	**< .001**	5.53	6.95	2.75
Anger>Amusement	4.07	**< .001**	0.83	2.44	0.65
Anger>Pride	17.95	**< .001**	5.80	7.25	2.82
Anger>Surprise	13.97	**< .001**	4.44	5.92	2.30
Amusement>Pride	12.01	**< .001**	4.08	5.70	1.65
Amusement>Surprise	9.86	**< .001**	2.83	4.27	1.22
Pride>Surprise	3.46	**.001**	-2.11	-0.57	0.49
Joy<Amusement	11.14	**< .001**	-5.43	-3.78	1.57
Joy=Surprise		ns			
Joy=Pride		ns			

Note. ns = nonsignificant; lowest nonsignificant $p = .011$, $d = .039$ (joy = surprise).

7.4.1.3 Age Group*Emotion Type interaction. Post hoc t tests, with α = 1%, were run to investigate the Age Group*Emotion Type interaction (see Figure 7.4.1). When comparing emotion recognition accuracy between the age groups then OAs were less able to recognise anger than YAs, $t(69) = 3.17$, $p = .003$, $d = 0.77$. All other comparisons were nonsignificant (all *p*s > .01; lowest nonsignificant $p = .036$ for pride).

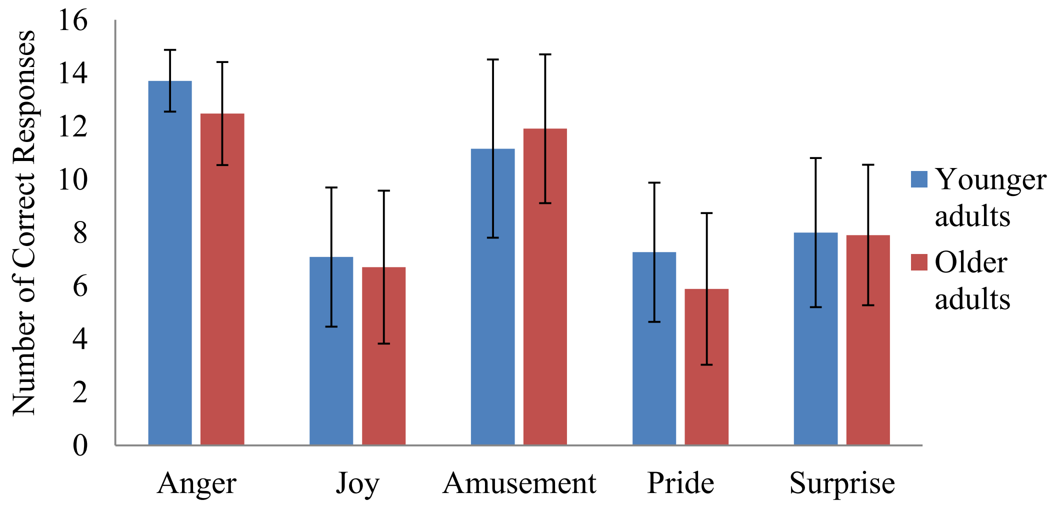


Figure 7.4.1. Total emotion recognition accuracy for each emotion type summed across presentation types by age group (YAs $n = 38$; OAs $n = 33$) (maximum $M = 15$).

The interaction can also be explained by the differences in the pattern of accuracy for emotion recognition across emotion types within each age group (see Tables 7.4.4 and 7.4.5). The findings for the YAs were similar to the pattern reported for the main effect of emotion; however, YAs did not significantly differ in their ability to recognise expressions of surprise and pride.

Table 7.4.4

*Inferential Statistics Comparing Recognition Accuracy between Emotion Types in **Younger Adults***

Comparison	*t*(37)	*p*	95% CI		*d*
			LL	*UL*	
Anger>Joy	15.70	**< .001**	5.78	7.49	3.27
Anger>Amusement	4.94	**< .001**	1.51	3.60	1.02
Anger>Pride	15.76	**< .001**	5.62	7.28	3.18
Anger>Surprise	12.37	**< .001**	4.77	6.65	2.66
Amusement>Joy	7.49	**< .001**	-5.18	-2.98	1.36
Amusement>Pride	7.29	**< .001**	2.81	4.98	1.30
Amusement>Surprise	6.47	**< .001**	2.17	4.15	1.02
Joy=Pride		ns			
Joy=Surprise		ns			
Pride=Surprise		ns			

Note. ns = nonsignificant; lowest nonsignificant $p = .047$ (joy = surprise)

When comparing recognition accuracy across different emotion types the OAs had higher accuracy for anger than all emotion types with the exception of amusement. In a similar manner to the YAs, OAs were less able to recognise joy than anger and amusement. However, OAs were also less able to recognise pride than surprise. Therefore, the interaction can be explained by OAs lower ability to recognise anger than YAs, and OAs' lower recognition accuracy for pride than surprise, which was not observed in YAs.

Table 7.4.5

*Inferential Statistics Comparing Recognition Accuracy between Emotion Types in **Older Adults***

Comparison	*t*(32)	*p*	95% CI		*d*
			LL	*UL*	
Anger>Joy	9.78	**< .001**	4.58	6.99	2.35
Anger>Pride	10.48	**< .001**	5.32	7.89	2.71
Anger>Surprise	7.82	**< .001**	3.38	5.77	1.97
Amusement>Joy	8.37	**< .001**	-6.48	-3.94	1.83
Amusement>Pride	10.61	**< .001**	4.87	7.19	2.13
Amusement>Surprise	7.56	**< .001**	2.92	5.08	1.47
Pride<Surprise	3.29	**.002**	-3.29	-0.77	0.74
Anger=Amusement		ns			
Joy=Pride		ns			
Joy=Surprise		ns			

Note. ns = nonsignificant; lowest nonsignificant p = .061 (joy = pride)

Of importance, the nonsignificant Age Group*Emotion Type*Presentation Type interaction implies that the lower ability to recognise anger in OAs than YAs did not differ across presentation types.

In summary, emotion recognition accuracy was higher on the cross-modal task than either the dynamic faces or prosodic sentence task, and accuracy was lowest for prosodic sentences for both age groups. Anger was the most accurately recognised emotion and joy was the most difficult emotion to recognise. However, OAs were less able to recognise anger than YAs and the magnitude of this difference was similar across the presentation types.

7.4.1.4 Comparing between the younger-older and older-older adults. The ANOVA analysis was re run with the between groups IV of age group consisting of three levels (YAs, younger-older adults, and older-older adults). The ANOVA was largely the same as that reported for the two age groups with the exception that there was no longer an Age Group*Emotion Type interaction. Importantly there was no evidence of further emotion recognition decline with advancing older age.

7.4.2 Negative experiment.

To investigate the influence of age, emotion, and presentation type on emotion recognition ability a 2*5*3 factorial ANOVA was run with Age Group (YAs and OAs) as the between participants IV, and emotion type (joy, sadness, fear, anger, and disgust) and presentation type the within participants IVs (unimodal and cross-modal dynamic faces and prosodic sentences). The DV was emotion recognition accuracy. Descriptive statistics for emotion recognition accuracy by YAs and OAs for each emotion and presentation types are presented in Table 7.4.6 and the descriptive statistics for total accuracy, regardless of age, by emotion and presentation type are presented in Table 7.4.7.

There was a significant main effect of age group, $F(1,69) = 5.34$, $p = .024$, $\eta_p^2 = 0.07$, as YAs had higher emotion recognition accuracy than OAs. There was also a significant main effect of presentation type, $F(2,138) = 87.76$, $p < .01$, $\eta_p^2 = 0\ .56$ and this was qualified with a significant Age Group*Presentation Type interaction effect, $F(2,138) = 13.54$, $p < .01$, $\eta_p^2 = 0\ .16$. Further, there was a significant main effect of emotion type, $F(4,276) = 65.33$, $p < .01$, $\eta_p^2 = 0\ .49$ and this was qualified by a significant Age Group*Emotion Type interaction, $F(4,276) = 2.63$, $p = .035$, $\eta_p^2 = 0\ .04$. There was also a significant Presentation Type* Emotion Type interaction, $F(8,552) = 38.06$, $p < .01$, $\eta_p^2 = 0\ .36$ although this interaction is not central to the research aims so post hoc tests are not reported. Furthermore, there was also a significant Age Group* Presentation Type* Emotion Type interaction, $F(8,552) = 2.53$, $p = .010$, $\eta_p^2 = 0\ .04$.

Table 7.4.6

Descriptive Statistics for Emotion Recognition Accuracy by Age Group, Emotion Type, and Presentation Type (Maximum M = 4)

Emotion	Faces				Sentences				Cross modal				Total/12			
	Younger		Older		Younger		Older		Younger		Older		Younger		Older	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Joy	3.45	0.50	3.55	0.51	2.00	1.19	0.70	0.98	3.53	0.51	3.36	0.55	8.97	1.44	7.61	1.41
Sad	2.76	1.15	3.06	0.86	3.39	0.95	3.33	0.82	3.24	1.00	3.52	0.62	9.39	2.47	9.91	1.51
Fear	3.53	0.80	3.24	0.90	3.55	0.72	3.03	1.10	3.66	0.75	3.58	0.61	10.74	1.48	9.85	1.70
Anger	3.76	0.43	3.55	0.75	3.39	0.75	3.00	0.97	3.74	0.50	3.48	0.71	10.89	1.29	10.03	1.91
Disgust	2.16	1.17	2.03	1.24	1.84	1.39	1.24	1.03	2.53	1.20	2.70	1.16	6.53	3.05	5.97	2.74
Total/20	15.66	1.99	15.42	2.41	14.18	3.11	11.30	2.72	16.68	2.18	16.64	1.85	46.53/60	5.91	43.36/60	5.57

Table 7.4.7

Descriptive Statistics for Emotion Recognition Ability for Each Emotion Type by Each Presentation Type (maximum M = 4)

Emotion	Faces		Prosodic sentences		Cross-modal		Total/12	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Anger	3.66	0.61	3.21	0.88	3.62	0.62	10.49	1.66
Fear	3.39	0.85	3.31	0.95	3.62	0.68	10.32	1.64
Sadness	2.90	1.03	3.36	0.88	3.37	0.85	9.63	2.08
Joy	3.49	0.50	1.39	1.27	3.45	0.53	8.34	1.58
Disgust	2.10	1.20	1.56	1.26	2.61	1.18	6.27	2.90
Total/20	15.55	2.18	12.85	3.25	16.66	2.02		

7.4.2.1 Presentation type. Post hoc t tests, with Bonferroni corrections set at $p = .017$, were run to investigate the main effect of presentation type. Regardless of age emotion recognition accuracy was higher for cross-modal presentations than either dynamic faces, $t(70) = 4.52$, $p < .001$, $d = 0.53$, or prosodic sentences, $t(70) = 11.09$, $p < .001$, $d = 1.41$ Furthermore, emotion recognition accuracy was higher when emotions were presented in dynamic faces than prosodic sounds, $t(70) = 7.04$, $p < .001$, $d = 0.98$.

7.4.2.2 Age Group*Presentation Type interaction.

Table 7.4.8

Inferential Statistics Comparing Emotion Recognition Accuracy in ***Younger Adults*** *between Presentation Types*

Comparison	*t*(37)	*p*	95% CI		*d*
			LL	*UL*	
Cross-modal > Faces	3.20	**.003**	0.38	1.68	0.49
Cross-modal > Sentences	5.98	**< .001**	1.65	3.35	0.93
Faces > Sentences	2.91	**.006**	0.45	2.50	0.57

Post hoc t tests, with Bonferroni corrections set at $p = .017$, were run to investigate the Age Group*Presentation Type interaction (see Table 7.4.8 and Table 7.4.9). The pattern reported for the main effect of presentation type was also observed when emotion recognition accuracy across the different presentation types was compared within the YAs and OAs. When comparing accuracy between the YAs and OAs then OAs were less able to recognise emotion from prosodic sentences than YAs, $t(69) = 4.13$, $p < .01$, $d = 0.98$, but the age groups did not differ in their ability to recognise emotions from dynamic faces ($p =. 656$) or cross-modal presentations ($p =. 922$). Therefore, the interaction is driven by a lower ability in OAs than YAs to recognise emotion from prosodic sentences.

Table 7.4.9

Inferential Statistics Comparing Emotion Recognition Accuracy in ***Older Adults*** *between Presentation Types*

Comparison	*t*(32)	*p*	95% CIs		*d*
			LL	*UL*	
Cross modal > Faces	3.16	**.003**	0.43	1.99	0.48
Cross modal > Sentences	12.21	**< .001**	6.22	12.21	2.30
Faces > Sentences	8.48	**< .001**	5.11	8.48	1.60

7.4.2.3 Emotion type. Post hoc t tests, with $\alpha = 1\%$, were run to investigate the main effect of emotion type (see Table 7.4.10). Accuracy was lowest for recognising disgust than all other emotion types, whereas accuracy for recognising joy was lower than accuracy for all emotion types with the exception of disgust. In contrast accuracy was highest for recognising anger.

Table 7.4.10

Inferential Statistics Comparing Emotion Recognition Accuracy between Emotion Types Summed across Presentation Types

Comparison	$t(70)$	p	95 %CI		d
			LL	UL	
Disgust<Joy	5.76	**< .001**	1.35	2.79	0.89
Disgust<Sadness	8.56	**< .001**	2.58	4.15	1.33
Disgust<Fear	12.42	**< .001**	3.41	4.71	1.72
Disgust<Anger	12.89	**< .001**	3.57	4.88	1.79
Joy<Sadness	3.82	**< .001**	-1.97	-0.62	0.70
Joy<Fear	9.38	**< .001**	-2.41	-1.56	1.23
Joy<Anger	8.67	**< .001**	-2.65	-1.66	1.33
Sadness=Fear		ns			
Anger=Sadness		ns			
Anger=Fear		ns			

Note. ns = nonsignificant; nonsignificant p = .010, d = 0.46 (anger-sadness; marginally nonsignificant

7.4.2.4 Age Group*Emotion Type interaction. Post hoc t tests, with α = 1%, were run to investigate the Age Group*Emotion Type interaction (see Figure 7.4.2). When comparing emotion recognition accuracy between the age groups then OAs were less able to recognise joy than YAs, $t(69) = 4.02$, $p < .001$, $d = 0.95$. All other comparisons were nonsignificant (all ps > .01; lowest nonsignificant p = .021 for fear).

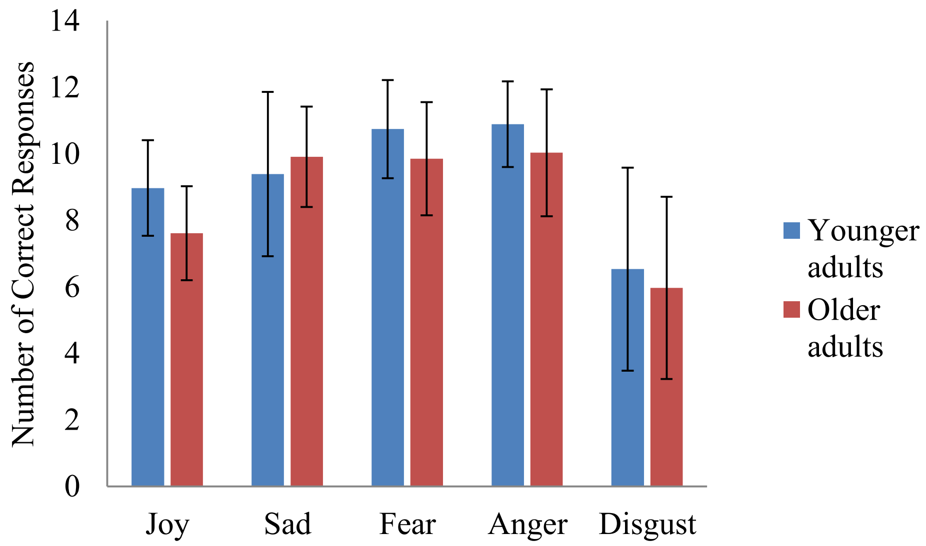


Figure 7.4.2. Total emotion recognition accuracy for each emotion type summed across presentation types by age group (YAs *n* = 38; OAs *n* = 33) (maximum *M* = 12).

The interaction can also be explained by investigating whether the pattern differs across emotion types for YAs and OAs (see Tables 7.4.11 and 7.4.12).

Table 7.4.11

*Inferential Statistics Comparing Recognition Accuracy between Emotion Types in **Younger Adults***

Comparison	*t*(37)	*p*	95% CI		d
			LL	*UL*	
Disgust<Joy	4.98	**< .001**	1.45	3.44	1.02
Disgust<Sadness	4.92	**< .001**	1.69	4.05	1.23
Disgust<Fear	9.46	**< .001**	3.31	5.11	1.76
Disgust<Anger	9.44	**< .001**	3.43	5.31	1.86
Joy<Fear	6.65	**< .001**	-2.30	-1.23	1.21
Joy<Anger	6.97	**< .001**	-2.48	-1.36	1.40
Sadness<Fear	3.22	**.003**	-2.19	-0.50	0.66
Sadness<Anger	3.26	**.002**	-2.43	-0.57	0.76
Anger=Fear		ns			
Joy=Sadness		ns			

Note. ns = nonsignificant; lowest nonsignificant *p* = .433 (joy = sadness)

YAs had lower accuracy for recognising disgust than all other emotion types. YAs were also less able to recognise joy and sadness than both fear and anger. A similar pattern of emotion recognition accuracy across emotion types to the YAs was observed for OAs in that disgust had lower accuracy than all other emotion types and accurate recognition of joy was lower than that of fear and anger. However, accuracy was also lower for recognising joy than sadness in OAs and accuracy for recognising sadness did not differ to that for anger or fear. Thus, the interaction is partially explained by difference in the pattern of sad recognition accuracy between the age groups. In addition the interaction is explained by lower accuracy for recognising joy in OAs than YAs.

Table 7.4.12

Inferential Statistics Comparing Recognition Accuracy Between Emotion Types in ***Older Adults***

Comparison	*t*(32)	*p*	95% CI		*d*
			LL	*UL*	
Disgust<Joy	3.11	**.004**	0.57	2.71	0.75
Disgust<Sadness	7.79	**<. 001**	2.91	4.97	1.78
Disgust<Fear	7.98	**<. 001**	2.88	4.87	1.70
Disgust<Anger	8.67	**< .001**	3.11	5.02	1.72
Joy<Sadness	7.01	**< .001**	-2.96	-1.64	1.57
Joy<Fear	6.65	**< .001**	-2.93	-1.56	1.43
Joy<Anger	5.63	**< .001**	-3.30	-1.55	1.44
Sadness=Fear		ns			
Anger =Sadness		ns			
Anger=Fear		ns			

Note. ns = nonsignificant; lowest nonsignificant $p = .601$ (anger = fear)

7.4.2.5 Age Group*Emotion Type*Presentation Type interaction.

To investigate the Age Group*Emotion Type*Presentation Type interaction three 2*5 ANOVAs were run, one for each presentation type. Age group (YAs and OAs) was the between participants IV and emotion type (joy, sadness, anger, fear, and disgust) was the within participants IV. The DV was emotion recognition accuracy.

7.4.2.5.1 Faces. For faces presented alone Mauchly's test of sphericity was significant, $\chi^2(9) = 35.17$, $p < .001$, therefore Greenhouse Geisser corrected values are reported. There was a significant main effect of emotion type, $F(3.26, 225.11) = 39.12$, $p < .001$, $\eta_p^2 = 0.36$ (see Table 7.4.13). Post hoc paired t-tests, with $\alpha = 1\%$, indicate that disgust was the most difficult emotion to recognise compared to all other emotions. Also sadness had lower recognition accuracy than joy, fear, and anger. All other comparisons were nonsignificant (all *p*s > .01). There was not, however, a significant main effect of age group, $F(1,69) = 0.20$, $p = .656$, $\eta_p^2 = 0.03$, nor a significant Age Group*Emotion Type interaction, $F(3.26, 225.11) = 1.42$, $p = .235$, $\eta_p^2 = 0.02$ (see Table 7.4.7 for descriptive statistics).

Table 7.4.13

Inferential Statistics Comparing Accuracy for Recognising Specific Emotions on the Negative Face Task

Comparison	*t*(70)	*p*	95 %CI		*d*
			LL	UL	
Disgust<Joy	9.17	**< .001**	1.09	1.70	1.51
Disgust<Sadness	4.63	**< .001**	0.46	1.15	0.72
Disgust<Fear	8.45	**< .001**	0.99	1.60	1.24
Disgust<Anger	10.84	**< .001**	1.28	1.84	1.64
Joy>Sadness	4.15	**< .001**	0.31	0.88	0.73
Sadness<Fear	2.86	**.006**	-0.84	-0.15	0.52
Anger>Sadness	5.29	**< .001**	-1.05	-0.47	0.90
Joy=Fear		ns			
Joy=Anger		ns			
Anger=Fear		ns			

Note. ns = nonsignificant; lowest nonsignificant $p = .023$ (anger=fear)

7.4.2.5.2 Prosodic sentences. For prosodic sentences presented alone there was a main effect of emotion type, $F(4, 276) = 85.58$, $p < .001$, $\eta_p^2 = 0.55$ (see Table 7.4.14). Post hoc comparisons suggest that accuracy for the recognition of joy and disgust was lower than for sad, fear, and anger in prosodic sentences. All other comparisons were nonsignificant (all *p*s > .01).

Table 7.4.14

Inferential Statistics Comparing Accuracy for Recognising Specific Emotions on the Negative Prosodic Sentence Task

Comparison	*t*(70)	*p*	95% CI		*d*
			LL	*UL*	
Disgust<sadness	10.47	**< .001**	1.46	2.15	1.67
Disgust<fear	10.99	**< .001**	1.43	2.06	1.57
Disgust<anger	10.78	< **.001**	1.34	1.95	1.52
Joy<sadness	10.92	< **.001**	-2.33	-1.61	1.81
Joy<fear	13.03	< **.001**	-2.21	-1.62	1.71
Joy<anger	10.80	< **.001**	-2.15	-1.48	1.67
Sadness=fear		ns			
Anger=sadness		ns			
Anger=fear		ns			
Disgust=joy		ns			

Note. ns =nonsignificant; lowest $p = .295$ (anger=sadness)

There was also a main effect of age group, $F(1, 69) = 17.01$, $p < .001$, $\eta_p^2 = 0.20$, with YAs having higher accuracy for recognising emotion from prosodic sentences than OAs. Furthermore, there was a significant Age Group*Emotion Type interaction, $F(4, 276) = 4.34$, $p = .002$, $\eta_p^2 = 0.06$. Post hoc comparisons suggest that this interaction reflects a lesser ability to recognise joy from prosodic sentences in OAs compared to YAs (see Table 7.4.15). Furthermore, YAs and OAs had a similar pattern of accuracy across emotion types (see Figure 7.4.3 and Appendix 7.13). All other comparisons were nonsignificant (all *p*s > .01).

Table 7.4.15

Inferential Statistics Comparing Emotion Recognition Accuracy Between Younger and Older Adults for Each Emotion Type on the Negative Prosodic Sentence Task

Emotion			95% CI		
Type	*t*(69)	*p*	*LL*	*UL*	*d*
Joy	4.99	**< .001**	0.78	1.82	1.20
Anger		ns			
Disgust		ns			
Sad		ns			
Fear		ns			

Note. ns = nonsignificant; lowest nonsignificant $p = .024$ (sad)

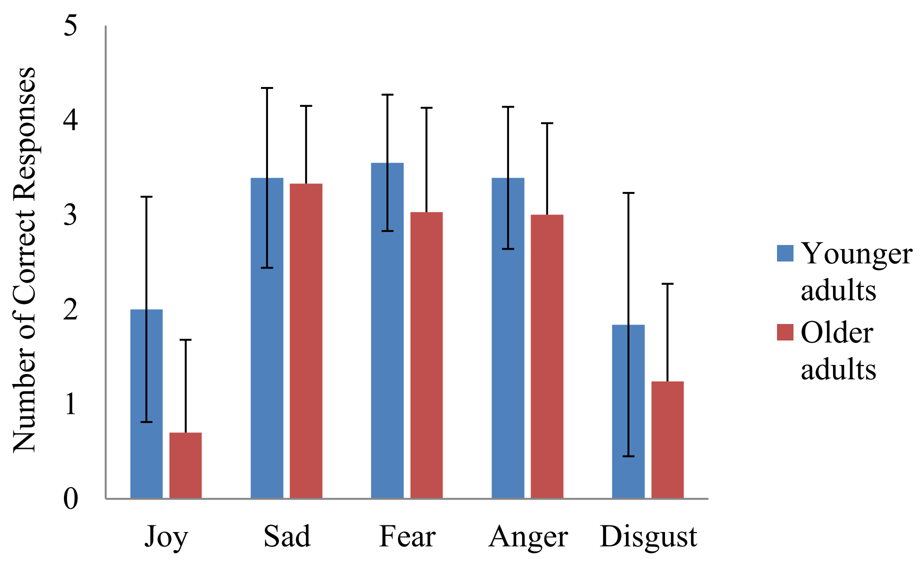


Figure 7.4.3. Emotion recognition accuracy from prosodic sentences by age group (YAs $n = 38$; OAs $n = 33$) and emotion type (maximum $M = 4$).

7.4.2.5.3 Cross-modal. Regarding the 2*5 ANOVA for the simultaneously presented dynamic facial expressions and prosodic sentences Mauchly's test of sphericity was significant, $\chi^2(9) = 40.65$, $p < .001$, therefore Greenhouse Geisser corrected values are reported. There was a main effect of emotion type, $F(2.93, 202.20) = 20.37$, $p < .001$, $\eta_p^2 = 0.23$ (see Table 7.4.16). Post hoc t-tests, with $\alpha = 1\%$, suggest that disgust was more difficult to recognise than all other emotion types; all other comparisons were nonsignificant (all *ps* > .01). However, there was not a significant main effect of age group, $F(1,69) = 0.01$, $p = .922$, $\eta_p^2 = 0 .00$, nor was there a significant Age Group*Emotion Type interaction, $F(2.93, 202.20) = 1.49$, $p = .219$, $\eta_p^2 = 0.02$.

Table 7.4.16

Inferential Statistics Comparing Recognition Accuracy for Specific Emotions on the Negative Cross-Modal Task

Comparison	*t*(70)	*p*	95% CI *LL*	95% CI *UL*	*d*
Disgust <joy	5.65	**< .001**	0.55	1.14	0.92
Disgust<sadness	4.36	**< .001**	0.41	1.11	0.74
Disgust<fear	6.45	**< .001**	0.70	1.33	1.05
Disgust<anger	7.34	**< .001**	0.74	1.29	1.07
Joy=sadness		ns			
Joy=fear		ns			
Joy=anger		ns			
Sadness=fear		ns			
Anger=sadness		ns			
Anger=fear		ns			

Note. ns = nonsignificant

In summary, OAs and YAs had similar emotion recognition accuracy for dynamic facial expressions and cross-modal presentations. However, OAs compared to YAs had lower accuracy for overall emotion recognition and recognition of joy from prosodic sentences.

The Age Group*Emotion Type*Presentation Type interaction can also be explained by any differences between the age groups in the pattern of recognition accuracy for each specific emotion across the presentation types. Therefore, to investigate the interaction further paired t-tests were run, with Bonferroni corrections set at $p = .017$. For conciseness only disparities in the pattern between YAs and OAs will be reported (see Appendix 7.13 for full outputs). For recognising sadness YAs, but not OAs (p = .163) were more accurate at recognising sadness in prosodic sentences than in faces, $t(37) = 3.46$, $p = .001$, $d = 0.60$. Whereas, OAs were less accurate when recognising disgust in faces than both cross-modal presentations, $t(32) = 3.45$, $p = .002$, $d = 0.56$, and prosodic sentences, $t(32) = 3.50$, $p = .001$, $d = 0.69$, but this was not the case for YAs (p = .070 and p = .183 respectively).

7.4.2.6 Comparing between the younger-older and older-older adults. The ANOVA analysis was re run with the between groups IV of age group consisting of three levels (YAs, younger-older adults, and older-older adults). The results from the ANOVA were largely the same as those reported for the two age groups with the exception that there was no longer an Age Group*Emotion Type interaction nor was there a significant main effect of age group. Thus, there was no evidence that emotion recognition ability was adversely affected by advancing older age.

7.5 Discussion

A central aim of Phase 2 was to investigate whether OAs have age-related emotion recognition deficits on tasks with higher levels of ecological validity than those used in Phase 1, particularly for anger and for prosodic sentences. Further aims were to investigate whether any age-related emotion recognition impairments in overall accuracy on the unimodal tasks are eliminated on cross-modal tasks, and whether age-related deficits are limited to select basic emotions or are observed in non-basic emotions. The experiments were also designed to tease apart two possible explanations, a positivity effect or task design, that may account for the typically reported pattern of emotion recognition accuracy across emotion types in OAs (i.e., maintained recognition of positive emotions alongside age-related deficits for recognising some negative emotions). The research also aimed to understand the effects of advancing older age on recognition ability from unimodal and cross-modal audio-visual presentations. Finally, measures of social functioning were conducted to understand whether any age-related emotion recognition impairments are a reflection of a more generalised deficit in social functioning; OAs did not have lower levels of social functioning than YAs suggesting that age-related emotion recognition deficits are not representative of a general impairment in social competence. However, maintenance of emotion recognition ability in older age maybe explained by higher levels of social activity in OAs than YAs. The findings are discussed first for those related to presentation types, then those related to emotion types and demonstrate that the hypotheses are only partially supported.

The results from both the positive experiment and negative experiments indicate that, as predicted, accuracy was higher on the cross-modal tasks than either of the unimodal tasks, but accuracy was lowest on the prosodic sentence tasks. This finding is in line with similar research (Wieck & Kunzmann, 2017).   Further, whilst OAs and YAs had similar accuracy on the cross-modal task and dynamic tasks, OAs did not appear to have enhanced benefits compared to YAs on the cross-modal task than unimodal tasks in the positive experiment. In contrast, emotion recognition impairments from prosodic sentences in OAs, compared to YAs, were eliminated on the cross-modal task in the negative experiment. Thus OAs may have used compensatory strategies, such as expertise or neural overactivation during cross-modal processing, to form emotion recognition judgements from cross-modal information and this is particularly evident on the negative tasks.

A lesser ability to recognise emotion from prosodic sentences in OAs than YAs was reported in the negative experiment and this finding is as predicted and supports similar research in the field (e.g., Mill, Allik, Realo, & Valk, 2009; Raithel & Hielscher-Fastabend, 2004).   However, the current experiments used nonsense sentences, which are devoid of the semantic information. OAs may rely on semantic information more than YAs when making emotion recognition judgements (Belin, Fillion-Bilodeau, & Gosselin, 2008); thus, a lesser ability in OAs than YAs to recognise emotion in nonsense sentences may result from OAs' being unable to use semantic information. Of importance is that the age-related impairment on the prosodic sentence task may reflect a more general decline in the ability to process auditory information in older age, as was observed in Phase 1. However, a general impairment in processing auditory information in Phase 1 was supported by an age-related deficit in OAs for recognising non-emotion information. Due to a lack of suitable stimuli a comparable non-emotion task was not used in Phase 2; thus, it is unclear whether the OAs in Phase 2 have a general impairment for processing auditory information or whether this is restricted to emotion processing. Nevertheless, the findings in Phase 2, and Phase 1, suggest that in certain conditions OAs are less able than YAs to accurately process affective auditory information.

The prediction for a general age-related deficit for anger in OAs was partially supported. Regarding different emotions types OAs were less able than YAs to recognise anger on the positive experiment, and the magnitude of this difference did not vary across the three presentation types. This finding supports the proposed prediction that OAs have a general impairment for recognising anger and extends findings from Phase 1 that OAs are less able than YAs to recognise anger across presentation types. In a similar manner to findings from the current positive experiment, Chaby et al. (2015) reported that OAs had recognition deficits for anger across unimodal and cross-modal presentations of static faces and non-verbal vocalisations. Further studies have reported impaired anger recognition in OAs compared to YAs for morphed faces (e.g., Horning, Cornwell, & Davis, 2012). However, most research in the field that have used acted, dynamic facial expressions or prosodic sentences have not distinguished emotion recognition ability by different emotion types; therefore, it is unclear whether the OAs in those studies had difficulties in recognising anger (e.g., Grainger, Henry, Phillips, Vanman, & Allen, 2015b; Kiss & Ennis, 2001). The current research, therefore, extends findings by reporting age-related differences in recognition ability for anger in unimodal and cross-modal presentations of dynamic faces and prosodic sentences.

As discussed in Chapter 6, a reduced ability to recognise anger in older age may be explained by neurological aging including the dopamine hypothesis and neural demise. For example, a reduction in dopamine availability with age may reduce anger recognition ability (Lawrence, Calder, McGowen, & Grasby, 2002) and the processing of anger has been related to activation in the OFC an area associated with volume reduction in OAs (Resnick, Lamar, & Driscoll, 2007; Sprengelmeyer, Rausch, Eysel, & Przuntek, 1998). However, in the current study the ability to recognise anger did not deteriorate further with advancing older age despite evidence that the availability of dopamine declines further with advanced older age (Ma et al., 1999). Thus as measured by the tasks in the current experiments OAs' recognition ability for anger seems to be resistant to further decline with progressive degradation of neurotransmitters and neurological structure.

Of interest in the current study, age-related deficits for recognising anger were only observed on the positive experiment. This experiment measured anger and several positively valenced emotions; thus, it may be expected that anger would be easier to recognise than other emotion types. Indeed, both OAs and YAs were more able to recognise anger than other emotions across the positive tasks but YAs were more able to do so than OAs. In contrast to the positive experiment, OAs were as able as YAs to recognise anger in the negative experiment. One explanation for this is that there were only four trials for each emotion type in the negative task; it is possible, therefore, that the task may have lacked the sensitivity to detect any variance in anger recognition.

Indeed, anger recognition accuracy for OAs and YAs was near ceiling; thus, making it difficult to reveal any significant differences between the age groups.

There was also an age-related decline for recognising joy and this finding appears to be driven by performance on the prosodic sentence task. Similar findings have been reported from auditory sentences (Mill, Allik, Realo, & Valk, 2009; Wong, Cronin-Golomb, & Neargarder, 2005). It appears, therefore, that the ability to recognise joy, which are arguably synonymous to happiness on emotion recognition tasks, in auditory sentences declines with age. In general the detection of joy was relatively low for both age groups compared to other emotion types. This may be due to the nature of prosodic sounds of joy being less distinctive, thus more difficult to recognise, than other emotion types, such as anger and fear (Paulmann, Pell, & Kotz, 2008). Furthermore, it is possible that the recognition of certain emotions such as joy relies on semantic information, which were not available in the nonsense sentences of the current study (Paulmann, Pell, & Kotz, 2008). Specifically, OAs may rely on semantic information in sentences more than YAs when making affective judgements (Dupuis & Pichora-Fuller, 2010). Thus, OAs may have been less able to detect joy in prosodic sentences on the negative task than YAs due to a lack of semantic information and lower distinctiveness of the prosodic information.

Finally, regarding recognition accuracy for specific emotions OAs were as able as YAs to recognise fear, disgust, surprise, and non-basic emotions of pride and amusement; thus findings do not support the prediction that OAs will have age-related recognition deficits for non-basic emotions. Neurological and cognitive explanations for preservation of fear and disgust have been discussed in Chapter 6, the current findings lend further support to the maintenance in recognition ability of these emotions when presented in unimodal and cross-modal dynamic faces and prosodic sentences. Furthermore, maintenance in the ability to recognise pride and amusement suggest that

OAs’ recognition deficits may be limited to select basic emotions. However, the current research only measured two non-basic emotions; thus, research incorporating a wider range of non-basic emotions is needed to investigate whether a maintained emotion recognition ability of non-basic emotions in OAs is general or whether OAs have select impairments for non-basic emotions. Nevertheless, taken together the findings in Phase 2 suggest that the breadth of OAs’ emotion recognition deficits is limited to a few basic emotion types.

The discussion now turns to whether the pattern of findings for recognition of emotions can be explained by a positivity effect or task design. In the positive experiment accuracy was higher for anger than other emotion types, regardless of age, and this suggests that it is easier to recognise a negative emotion than a positive emotion from an array of positive emotions, and this finding suggests that the pattern is influenced by the task design. The findings are less clear when considering the negative experiment, as the results do not mirror the typical pattern observed in the field. Essentially, accuracy for recognising negative emotions of anger, fear, and sadness was higher than joy and disgust, and OAs were less able to recognise joy than YAs. Thus, OAs and YAs were less able to select a positive emotion from an array of negative emotions, a task that should be relatively easy, and OAs were more compromised in this ability than YAs. Low accuracy for recognising joy from a selection of negative emotions does not suggest either a function of task design or a positivity effect. It is likely that the pattern of findings from the two experiments, such as a relatively high recognition ability for anger and low recognition ability for joy, is a function of the particular stimuli used in the GEMEP, as anger was one of the most accurately recognised emotions in the validation study (Bänziger, Mortillaro, & Scherer, 2012). To further clarify the effects of task design from the positivity effect on the pattern of emotion recognition ability in OAs it would be beneficial to replicate the experiments in Phase 2 using stimuli taken from an alternative database.

Of interest, and against predictions, emotion recognition ability in OAs did not differ with advancing older age. The current findings suggest that despite an age-related decline in verbal intelligence and slowing in processing speed in the older-older adults, older-older adults were as able as younger-older adults to recognise emotions. This finding is perhaps a further example of OAs' use of compensatory strategies, such as neural overactivation or expertise, for processing emotion information and suggests that compensatory strategies are still effective with advancing older age. However, these strategies were not specifically measured in the current research, therefore, it is important to further understand the role of compensatory strategies used by OAs, and particularly older-older adults, when forming emotion recognition judgements.

In summary, OAs generally had comparable emotion recognition ability to YAs. For both age groups emotion recognition ability was higher for the cross-modal tasks than both of the unimodal presentations, and in the negative experiment OAs appear to benefit to a greater extent than YAs on the cross-modal task. However, there was further evidence for a general age-related deficit for recognising anger on the positive experiment and for recognising emotion from auditory stimuli in the negative experiment, specifically joyous prosody. Finally, performance on the social functioning tasks suggests that any emotion recognition deficits are not a reflection of global reductions in social competence.

7.6 Conclusion.

When comparing the characteristic profiles of the YAs and OAs it appears that the OAs were not disadvantaged on some aspects that may influence emotion recognition ability, such as fluid and emotion intelligence; thus any age-related emotion recognition deficits are likely to reflect direct difficulties in emotion processing. Despite this, it appears that when tasks have higher levels of ecological validity than those used in Phase 1 then compared to YAs, OAs still have difficulties in recognising anger and emotions from auditory information. Of importance, however, OAs were as able as YAs to recognise many emotions across the presentation types, suggesting that OAs do not have a general decline in emotion recognition ability. These findings have to be considered within the context of the social characteristics of the OAs as having good levels of emotion intelligence, being socially active, and having positive attitudes to friendships; thus the findings may differ in OAs with a less positive aptitude for social functioning. Of importance, the careful design of the tasks within each experiment, for example to be as closely matched as possible in processing demands, and the within participants nature of the study allows for meaningful comparisons across the unimodal and cross-modal tasks and across emotions.

Chapter 8-Discussion

8.1 Overview

The overarching aim of the research in this thesis was to extend and clarify our understanding of the scope of age-related emotion recognition impairments in OAs. Emotion recognition accuracy was measured across different stimuli, presentation, and emotion types to gauge the breadth of age-related deficits in OAs. Importantly, the experiments in both phases were carefully designed to control and account for several variables, such as task demands; methodological disparities; and sample characteristics, which may otherwise make interpretation of results difficult. In this manner findings can be more confidently attributed to age differences in emotion processing than research that has not applied such rigorous methods.

In Phase 1 emotion recognition was measured across three presentation types: facial expressions, non-verbal vocalisations, and visual single words, whereas in Phase 2 emotion recognition ability was measured using more ecologically valid stimuli (i.e., unimodal and cross-modal presentations of dynamic faces and prosodic sentences) than those in Phase 1 (e.g., static faces). The experimental procedure within both phases of the research was carefully matched, as far as possible, across the presentation types. Furthermore, although different samples were used between Phase 1 and Phase 2 the experiments within the separate phases used a within participants design. Thus within each phase informative comparisons can be made, as any difference in the pattern of emotion recognition ability in OAs between presentation types is likely to be attributable to the presentation type rather than other methodological disparities or sample differences. Moreover, across both Phase 1 and Phase 2 several characteristics such as intelligence, processing speed, and affect that may influence emotion recognition ability were measured so that the emotion recognition findings can be discussed within the context of any sample differences.

To further understand emotion recognition ability in OAs each phase contained a novel approach. In Phase 1 non-emotion tasks for each presentation type were specifically designed to be as visually and procedurally similar as possible to the corresponding emotion task thus allowing for direct comparisons to be made. Importantly the non-emotion tasks enabled emotion recognition differences between YAs and OAs to be interpreted in terms of their ability to meet the demands of the task and to process the stimuli presented. In Phase 2 a novel task (measuring recognition ability of several positive emotions and one negative emotion) was designed to tease apart the positivity effect from task design as an explanation for the typical pattern of emotion recognition ability in OAs. Furthermore, this task included two non-basic emotions and thus provided an insight into OAs' emotion recognition ability beyond the basic emotions. Table 8.1 presents a summary of the findings across the two phases. The information in the table highlights several standout findings and these are listed below and then discussed in turn.

1. OAs are as able to recognise emotions as YAs with a few select exceptions.

2. OAs are less able than YAs when making categorical judgements from auditory stimuli.

3. Emotion processing is not supported by a domain specific processor.

4. OAs have a specific age-related difficulty for recognising anger.

5. OAs are more able to recognise disgust than YAs.

6. It is important to understand the effect of advancing older age on emotion recognition ability

Table 8.1 *Older and Older-Older Adults Emotion Recognition Ability across Emotion and Stimuli Types.*

	Static faces		Non-verbal vocalisations		Single words		Total Phase 1		Dynamic faces		Prosodic sentences		Cross-modal	
	OA	O-OA	OA	O-OA	OA	O-OA	OA	O-OA	Positive	Negative	Positive	Negative	Positive	Negative
Total	ns	**D***	**D**	ns	**I**	ns	ns	ns	ns	ns	ns	**D**	ns	ns
Happy/joy	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	**D**	ns	ns
Sad	ns	**D**	ns	ns	**I**	ns	ns	**D**	ns	ns	ns	ns	ns	ns
Fear	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Anger	D	ns	ns	ns	ns	ns	**D**	**D***	**D**	ns	**D**	ns	**D**	ns
Disgust	ns	ns	ns	ns	ns	ns	**I**	**I***	ns	ns	ns	ns	ns	ns
Neutral	ns	ns	ns	ns	ns	ns	ns	ns	-	-	-	-	-	-
Amusement	-	-	-	-	-	-	-	-	ns	-	ns	-	ns	-
Pride	-	-	-	-	-	-	-	-	ns	-	ns	-	ns	-
Surprise	-	-	-	-	-	-	-	-	ns	-	ns	-	ns	-
Control	ns	**D**	**D**	ns	**I**	ns			-	-	-	-	-	-

Note. OA (older adults) findings are compared to YAs (younger adults). Unless stated the findings for O-OAs (older-older adults) are related to differences to younger-older adults, however, * indicates differences are compared to YAs

8.2 Maintained Emotion Recognition Ability in Older Age

The most striking conclusion from the current research and one that is contrary to much research in the field is that taken together the findings from Phase 1 and Phase 2 indicate that, with only a few exceptions, OAs' and YAs' emotion recognition abilities are comparable (i.e., there were few statistically significant differences in emotion recognition ability between the two age groups). This conclusion strongly contradicts the opinion that OAs are less able to recognise emotions than YAs (e.g., Ruffman, Henry, Livingstone, & Phillips, 2008). The abundance of studies that report emotion recognition declines with older age present a picture of emotion recognition decline in OAs (Richter, Dietzel, & Kunzmann, 2010). Indeed as Kunzmann and Isaacowitz (2017) state that, "the findings have been taken to suggest lower emotion perception (recognition) performance in older than younger adults" (p. 192). However, the current findings highlight that researchers are in danger of exaggerating the extent of age-related impairments in emotion recognition by focussing on selective deficits rather than also looking more broadly at the similarities between YAs and OAs. The current findings represent a much more positive view of aging and emotion recognition than has been previously reported.

As stated throughout this thesis, however, methodological differences in the field may restrict meaningful cross-study comparisons and a focus on facial expressions limits our knowledge as to the breadth of emotion recognition declines in older age. In contrast, the tight methodological design of the tasks in the current study allows for meaningful comparisons of findings within each phase and the results suggest that a conclusion of emotion recognition decline with age is simplistic and masks the complexities of emotion recognition ability in OAs. Overall the current results suggest that emotion recognition accuracy is generally maintained and deficits tend to be particular to certain presentation, stimuli, and emotion types. Furthermore, there is evidence that compared to YAs, OAs may be more able to accurately recognise disgust and emotions from words, particularly words semantically related to sadness. Of importance, to the author's knowledge this is the first study to report higher levels of recognition ability in OAs than YAs for affective words.

The largely positive findings for emotion recognition ability in the current study may reflect the sample characteristics, as with the exception of slower processing speed the OAs were not disadvantaged compared to YAs on many of the potential skills and abilities that are associated with emotion recognition ability, such as alexithymia; empathy; and personality traits. Conversely, the findings may reflect the sample characteristics of the YAs as being disadvantaged compared to OAs on these characteristics. Thus the findings may not generalise to OAs with less favourable skills and abilities for emotion recognition.

8.3 Emotion Recognition across Presentation Types

When emotion recognition tasks are closely matched on procedural demands then a diverse pattern of results is revealed across presentation types. Specifically, in the current study overall emotion recognition ability was: similar between OAs and YAs from static and dynamic faces, cross-modal information, and prosodic sentences (in the positive experiment); lower in OAs than YAs from non-verbal vocalisations and prosodic sentences in the negative experiment; and higher in OAs than YAs from single words. However, as discussed in Chapters 4 and 5, of importance the novel inclusion of closely matched emotion and non-emotion tasks enabled findings to be interpreted within the context of the ability to process stimuli and meet the demands of the task. Thus lower emotion recognition accuracy from non-verbal vocalisations and higher emotion recognition accuracy from words in OAs than YAs might reflect a lower ability to process auditory information alongside a higher ability to process words in older age rather than age-related differences in emotion processing per se. Nevertheless, as discussed in Chapter 6, the disparate pattern of emotion recognition accuracy across presentation types is in conflict with a general emotion processing theory (Borod et al., 1999). Crucially the current findings add to theoretical understanding of emotion processing: emotion processing appears to be supported by systems that vary across modality and presentation types.

8.4 Anger Recognition Declines in Older Age

One of the most salient findings of the research programme is that OAs appear to have difficulty in recognising anger across several modality, presentation, and stimuli types. This pervasive emotion recognition deficit is in line with some of the literature in the field, as anger recognition is often reported as being impaired in older aged participants (e.g., Chaby, Boullay, Chetouani, & Plaza, 2015). As discussed in Chapters 3, 6, and 7 an age-related impairment for recognising anger is best explained by a neurological account. Specifically age-related reductions in dopamine and changes in the OFC, a brain region associated with processing anger, may lead to lower recognition ability of anger in older age (Lawrence, Calder, McGowen, & Grasby, 2002; Quadflieg, Mohr, Mentzel, Miltner, & Straube, 2008; Raz et al., 1997).

However, other explanations need to be considered. Given the characteristics of the OAs in the current thesis it is unlikely that this age-related deficit is a function of intelligence, socio-emotion skills, or personality. Furthermore, despite slower processing speed in OAs than YAs in the current study, several other studies have reported that speed of processing does not fully account for age-related impairments for anger recognition in OAs (Orgeta & Phillips, 2007; Sullivan & Ruffman, 2004; Suzuki & Akiyama, 2013). Moreover, the tasks in the current study had imposed time restrictions; thus, difficulties in recognising anger due to processing speed may be understood in relation to the number of time-outs. However, across all of the presentation types, with the exception of non-verbal vocalisations, OAs had fewer time-outs for anger recognition than most emotions. Thus, there is little evidence to support the proposition that an age-related impairment for recognising anger is a function of slower processing speed in older age.

Furthermore, as discussed in Chapter 6 an age-related decline in anger recognition is also unlikely to reflect age group differences in affect. However, it is possible that the current finding for anger recognition may result from a lower sensitivity in OAs compared to YAs to detect threat due to lower levels of anxiety in older age. Evidence suggests that when presented in an array of neutral faces, angry faces appear to pop out more readily for individuals with higher levels of anxiety than individuals with lower levels of anxiety (Byrne & Eysenck, 1995). Given that OAs in the current study had lower levels of anxiety than YAs, then YAs may have been more responsive to threatening stimuli than OAs. However, if this were the case then it may be expected that OAs would demonstrate a lower ability to detect fear than YAs, as fear in evolutionary terms is a signal of threat and is most commonly associated with levels of anxiety (Richards et al., 2002). Yet in the current study, OAs and YAs did not differ in their ability to recognise fear across any of the presentation types. Moreover, anxious individuals may have an overactive perception of anger from faces; however, the current research suggests that the OAs' lesser ability to recognise anger than YAs was not restricted to faces. Thus, it is unlikely that age differences in anxiety fully account for the decline in anger recognition in older age.

Of note, in contrast to the observed decline in anger recognition in older age across several tasks, the findings from the negative experiment in Phase 2 did not reveal an age-related difference in anger recognition. This may reflect a lack of sensitivity in the task to reveal a statistical difference as the negative experiment only had four trials per emotion. Indeed, inspection of the means suggest that anger recognition did decline with age across all of the tasks in the negative experiment. It is important, therefore, that the negative experiment is replicated with more trials to understand whether an age-related impairment of anger is revealed.

8.5 Disgust Recognition in Older Adults

A further critical finding of the current research was that in Phase 1 OAs had higher recognition accuracy for disgust than YAs when accuracy was summed across presentation types and this has been discussed in Chapter 6 in relation to neurological stability in the insula and basal ganglia (e.g., Calder et al., 2001). However, in the negative task in Phase 2 OAs and YAs did not significantly differ in their ability to recognise disgust. Thus, it appears that an improved ability to recognise disgust with age is limited to stimuli with impoverished cues and extra cues such as unfolding expressions are not useful to OAs' recognition of disgust.

However, the difference in findings regarding disgust recognition between the two phases may be a function of the stimuli, as the stimuli came from different databases; thus, the ability of the actors to encode disgust may differ. According to the Brunswik lens model (Brunswik, 1956) the ability to recognise emotions not only rely on the perceiver's ability to decode the information but also the sender's ability to encode the information. Indeed, in the validation studies for the FACES dataset (used in Phase 1) disgust had an accuracy of 68% (Ebner, Riediger, & Lindenberger, 2010), whereas for the GEMEP-CS disgust had low accuracy for audio presentations (20%) alongside relatively high accuracy for cross-modal presentations (80%) (Bänziger, Mortillaro, & Scherer, 2012). When comparing accuracy between the YAs and OAs on the GEMEP-CS based tasks in the negative experiment, OAs had marginally lower mean scores for recognising disgust from dynamic faces and prosodic sentences but had marginally higher accuracy for cross-modal presentations. Thus, it is feasible the findings in the current study demonstrate that OAs are as able to recognise disgust as YAs when the expressions in the stimuli are less accurately encoded, whereas OAs are more able to recognise disgust than YAs when the expressions in the stimuli are more accurately encoded.

8.6 Older Adults are less able to Process Auditory Information than Younger Adults

A further vital key finding was that, in both Phase 1 and Phase 2, overall emotion recognition impairments for OAs compared to YAs were confined to the auditory tasks. These age-related deficits were reported for non-verbal vocalisations and prosodic sentences (in the negative experiment) as well as a lesser ability to process non-emotion auditory information in OAs than YAs. The findings for age-related emotion recognition impairments from non-verbal vocalisations and prosodic sentences are in line with existing research (Chaby, Boullay, Chetouani, & Plaza, 20; Mill, Allik, Realo, & Valk, 2009; Raithel & Hielscher-Fastabend, 2004). Thus, importantly it appears, that compared to YAs, OAs have general processing difficulties for auditory information and as discussed in Chapter 4 this may reflect a central auditory processing deficit or changes in temporal processing with age (Atcherson, Nagaraj, Kennett, & Levisee, 2015; Strouse, Ashmead, Ohde, & Grantham, 1998). However, it is likely that the observation of an age-related decline in recognising prosodic sentences is exacerbated by OAs' lesser ability to recognise joy compared to YAs in the negative experiment, as OAs did not have an age-related deficit on the prosodic sentence task in the positive experiment despite lower mean scores for all of the emotion types, with the exception of amusement. Thus, the general age-related deficit for processing sounds appears to be specific to short sound bursts of auditory information and some prosodic sentences including selective impairments for recognising joyous sentences.

8.7 The Influence of Advancing Older Age on Emotion Recognition Ability

Cognitive and neural changes may further deteriorate in older-older age and these changes may reflect a progressive decline in emotion recognition ability with age (Hartshorne & Germine, 2015; Raz, 2000). Indeed, when emotion recognition accuracy was summed across experiments in Phase 1 older-older participants were less able to recognise sadness than younger-older adults, and anger than YAs. Furthermore for static faces, older-older adults had lower emotion recognition than younger-older adults, specifically for sadness, and were less able to make non-emotion judgements. However, the age-related decline in emotion recognition ability from non-verbal vocalisations did not progress further with advancing older age. Furthermore, older-older adults did not differ in emotion recognition ability to younger-older adults on the emotion word task or any of the tasks in Phase 2. Thus, age-related demise in the ability to process static faces and to recognise anger and sadness in tasks with limited contextual cues appear to be a function of advancing older age. Despite the inconstancies of progressive decline in emotion recognition ability with age across emotions and presentation types, the findings underscore the importance for lifespan research to distinguish findings between younger-older and older-older adults.

8.8 Applying the Findings to Theory

Despite a wealth of research in the area, particularly for facial expressions, it remains unclear as to the cause of differences in emotion recognition ability between OAs and YAs. Several theories have been posited including a motivational shift with older age towards positive emotion experiences and information, and age-related cognitive and neurological changes (Charles, Mather, & Carstensen, 2003; Hartshorne & Germine, 201; Raz et al., 1997). The information gathered in the current research may help to inform upon which of these theories, if any, provides the best explanation for emotion recognition ability in OAs and are discussed below.

8.8.1 Positivity effect.

A shift in motivation in older age towards positive experiences and information has been related to OAs' enhanced processing of positive stimuli over negative stimuli, often to a greater extent than YAs (Charles, Mather, & Carstensen, 2003). The current findings give mixed support for a positivity effect in emotion recognition ability in OAs. In support of the positivity effect, in Phase 1 OAs had age-related impairments for recognising anger (and sadness in older-older adults) alongside a maintenance of happy recognition. However, OAs did not demonstrate an age-related positivity effect for emotion recognition ability from non-verbal vocalisations, single words, unimodal or cross-modal dynamic faces and prosodic sentences in the negative experiment. Indeed, OAs were less able than YAs to recognise joyous prosodic sentences and more able to detect sad related words and these findings are in direct conflict with a positivity effect.

Moreover, the positive experiment was specifically designed to tease apart the positivity effect and task design as explanations for the typical pattern of emotion recognition ability in OAs. In the positive experiment (several positive emotions and one negative emotion) in Phase 2, OAs and YAs were equally proficient in distinguishing between different types of positive emotions alongside a deficit for recognising anger; however, accuracy for recognising anger was higher than accuracy for the positive emotions for YAs and OAs. Thus, findings from the positive experiment are not suggestive of a positivity effect; rather the pattern may reflect the ease of discriminating a negative emotion from an array of positive emotions, a function of task design. Findings from the negative experiment (several negative emotions alongside one positive emotion) show a pattern of emotion recognition ability opposite to that typically found in the field, as anger was recognised more accurately than other emotion types. Thus, the findings do not demonstrate a positivity effect or an effect of task design. As discussed in Chapter 7 a higher ability to recognise anger than other emotions might be particular to the stimuli provided in the GEMEP-CS; thus the experiments need to be replicated using different stimuli to further clarify the role of task design and positivity effect in the pattern of emotion recognition ability in OAs. Taken together a positivity effect in emotion recognition ability in OAs was limited to static faces and was not evident across other presentation or stimuli types in the current study.

8.8.2 Cognitive aging.

There is mixed support for a cognitive aging explanation for emotion recognition ability in OAs (i.e., that declines in some cognitive abilities and function in older age may influence emotion recognition ability). As discussed in Chapters 4 and 7 a central processing deficit or differences in processing ability may explain the findings for age-related impairments for processing auditory information, whereas compensatory mechanisms may explain maintained ability on dynamic face and cross-modal tasks. Furthermore, as discussed above specific age-related emotion recognition deficits appear to be a function of older-older adults. It is likely that these older-older adults had experienced greater cognitive demise than younger-older adults and this in turn may have reduced their emotion recognition ability. Taken together a cognitive aging explanation of emotion recognition ability in OAs appears to be specific to the ability to process static faces and auditory information. However, as discussed a neurological explanation may more adequately explain age-related impairment for anger recognition.

8.8.3 Neurological aging.

As explained in Chapter 1 several studies report observations of age-related changes in the brain (Ruffman, 2011). However, there are also several gaps in the neurological and emotion literature; thus, the extent and pattern of age-related neurological changes and implications on emotion processing is unclear with some conflicting results (Isaacowitz & Stanley, 2011). Nevertheless, as observed in the discussion for age-related deficits for recognising anger a neurological explanation may account for the current findings regarding emotion recognition ability in OAs. In addition older-older adults were less able to recognise sad static faces than YAs and sadness across tasks in Phase 1 than younger-older adults. It is likely that an age-related impairment for processing sadness is a function of age-related changes in cingulate cortex (Ruffman et al., 2008). Furthermore, as discussed above the current findings for disgust recognition may reflect the stability in the insula and basal ganglia with age. However, the findings in the current research are not wholly consistent with an explanation of neurological aging. For example, there is evidence of reduced activity in the amygdala with age, an area associated with processing fearful faces (Cacioppo, Berntson, & Decety, 2012); however, an age-related impairment for fear recognition was not observed in the current study.

Neurological changes with age may explain the observed age-related decline in recognising sadness and anger as well as maintenance of disgust. However, it is possible that simply trying to map emotion recognition ability of distinct emotion types to specific brain areas is reductionist and more fruitful findings might result from understanding more complex neural circuits of emotion recognition (Ruffman et al., 2008). It appears that much work is yet to be undertaken to fully comprehend the neural pathways of specific emotions and how these interact with neural networks for different modality and presentation types.

8.8.4 Summary.

Taken together, the evidence from the current research points to a complex and disparate emotion processing system that appears to be dependent upon the presentation, stimuli, and emotion types rather than a general processor. It is likely that these disparate processing systems are differentially influenced by cognitive and neurological changes with age. Thus age-related differences in emotion recognition ability in OAs are specific to emotion, stimuli, and presentation types dependant on age-related changes or maintenance in systems that support these elements. Importantly, despite the cognitive and neurological changes with age, OAs often have preserved emotion recognition ability and this might result from the OAs drawing on compensatory mechanisms, such as experience or neural over activation, to overcome any age-related demise in cognitive and neurological function. Given the number of neurological and cognitive processing systems that may be implicated in emotion recognition and the lack of uniformity in age-related changes in these systems coupled with possible compensatory mechanisms it is not surprising that emotion recognition ability in OAs is variable across presentation, stimuli, and emotion types. It is, therefore, recommended that an integrated approach, incorporating neurological and cognitive measures, is taken to further understand the complex development of emotion recognition into older age (Charles & Campos, 2011).

8.9 Limitations and Future Research

The current research was based on laboratory experiments and self-report measures as these tasks are important for experimental control; however, these tasks might not capture behaviour that occurs in real world situations. Emotion recognition research, therefore, needs to advance by employing sophisticated observation methods to determine emotion recognition in naturally occurring social interactions. Furthermore, eliciting third party opinions regarding social behaviours from a close relative or friend would avoid response bias in self-report measures.

Of importance the performance on a given task is influenced by the quality of the stimuli and it was often difficult to locate adequate databases suitable for the current research, especially for Phase 2. There is a need for the development of a database of emotion stimuli, the design of which should address several areas that are limitations or omissions in current databases. For example, the prosodic sentences included in the GEMEP are spoken in Swiss-French; thus, the accent may have reduced emotion recognition accuracy in participants with English as their first language (Laukka et al., 2016). It is possible that any negative influence of accent may have been greater for OAs than YAs as evidence suggests that OAs are less able than YAs to comprehend accented sentences and words (Burda, Scherz, Hageman, & Edwards, 2003). Thus the use of accented speech may have reduced emotion recognition ability in OAs to a greater extent than YAs in the current study and tells us little about how OAs achieve emotion recognition ability in their native language. Therefore, a new database is required that allows for the measurement of emotion recognition from prosodic and affective semantic sentences spoken in an English accent. To control for differences in sentence structure in the prosodic stimuli the same sentence should be spoken across all emotion types. Sentence structure including matching the number of words across emotion types also needs to be considered when developing the semantic stimuli.

A further limitation of available databases is the absence of a standardised set of affective body gestures. There is some evidence that OAs are less able than YAs to recognise emotions from body gestures (Ruffman, Sullivan, & Dittrich, 2009) but research is limited to basic emotions. Little is known, however, as to whether OAs and YAs may differ in recognition ability of body gestures of non-basic emotions such as pride. Furthermore, OAs are not equally represented in the datasets for body gestures;

thus, a possible own-age bias may favour task performance for YAs and disadvantage OAs. Thus, the new database should have a selection of affective body gestures that display the same expressions as the other expressions in the dataset (both basic and non-basic emotions), have equal representation of OAs as other age groups, and use both dynamic film clips and static images to allow for comparisons with static or dynamic facial expressions.

Furthermore, to understand the breadth of any age-related differences in emotion recognition there needs to be a move away from simply studying the traditional basic emotions towards a more inclusive set of emotions or emotion states. For example, facial expressions of pain are believed to be an evolutionary state aimed to alert others that help is needed (Williams, 2002). However, research is yet to understand age-related differences in recognising cues of acute or chronic pain. Of importance the same emotions need to be represented across all the different modality and presentation types included in the new database to allow for comparisons. Furthermore, the criteria for suitable stimuli in the current thesis resulted in only four trials in the negative experiment in Phase 2 and this may have limited the power to detect age group differences. Therefore, the new database needs to include sufficient examples of each emotion so that there is enough power to detect differences in performance.

Finally, the stimuli typically contain acted or posed expressions of emotion portrayed by strangers. This limits the ecological validity of the stimuli and fails to inform as to how OAs perceive emotion in people who are familiar to them. OAs tend to focus social interactions on familiar partners and spend less time interacting with strangers than YAs (Carstensen, 1992). Moreover, in one study it was found that OAs are less able than YAs to identify emotions in dynamic faces of familiar partners and strangers but the effect size is smaller in the familiar condition (Stanley & Isaacowitz, 2015). This suggests that age-related differences in emotion recognition ability in OAs may be partially exacerbated by the lack of knowledge about the stranger used in the traditional emotion recognition tasks. However, Stanley and Isaacowitz (2015) used dynamic videos and it would be interesting to determine if familiarity effects attenuate age-related differences in emotion recognition from static faces. The new dataset should, therefore, include a combination of familiar and unfamiliar actors. For example, the familiar condition may include clips of celebrities but this would also require a scale to measure how familiar the celebrity is to the participant. The unfamiliar condition would consist of clips of strangers. In this manner tasks can be designed to account for the effect of familiarity.

Further consideration in the development of the new stimuli includes the method chosen to produce the emotion expression. Typically emotion expressions are either coded facial expressions (which are criticised for lacking the diversity of emotion expression and are considered prototypes of emotion [Barrett, Lindquist, & Gendron, 2007]), induced for more spontaneously produced expressions (this can be time consuming), or are produced by actors (this method can be prone to encoding effects). Some datasets have used a mixture of the above including the FACES and GEMEP. The new database should consider the benefits and limitations of each method but a move to more naturally produced expressions would allow for stronger insight into how emotions are processed in real world social interactions. Of importance to control for encoding effects the same actors/models should be represented across all emotion and presentation types in the new dataset.

Taken together the omissions and limitations of current datasets highlight the need for a new dataset of emotion expressions. Ideally the dataset would incorporate spontaneous and acted expressions presented in static and dynamic faces, static and dynamic body gestures, prosodic and semantic sentences and non-verbal vocalisations spoken with an English accent, and cross-modal presentations. The new dataset should also include an equal representation of ages. Furthermore, the dataset should comprise of a more comprehensive set of emotions or feelings including pain.

Further to emotion expressions the current research highlights the need to include non-emotion tasks that are as similar as possible to the emotion task. Therefore, it would be recommended that where possible any new dataset of emotion expressions also included a comparable non-emotion dataset. The emotion and non-emotion stimuli need to be similar in presentation and minimise any differences such as duration and linguistic content.

As with any new measure the new dataset would need evidence of validity and reliability. Therefore, after the creation of the stimuli a pilot or validation study is required. The aim of this experiment would mainly determine that the expressions can be interpreted as the target emotion, or target category for non-emotion tasks, above that of chance. Taken together the proposed new and extensive database suitable for native English speakers would help further our understanding of emotion recognition ability in older age. The vital need for this new measure would make for a sound and convincing proposal for a post doc project.

A further limitation of the current research is that the OA and YA samples consisted of more females than males; however, in both studies the OA sample had more males than the YA sample and this was more evident in Phase 2. The disparity in the ratio of males to females between the age groups may confound interpretation of the findings as emotion recognition is often higher in females than males (Sasson et al., 2010; Sullivan, Campbell, Hutton, & Ruffman, 2017). However, despite the OA age groups being disadvantaged compared to YAs in the proportion of males in the sample, emotion recognition was largely maintained in OAs. Thus the disproportionate ratio of males and females between the YA and OAs samples did not appear to overly influence the current findings.

Furthermore, the OA samples in the current study were specifically selected to minimise differences in sample characteristics between the age groups, including intelligence and education. However, given the high levels of intelligence and education in the OA participants the current findings cannot be generalised to a more diverse population of OAs. Further emotion recognition research, therefore, is required that acknowledges the heterogeneity of the OA population to understand how different OA groups (based on differences such as social activity, socio-economic status, or intelligence) differ in emotion recognition ability. Understanding the differences in emotion recognition ability within OAs may help to further the understanding as to the causes of age-related emotion recognition differences reported in the field.

In large Phase 1 and Phase 2 used different participants so any comparisons between the phases maybe confounded by sample differences. In particular research comparing age-related emotion recognition performance on the face tasks (i.e., static v dynamic faces) and the auditory tasks (i.e., non-verbal vocalisations and prosodic sentences) may be compromised by these possible confounds. To control for sample differences emotion recognition ability from static and dynamic faces and non-verbal vocalisations and prosodic sentences should be assessed using the same participants.

8.10 Conclusion

The stringent methodological considerations taken in designing the tasks used in the current thesis enables a clearer picture as to the extent of age-related deficits in OAs across several emotion, presentation, and stimuli types than has previously been reported. Of upmost importance and contrary to much research in the field OAs, at least equal to YAs on aspects such as intelligence; education; alexithymia; and current affect, are as able to recognise emotions as YAs with a few selective impairments. This positive view of emotion recognition development should help to put into context the often negative and exaggerated view of a general decline in emotion recognition ability in older age.   Vitally however, particular difficulties for OAs compared to YAs arise from processing auditory stimuli and anger. Moreover, many of the age-related differences in tasks with limited contextual cues were a function of the older-older adults' performance; thus, highlights the need to investigate the effects of advancing older age on emotion recognition ability. The current study also underscores the importance of using closely matched non-emotion tasks to help interpret findings from age-related emotion recognition studies. The critical findings of this thesis should be used to inform on the design and interpretation of research in the field.

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Table of Contents

Appendix a and b

Letters of Confirmation for Ethical Approval for Phase 1 and Phase 2 of the Research Project

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Our Ref AM/SW/6-2013

Nicola Dimelow
21 Cherry Tree Road,
Sheffield,
S11 9AA

20th March 2013

Dear Nicola

Request for Ethical Approval of Research Project

Your research project entitled **"Emotion Perception in Older Adults a Multimodal Study?"** has been submitted for ethical review to the Faculty's rapporteurs and I am pleased to confirm that they have approved your project.

I wish you every success with your research project.

Yours sincerely

Ann Macaskill

Professor A Macaskill
Chair
Faculty Research Ethics Committee

Office address :
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Sheffield Hallam University

Our Ref AM/FREC/105-DIM

23rd April 2015

Nicola Dimelow
21 Cherry Tree Road,
Sheffield,
S11 9AA

Dear Nicola

Request for Ethical Approval of Research Project

Your research project entitled "**Emotion perception in older adults: The influence of stimulus type and experimental task**" has been submitted for ethical review to the Faculty's rapporteurs and I am pleased to confirm that they have approved your project.

I wish you every success with your research project.

Yours sincerely

Ann Macaskill

Professor A Macaskill
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Appendix 1.1

Table 1.1

Summary of the Literature Investigating Emotion Recognition in Older Adults

Authors	Stimuli	Valence		Emotions Measured								
		P	N	H	Su	F	A	S	C	Di	Ne	Total
Circelli, Clark, and Cronin-Golomb (2013)	Faces	-	-	ns	ns	D	ns	ns	-	I	ns	ns
Krendl, Rule, and Ambady (2014)	Faces	-	-	ns	-	D	D	ns	-	-	-	D
MacPherson, Phillips, and Della Sala (2002)	Faces	-	-	ns	ns	ns	ns	D	ns	ns	-	D
Murphy and Isaacowitz (2010)	Faces	-	-	ns	-	D	D	D	-	-	-	D
Sasson et al. (2010)	Faces	-	-	D	-	D	D	D	-	-	ns	D
Stanley and Isaacowitz (2015)	Faces	-	-	ns	ns	ns	D	D	-	ns	D	D
Suzuki, Hoshino, Shigemasu, and	Faces	-	-	ns	ns	ns	ns	D	-	I	-	ns

Kawamura (2007)

Author	Stimuli	Valence P	Valence N	H	Su	F	A	S	C	Di	Ne	Total
				Emotions Measured								
Suzuki and Akiyama (2013)	Faces	-	-	D	D	D	D	D	-	I	-	D
Williams et al. (2009)	Faces	-	-	ns	-	D	D	D	-	D (80+)	ns	
Calder et al. (2003)	Faces	-	-	ns	ns	D	ns	D	-		-	D
	Faces (linear age)			ns	ns	D	D	ns	-	I	-	
	Morphed faces (linear age)			ns	ns	D	D	ns	-	I	-	
Horning, Cornwell, and Davis (2012)	Morphed faces	-	-	D	ns	D	ns	D	-	I	-	NR
Di Domenico, Palumbo, Mammarella, and Fairfield (2015)	Morphed faces	ns	ns	ns	-	-	ns	-	-	-		ns
Kessels, Montagne, Hendriks, Perrett, and de Haan (2014)	Morphed faces	-	-	D	-	D	D	D	ns	ns	-	D
Orgeta and Phillips (2008)	Morphed faces	-	-	ns	ns	D	D	D	-	ns	-	D
West et al. (2012)	Morphed faces	-	-	ns	ns	D	D	D	-	I	-	D
Krendl and Ambady	Faces	-	-	D	-	D	D	D	-	-	-	D
				-	-	-	-	-	-	-	-	ns

(2010)	Dynamic faces	ns	ns

Author	**Stimuli**	**Valence**		**Emotions Measured**								
		P	**N**	**H**	**Su**	**F**	**A**	**S**	**C**	**Di**	**Ne**	**Total**
Montagne, Kessels, De Haan, and Perrett (2006)	Morphed faces (100% intensity)	-	-	ns	ns	D	D	D	-	ns	-	NR
Grainger et al. (2015)	Faces	Contempt, pride, embarrassment		NR	NR	NR	NR	NR		NR	NR	D
	Dynamic faces	Contempt, pride, embarrassment		NR	NR	NR	NR	NR		NR	NR	D
Sze, Goodkind, Gyurak, and Levenson (2012)	Faces	ns	ns	ns	-	ns	ns	D	-	D	-	D
	Videos	I	I	-	-	-	-	-	-	-	-	I
Sullivan and Ruffman (2004)	Morphed faces	-	-	ns	-	ns	D	D	-	-	-	-
	Sounds-Faces	-	-	ns	ns	ns	D	D	-	D	-	-
Demenescu, Mathiak, and Mathiak (2014)	Faces	-	-	NR	-	NR	NR	NR	-	NR	NR	D
	Prosodic words	-	-	NR	-	NR	NR	NR	-	NR	NR	D
Mill, Allik, Realo, and Valk (2009)	Faces	-	-	D	D	D	D	D	ns	D	ns	D
	Prosodic sentences	-	-	D	-	-	D	D	-	-	ns	D
Hunter, Phillips, and MacPherson (2010)	Faces	-	-	-	-	NR	NR	NR	-	NR	-	D
	Vocalisations	-	-	-	-	NR	NR	NR	-	NR	-	D
	Audio-visual	-	-	-	-	NR	NR	NR	-	NR	-	ns

Author	Stimuli	Valence		Emotions Measured								
		P	N	H	Su	F	A	S	C	Di	Ne	Total
Lambrecht, Kriefelts,					Alluring			-	-			
and Wildgruber (2012)	Dynamic faces	-	-	D	D	-	D	-	-	D	D	D
	Prosodic word			D	D	-	D	-	-	D	D	D
	Audio-visual			D	D	-	D			ns	D	D
Chaby, Boullay,	Faces	-	-	ns	-	ns	D	D	-	D	ns	D
Chetouani, and Plaza	Vocalisations	-	-	ns	-	D	D	ns	-	ns	ns	D
(2015)	Audio-visual	-	-	ns	-	ns	D	ns	-	ns	ns	
Schaffer, Wisniewski,	Faces	ns	D	ns	D	D	ns	D	-	ns	-	ns
Dahdah, and Froming	Prosody	-	-	NR	-	NR	NR	NR	-	-	NR	D
(2009)	Semantic sentences	NR	NR	-	-	-	-	-	-	-	-	ns
Wong, Cronin-Golomb,	Faces	-	-	ns	ns	D	D	D	-	I	-	D
and Neargarder (2005)	Sentences	-	-	D	ns	ns	ns	D	-	ns	-	ns
Ryan, Murray, and	Voices-Faces	-	-	D	ns	D	D	D	-	ns	-	D
Ruffman (2009)	Voices-Words	-	-	ns	ns	ns	D	D	-	ns	-	D
Mitchell (2007)	Prosodic sentences	-	-	NR	-	-	-	NR	-	-	NR	D

Authors	Stimuli	Valence		Emotions Measured								
		P	N	H	Su	F	A	S	C	Di	Ne	Total
Lima, Alves, Scott, and Castro (2014)	Vocalisations	-	-	Achievement Amusement Pleasure Relief all = D		D	D	ns	-	D	-	D
Orbelo, Testa, and Ross (2003)	Vocalisations	Disinterest NR		NR	NR		NR	NR	-	-	NR	D
Orbelo, Grim, Talbott, and Ross (2005)	Prosody	-	-	NR	NR	-	NR	NR	-	-	NR	D
Dupuis and Pichora-Fuller (2010)	Prosodic sentences	-	-	ns	-	-	-	ns	-	-	-	ns
	Semantic sentences			ns	-	-	-	ns	-	-	-	ns
	Incongruent			D	-	-	-	D	-	-	-	D
Kiss and Ennis (2001)	Prosodic sentences	-	-	NR	-	NR	NR	NR	-	-	NR	D
Raithel and Hielscher-Festabend (2004)	Prosodic sentences	Anxious NR		NR	-	-	NR	NR	-	-	NR	D
Keightley et al. (2006)	Words	ns	ns	-	-	-	-	-	-	-	NR	ns
	Faces	ns	ns	ns	ns	D	ns	D	ns	ns	ns	D
Isaacowitz et al. (2007) (initial analysis)	Faces	-	-	D	ns	ns	D	ns	-	ns	ns	D
	Read sentences	-	-	D	D	D	D	ns	-	D	D	D

Authors	Stimuli	Valence		Emotions Measured								
		P	**N**	**H**	**Su**	**F**	**A**	**S**	**C**	**Di**	**Ne**	**Total**
Phillips, MacLean, and	Faces	-	-	ns	ns	ns	D	D	-	ns	-	ns
Allen (2002)	Stories	-	-	non	basic	emotion	-	-	-	-	-	ns
Grunwald et al. (1999)	Words	-	-	NR	NR	NR	NR	NR	-	NR	-	D

Key:

Emotions: H = Happy, Su = Surprise, F = Fear, A = Anger, S = Sad, C = Contempt, Di = Disgust, Ne = Neutral
Valence: P = Positive, N = Negative
Results: D = Older adult lower accuracy compared to younger adults
I = Older adult higher accuracy compared to younger adults
ns = No significant age-related difference/decline in performance
\- = Emotion not measured
NR = Emotion was measured but not reported

Appendix 1.2

Table 1.2. Age and Gender Composition of Older and Younger Adult Samples used in Emotion Recognition Research using Faces as Stimuli

Author	YAs	MAs	OAs	Other	Sex			
					YAs		OAs	
					Male	Female	Male	Female
Calder et al. (2003) Experiment 1 static faces	18-30 years (*M* = 25.00; *SD* = 3.84)	NA	58-70 years (*M* = 65.08; *SD* = 3.84)		12	12	12	12
Experiment 2a static faces	17-30 years (*M* = 24.30; *SD* = 3.20)	31-60 years (3 different age groups)	61-70 years (*M* = 65.22; *SD* = 2.99)		37	36	26	32
Experiment 2b dynamic faces	18-30 years (*M* = 23.93; *SD* = 2.85)	31-60 years (3 different age groups)	61-75 years (*M* = 66.48; *SD* = 4.51)		14	14	11	12
Chaby et al. (2015)	20-35 years (*M* = 25.80; *SD* = 6.40)	NA	60-76 years (*M* = 67.20; *SD* = 5.80)		15	16	14	17
Circelli et al. (2013)	18-21 years (*M* = 19.20; *SD* = 1.00)	NA	62-79 years (*M* = 68.90; *SD* = 6.00)		5	11	7	9
Demenescu et	18-35 years	36-55 years	56-75 years		8	13	8	7

al. (2014)	(*M* = 25.76; *SD* = 5.18)	(*M* = 45.76; *SD* = 5.82)	(*M* = 63.80; *SD* = 6.63)					

Author	YAs	MAs	OAs	Other	Sex			
					YAs		OAs	
					Male	Female	Male	Female
Di Domenico et al. (2015)	*M* = 23.63; *SD* = 3.90	NA	*M* = 70.25; *SD* = 7.20		20	20	19	21
Grainger et al. (2015) Experiment 1	19-38 years (*M* = 26.00; *SD* = 5.91)	40-64 years (*M* = 54.40; *SD* = 7.98)	66-86 years (*M* = 74.00; *SD* = 5.58)		15	27	17	22
Experiment 2 Dynamic faces	NR	NA	NR		12	28	19	25
Horning et al. (2012)	M = 23.31; SD =5.61	M = 52.32; SD =7.35	M = 74.48 SD = 5.71		81	207	29	113
Hunter et al. (2010) Experiment 1	18-40 years (*M* = 22.64; *SD* = 5.86)	NA	60-79 years (*M* = 66.96; *SD* = 6.10)		9	16	15	10
Experiment 2 Cross-modal	18-23 years (*M* = 20.00; *SD* = 1.48)	NA	63-78 years (*M* = 70.55; *SD* = 4.12)		8	12	10	10
Isaacowitz et al. (2007)	18-39 years (*M* = 27.05;	40-59 years (*M* = 48.01;	60-85 years (*M* = 71.90;		93	96	29	49

	SD = 6.38)	*SD* = 5.30)	*SD* = 7.13)

Appendix 2.1

Table 2.1

The Methods used in Emotion Recognition Tasks in Studies Investigating Emotion Recognition Ability in Older Adults from Facial Expressions.

Study	Dataset	Number of responses	Number of trials	Response time	Number of emotion deficits for OAs
Calder et al. (2003)	Ekman & Friesen (1976)	6	10	Self-paced	2/5 fear and sad
Chaby, Boullay, Chetouani, & Plaza (2015)	Karolinska Directed Emotion Faces (Lundqvestet al., 1998)	6	10	Displayed/repeated until response Self-paced	3/6 (anger, sadness, disgust)
Circelli, Clark, & Cronin-Golomb, (2013)	Ekman & Friesen (1976)	7	10	Self-paced	1/7 (fear)(disgust better in OAs than YAs)
Demenescu, Mathiak, & Mathiak (2014)	Emotion Recognition and Identification Test (Gur, 2002)	6	6	Self-paced	General decline
Di Domenico, Palumbo, Mammarella, & Fairfield (2015)	Karolinska Directed Emotion Faces (Lundqvestet al., 1998)	2	100 morphed trials	400ms morph Self-paced	0/2
Grainger et al. (2015b)	ADFES (van der Schalk et al., 2011)	10	40 for each presentatio	Self-paced	General decline with no age-related differences for specific

			n format		emotions
Study	**Dataset**	**Number of responses**	**Number of trials**	**Response time**	**Number of emotion deficits for OAs**
Horning, Cornwell, & Davis (2012)	Based on Ekman & Friesen (1976)	6	6	1000ms morph	3/5 happy, fear and sad (disgust increased in OAs)
Isaacowitz et al. (2007) (initial analysis)	Pictures of Affect (PAT; Rau, 1993). Faces taken from Ekman & Friesen (1976)	7	5	Self-paced	2/7 (happy and anger)
Keightley et al. (2006)	JACFEE & JACNeuf (Matsumato & Ekman, 1988)	8	6	Self-paced	2/8 (fear and sad)
Kessels et al. (2014)	Emotion Recognition Task (Montagne et al., 2007)	6	24 trials for each intensity	1-3s morphed trials Self-paced	4/6 (happy, sad, fear and anger)
Krendl & Ambady (2010)	DANVA 2 (Nowicki & Duke, 1994)	4	6	2s display	4/4
Krendl, Rule & Ambady (2014)	DANVA 2 (Nowicki & Duke, 1994)	4	6	2s display	2/4 (fear and anger)
Lambrecht, Kriefelts, & Wildgruber (2012)	Actors	5	5	10s response time	General decline
MacPherson, Phillips, & Della Sala (2002)	JACFEE	7	7	Displayed until response Self-paced	1/7 (sad)
Mill et al. (2009)	JACFEE & JACNeuf	8	4	10 seconds	6/8 (happy, surprise, fear,

Study	Dataset	Number of responses	Number of trials	Response time	Number of emotion deficits for OAs
	(Matsumato & Ekman, 1988)				anger, sad, and disgust)
Orgeta & Phillips (2008)	FEEST (based on Ekman & Friesen, 1976)	6	6	Self-paced	3/6 (fear,anger and sad)
Phillips, MacLean, & Allen (2002)	Ekman & Friesen (1976)	6	4	Not specified	2/6 (anger and sad)
Sasson et al. (2010)	Penn Emotion Recogntion Task (ER-40) (Gur & Kohler)	5	8	Self-paced	
Schaffer, Wisniewski, Dahdah, & Froming (2009)	Comprehensive Affect Testing System (CATS; Schaffer, Gregory, Froming, Levy, & Ekman, 2006) based on images in Ekman & Friesen (1976)	6	6	Not specified	2/6
Sullivan & Ruffman (2004)	Ekman & Friesen (1976) JJ	4	2 (final emotion)	1200ms Morph sequence	2/4 (anger and sad)
Stanley & Isaacowitz (2015)	Ekman & Friesen (1976)	7	6	Self-paced	2/7 (anger and sad)
Suzuki, Hoshino, Shigemasu, & Kawamura (2007)	JACFEE (Matsumoto & Ekman, 1988)	6	8	Not specified	1/6 (sad)
Sze, Goodkind, Gyurak, & Levenson (2012)	NJIT (Ekman)	8 (including 3 fillers: embarrassment, neutral, pride)	5	Self-paced	2/5 (sad and disgust)
West et al. (2012)	Animated Full Facial Expression Comprehension Test (AFFECT). Based on Ekman & Friesen (1976)	6	100 morphed trials	1000ms morph sequence, 500ms static final image then response required	3/6 (fear, anger and sad) disgust increased in OAs

Study	Dataset	Number of responses	Number of trials	Response time	Number of emotion deficits for OAs
Williams et al. (2009)	Emotion Recognition and Identification Test (Gur, 2002) on WEbNeuro (Silverstein et al., 2007)	6	8	2s presentation valid response< 10s	3/6 (anger, fear and sad) Disgust declined over 80 years of age
Wong, Cronin-Golomb, Neargarder (2005)	Ekman & Friesen (1976)	3 (measured 6 emotions)	10	Displayed until response Self-paced	3/6

Table 2.2

The Methods used in Emotion Recognition Tasks in Studies Investigating Emotion Recognition Ability in Older Adults from Auditory Expressions.

Study	Dataset/Stimuli type	Number of response options	Number of trials	Response time	Number of emotion deficits for OAs
Chaby, Boullay, Chetouani, & Plaza (2015)	MAV	6	10 trials each emotion	Presented or repeated stimulus until response entered Self-paced	2 (fear, anger)
Demenescu, Mathiak, & Mathiak (2014)	Prosodic pseudo words	6	108 trials	Stimuli 700ms Self-paced-NR	NR across emotions, just a general decline
Dupuis & Pichora-Fuller (2010a)	20 sentences with emotion meaning and spoken with prosodic tone (Morton & Trehub, 2001)	2	10 each congruent 10 each incongruent	Self-paced	None on congruent task OAs worse than YAs across 2 emotions incongruent task
Fecteau, Armony, Joanette, & Belin (2005)	Collection from an array of auditory files. Short non-linguistic vocalisations	3	563 trials	Self-paced-NR	Not across discrete emotions
Hunter,	MAV	6	8 per emotion	Presentation time	4 (anger, fear, sadness, disgust)

Phillips, & MacPherson (2010a) Hunter, Phillips, & MacPherson (2010b)	MAV	4	10 per emotion	no longer than 450ms. Self-paced Presentation time no longer than 450ms. Self-paced	NR across emotions, just a general decline

Study	Dataset/Stimuli type	Number of response options	Number of trials	Response time	Number of emotion deficits for OAs
Kiss & Ennis (2001)	EPT-R 3 sentences and nonsense phrases in prosodic tone	5	90	Self-paced	Performance across emotion types was not reported.
Lambrecht, Kriefelts, & Wildgruber (2012)	Prosodic words (8 different words; 4 neutral, 2 positive and 2 negative) (Kreifelts et al., 2007)	5	8 per emotion x 2 presentations = 80 trials	10 second response. Rating scale was shown after the stimulus	5 (alluring, happy, neutral, angry, disgusted)
Lima, Alves, Scott, & Castro (2014)	Brief vocal sounds	8 emotions but not a forced choice categorical response.	10 per emotion presented 8 times = 640 trials	Self-paced	OAs had lower ratings for the intended emotion for all emotions with the exception of sadness.
Mill, Allik, Realo, and Valk (2009)	Semantically neutral prosodic sentences (Realo et al., 2004)	4	64	Tested in groups Self-paced-NR	3 (happy, anger, sadness)
Mitchell (2007)	Sentences of neutral scenarios in sad/happy tone	3	60	Self-paced-NR	YAs better on all 3 tasks than OAs and this did not deteriorate with advancing older age.
Orbelo, Testa, & Ross (2003)	Prosodic word/sentences Prosodic monosyllabic Prosodic asyllabic	6	24 trials per task, 2 trials per each emotion	Self-paced-NR	Performance across emotion types was not reported

			(6) in each task and repeated.		

Study	Dataset/Stimuli type	Number of response options	Number of trials	Response time	Number of emotion deficits for OAs
Orbelo, Grim, Talbott & Ross (2005)	Prosodic word/sentences Prosodic monosyllabic Prosodic asyllabic	6	24 trials per task, 2 trials per each emotion (6) in each task and repeated.	Self-paced-NR	Performance across emotion types was not reported
Raithel & Hielscher-Festabend (2004)	Prosodic semantically neutral sentences	5	15 in prosodic subset with neutral sentences	Self-paced-NR	Performance across emotion types was not reported
Ryan, Murray, & Ruffman (2010)	Non-verbal expressions and prosodic semantically neutral sentence (Hobson et al., 1988)	6	24 trials (2 non-verbal vocalisations and 2 sentences per emotion)	Self-paced-NR	2 (sad, anger) voice to label 4 (sad, anger, fear, happiness) voice to faces
Schaffer, Wisniewski, Dahdah, & Froming (2009)	CATS- prosodic sentence	5	12	Self-paced-NR	Performance across emotion types was not reported
Sullivan & Ruffman (2004b)	Non-expressive sounds/Passage spoken in prosodic tone (Hobson et al., 1988)	6	24	Self-paced- NR	3 (sad, anger, fear)
Wong, Cronin-Golomb, & Neargarder (2005)	NYEB- prosodic semantically neutral sentences	6	3 per emotion = 18 trials	Sentence was heard twice	2 (sad, happy)

Appendix 2.2

Pilot Study

A pilot study was conducted for three reasons: to determine content validity, to assess the difference of task demands between the non-emotion and emotion task and to ensure the demographic questionnaire is worded clearly. First it is important that the task has validation that it is fit for purpose so content validity of the stimuli used in the emotion and non-emotion tasks was tested.

There are several types of validity and often the definitions become interchangeable or confused. Frequently internet-based definitions of construct validity refer to a processing of understanding whether a test measures what it is supposed to measure. However, Cronbach and Meehl (1955) state that construct validity is more than evidence that a test measures what we think it measures, as good construct validity can inform upon a theory that can be tested. Alternatively, a task can be submitted to a test of face validity and this entails individuals who use or conduct a task to give their opinion on whether they believe the task to measure what it is meant to measure (Anastasi, 1988). However, the aim of the current pilot study was to validate the stimuli in a more rigorous sense than face validity, as this only provides a superficial test of validity (Anastasi, 1988), but not to the extent of construct validity as the test does not directly test a theory in itself. Given the differences in the types of validity the most appropriate test of validity for the pilot study is content validity. Content validity refers to a test that represents a good measure of the target behaviour (Burns, 1996). In the current experiments content validity was measured as the participants' ability to accurately recognise the target emotion above that of chance.

Since there were six-emotion choices chance was 17% accuracy. However, for the current tasks 17% chance was deemed too low so content validity was set at 50% accuracy.

Secondly, the pilot was used to investigate whether the emotion and non-emotion tasks differed on task demands as measured by accuracy and RTs for accurate recognition. Similar performance across the two tasks would indicate that the tasks do not differ on task demands. Finally, the pilot study also ensured face validity of the demographic questionnaire, as participants were encouraged to comment of their belief that the questionnaire was clearly written and was easy to complete.

Method

Participants

The same participants completed all of the piloted non-emotion and emotion tasks. Fourteen volunteers responded to a text request for participants. Two were male and 12 females and were aged between 39 years and 71 years of age (Mean age 47.14 years; *SD* 10.41).

Materials used in the Pilot Study for Phase 1

A total of 28 E prime tasks were created consisting of six versions of the emotion recognition experiment using static faces as stimuli, and five versions each for both the emotion and non-emotion tasks using vocalisations and single word emotion as stimuli. The tasks in the pilot study and the experimental study were similar so full details of the tasks are presented in the main text. The main difference between the pilot tasks and the experimental tasks was that the pilot study was self-paced but the experimental study had a 4000 ms response limit.

Several versions for each experiment were necessary to avoid response bias of end effects. The different versions enabled the position of the emotion labels to be counterbalanced. Single versions were created for the two piloted non-emotion face tasks as it was considered that counterbalancing the order of age groups would be counter intuitive and may confuse the participants. All tasks had 36 trials except for one of the facial expression control tasks that required age classification. For this task the first nine participants completed 36 trials of this task, this was increased for the last five participants to 57 trials. The rationale for introducing more trials resulted from an initial analysis of the data from the first nine participants. It was apparent from the data that approximately a third of the face stimuli failed to reach target accuracy. Hence, new trails were added to assess task validity.

Participants also completed a demographic questionnaire designed by the researcher. This questionnaire comprised of 11 questions aimed to gain information on age, gender, health, ethnicity, education, employment and computer literacy (see Appendix 1).

General Procedure for the Pilot Study for Phase 1

The participants conducted the pilot study individually in a quiet environment at a time convenient to themselves. Participants gave informed consent and were reminded of their right to withdraw and that they could refuse to answer any question. Ten participants completed a demographic questionnaire during which participants were encouraged to comment on the wording and if they believed that the questions were worded to aid ease of understanding. As all of the initial ten participants stated that the questions were easy to understand the final four participants were not required to complete the questionnaire.

After completing the demographic questionnaire the participants completed seven tasks run on E prime software (Psychology Software Tools, Pittsburgh, PA). The tasks measured emotion recognition of happy, sad, fear, anger and disgust as well as neutral states from facial expressions, single words and non-verbal sounds. The emotion tasks for each stimuli type were procedurally and visually similar, as far as possible, to the non-emotion tasks. Whilst one non-emotion task was piloted for the sound and word tasks, two non-emotion tasks were piloted for the face experiment. One non-emotion face task required participants to judge the age group and sex of the model (i.e., young-male; older-female), and another non-emotion face task required participants to judge the age group of the model (i.e., 20-30 years). The non-emotion word task required participants to classify words as being related to parts of the body (hand, hair, body, teeth, eyes and non-body) and the non-emotion sound task required participants to judge which animal had made the sound (cat, dog, insect, bird, horse or non-animal). Tasks were counterbalanced between stimuli types and the emotion task was presented first followed by non-emotion task. Participants were debriefed and the sessions lasted approximately 40 minutes.

Results

Content Validity of the Emotion and Non-emotion Tasks using Faces as Stimuli

Emotion recognition accuracy using static faces as stimuli was 88%. Most of the experimental trials met the validity criteria of 50% accuracy but one trial was just below 50% accuracy and this was for a neutral face that was mainly incorrectly categorised as sad. Accuracy on the age and gender task from facial information was 92.66%. Furthermore all of the 36 trials met the 50% validity target and 100 % accuracy was achieved on 17 trials. Accuracy on the age group task was 62.5%. For this task 14 trials had accuracy rates below the validity criteria 50% and three trials had 100% accuracy.

Table 1.

Descriptive Statistics for RTs and Accuracy for Emotion Recognition across Emotion Types

Emotion	RTs (ms)		Accuracy (max. score= 6)	
	Mean	SD	Mean	SD
Happy	1826	738	5.69	0.63
Sad	3011	1388	4.62	1.45
Fear	4200	3283	5.15	0.90
Anger	3372	1890	4.54	0.97
Disgust	2960	823	5.08	0.76
Neutral	3500	2332	4.77	1.17

Table 2.

Descriptive Statistics for RTs (ms) and Accuracy for Classifying Models shown in the Face Stimuli by Age Group and Gender

Age-Gender Category	RTs		Accuracy (max. score= 6)	
	Mean	SD	Mean	SD
Male Young	2232	1352	4.93	0.83
Female Young	2532	1197	5.50	0.65
Male Middle-aged	3743	1698	5.29	0.73
Female Middle-aged	3586	1912	4.57	1.34
Male Older	3026	1706	5.50	0.65
Female Older	2892	1460	5.36	1.08

Table 3.

Descriptive Statistics for RTs (ms) and Accuracy for Classifying Models shown in the Face Stimuli by Age Group

Age Group(years)	RTs		Accuracy (max. score= 6)	
	Mean	SD	Mean	SD
20-25	2697	1690	6.00	2.66
30-35	3740	2211	3.71	0.83
40-45	3579	1674	3.29	1.59
50-55	3808	1634	4.79	1.81
60-65	4069	2158	4.36	1.69
75-80	3482	1887	3.71	1.73

Similarity of Performance Across the Emotion and Non-emotion (Age Categorisation) Tasks using Faces as Stimuli

The purpose of the non-emotion task was to explore whether the emotion and non-emotion tasks were similar in task demands. To achieve this the non-emotion task was designed to have similar task demands to the emotion task (this is detailed elsewhere in the thesis) but without the demands of emotion processing. Paired t-tests were conducted to understand whether the emotion task and the non-emotion (age categorisation) task differed on accuracy and RTs for accuracy. There was no significant difference in RTs between emotion (M = 3038; SD =1501) and age categorisation (M = 3416; SD = 1877), $t(12)$= 1.18, p = 0.262, but there was significant difference in accuracy between the two tasks, $t(12)$=2.80, p = 0.016, with higher accuracy for the emotion recognition task (M 29.85; SD = 0.53) than the non-emotion age categorisation task (M = 25.23; SD =1.5). The results suggest a good match between the emotion and age control task for RTs but not for accuracy, as the emotion task appears to be easier. Conversely, there was no significant difference in RTs between the emotion (M = 3038; SD =1501) and age and gender categorisation task (M = 3032; SD = 1432), $t(12)$= 0.012, p = 0.990, nor was there a significant difference in accuracy between the two tasks, $t(12)$= 1.36, p = 0.198, (age/gender categorisation task [M = 30.85; SD =1.68]). The results suggest that the emotion and age/gender non-emotion task were matched for both RTs and accuracy.

Regarding the non-emotion tasks the age categorisation task failed to meet the requirements set for content validity valid as many of the trials fell below 50% accuracy. Thus it is suggested that this task does not provide a valid measure of categorisation of age groups for the non-emotion faces. Furthermore, the age group classification task had lower accuracy than the emotion task in the pilot study suggesting that the task demands for the age group classification task were greater than the task demands of the emotion task. However, the non-emotion age and gender categorisation task does have good content validity and has similar accuracy scores to the emotion task. Given these findings the age gender categorisation task will be used in the experimental phase of the research.

Emotion recognition accuracy from non-verbal vocalisations.

Table 6.

Means and Standard Deviations for RTs (ms) and Accuracy Scores for Classifying Non-verbal Vocalisations by Emotion Type (two d.p.)

Emotion	RT		Accuracy	
	Mean	SD	Mean	SD
Happy	1849	136	5.45	0.21
Sad	2218	125	5.73	0.14
Fear	2172	142	5.18	0.23
Anger	1812	223	2.36	0.36
Disgust	1873	119	5.27	0.24
Neutral	2087	290	4.45	0.43

Non-emotion sound task.

Table 7.

Mean and Standard deviations for RTs (ms) and Accuracy for Classifying Non-emotion Sounds (two d.p.)

Emotion	RT		Accuracy	
	Mean	SD	Mean	SD
Horse	1949	82	5.23	0.26
Insect	2167	168	3.92	0.33
Dog	1678	109	5.92	0.08
Cat	1708	116	4.77	0.12
Bird	2292	133	3.85	0.39
Non-animal	2509	157	5.38	0.24

To investigate whether the two sound tasks were in processing paired t-tests were run on RTs and accuracy. There was no significant difference in both RTs between emotion (M = 2105; SD = 131) and non-emotion sounds (M = 2023; SD = 109), $t(12) = 0.89$, $p = .393$, and accuracy (emotion sounds M = 28.31; SD = 2.75; and control animal sounds M = 29.08; SD =1.80) , $t(12) = 0.99$, $p = .342$. The results indicate that the sound tasks appear to be similar in task demands.

Content validity on the sound tasks.

Accuracy for emotion recognition from sounds was 83%. Regarding individual trials, six of the 36 trials failed to meet the validity criteria of 50%. Of these six trials, five were for anger and one for disgust. The failure to recognise the target emotion was not due to the sound being more accurately identified as another emotion as the responses were inconsistent with some identifying angry non-verbal vocalisations as happy, neutral, fear or disgust. However, anger overall was more likely to be mistaken as fear accounting for 25 of the 46 incorrect responses.

Accuracy for on the non-emotion sound task was 85.1%. Two of the 36 trials failed to meet the validity criteria of 50% accuracy. These trials were supposed to depict an insect and a cat. The insect was consistently classified as a bird whilst the cat was either labelled as non-animal or bird. These trials were substituted with trials from the practice task that did demonstrate good content validity.

Emotion recognition on the word task.

Table 4.

Mean and Standard Deviations for RTs (ms) and Accuracy Scores for Classifying Words by Emotion Type (two d.p.)

Emotion	RT		Accuracy	
	Mean	SD	Mean	SD
Happy	1674	525	5.92	0.28
Sad	1806	345	5.46	0.66
Fear	2366	611	5.46	0.78
Anger	2169	759	5.54	0.66
Disgust	2693	1369	3.92	1.19
Neutral	3733	1725	3.85	1.52

Non-emotion word task

Table 5.

Means and Standard Deviations for RTs (ms) and Accuracy for Classifying Non-Emotion Words (two d.p.)

Emotion	RT		Accuracy	
	Mean	SD	Mean	SD
Hand	1862	400	5.23	0.20
Eyes	1652	361	5.77	0.12
Hair	1788	400	5.77	0.17
Body	1928	394	5.31	0.26
Teeth	1818	394	6.00	0.00
None	2224	640	5.08	0.18

To determine whether the emotion and non-emotion tasks were similar in task demands paired t-tests were run on RTs and accuracy. There was significant difference in both RTs between the emotion (*M* = 2352; *SD* = 706) and non-emotion tasks (*M* = 1865; *SD* = 360.9), $t(12) = 2.53$, $p = 0.026$, and accuracy $t(12) = 3.57$, $p = 0.004$ (emotion words *M* = 30.15; *SD* = 2.40; and control non-emotion words *M* = 33.15; *SD* = 1.4). The results indicate that the non-emotion task may be easier than the emotion task; hence, the word tasks do not appear to be well matched on task demands.

Content Validity on Word Tasks

Accuracy on the non-emotion word tasks was 97.7%. None of the trials had accuracy rates below 50%, indeed 27 trials received 100% accuracy scores. For the emotion word task accuracy was 90%. Regarding individual trials, two of the trials 36 trials had accuracy rates below the validity criteria of 50%. The target emotions for these words were for disgust (offend and sick), and neutral (sceptical) categories. Consequently, these words were replaced with words from the practice task that demonstrated good content validity.

Discussion

The pilot study demonstrated that most of the trials across the tasks appear to have good content validity. Furthermore, the findings suggest that for the tasks based on faces the emotion and gender and age tasks are similar in task demands. Likewise, the emotion and non-emotion sound tasks have similar task demands. Thus the emotion and non-emotion tasks in the face and sound experiments do not appear to differ in task difficulty.

The FACES dataset has evidence of validity and the pilot supports this (Ebner et al., 2010) with the exception of one neutral face, which was only marginally below the 50% target. Therefore, the emotion face task was considered to have good content validity. However, the age categorisation task did not demonstrate good content validity with many of the trials failing to reach 50% accuracy. Thus it is suggested that this task not provide a valid measure of non-emotion categorisation from faces; thus, is not a suitable non-emotion task. Conversely, there is evidence that the age and gender categorisation task has good content validity and seems to have similar task demands to the emotion task. In light of these findings the age gender categorisation task will be used in the experimental phase of the research.

However, a few trials in some of the experiments failed to demonstrate good content validity, as accuracy was lower than 50%. Within the emotion sound task three of the six experimental trials that were supposed to depict the emotion of anger failed to meet the 50% accuracy criteria. However, the pilot study was based on a small sample size and the dataset has evidence of validity, demonstrating accuracy for anger to be 78% (*N* = 30, mean age 23.3) (Belin et al., 2008). Furthermore, the database has been used in several other studies (Collignon et al., 2008; Peelin, Atkinson, & Vuilleumier, 2010; Hunter, Phillips & MacPherson, 2010; Nanjo et al., 2011). Therefore, it was decided that the trials with low accuracy ratings should be maintained in the task. In contrast, accuracy for the non-emotion sound task demonstrated good content validity with the exception of two e trials. To increase content validity these trials were substituted for the main experiment.
Finally, the emotion and non-emotion sound tasks had similar task demands.

For the emotion word task content validity was good with the exception of three words. These words were substituted with words taken from the practice trial. This substitution did not alter the matched word length and word frequency within the categories of the emotion word task nor between the emotion and non-emotion task. Furthermore, the findings from the pilot suggest that the non-emotion word task has good content validity. However, this task may seem easier than the emotion task and this needs to be considered when interpreting the results of the main experiment.

To conclude the tasks with a few amendments are considered by the researcher to have good content validity and most of the emotion and non-emotion tasks within an experiment have similar task demands. Thus the results of the main study can be interpreted with confidence.

Appendix 2.3

Correlation Analysis for Emotion Recognition Ability and Cognitive, Socio-emotional, Mood, and Personality Measures in Younger Adults

Correlations[a]

		tas20	panaspositive	panasnegative	STAIstateanxiety	STAItraitanxiety	Empathyquotient	crystallisediq	fluidiq	mmse	sofprocessing	neoneurotic	neoextrovert	neoopeness	neoagreeableness	neoconscientious	totalemotionfacecorrect	totalemotionsoundcorrect	totalemotionwordcorrect
tas20	Pearson Correlation	1	-.271	.287	.265	.346*	-.591**	-.323	.165	-.364*	-.059	.329	-.213	-.282	-.155	-.250	.065	-.346*	.083
	Sig. (2-tailed)		.116	.094	.124	.042	.000	.059	.345	.032	.736	.053	.218	.101	.375	.147	.713	.042	.634
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
panaspositive	Pearson Correlation	-.271	1	-.140	-.336*	.142	.070	-.089	-.073	.190	-.193	.044	.342*	.324	-.023	.263	-.332	-.062	-.008
	Sig. (2-tailed)	.116		.422	.049	.415	.691	.611	.678	.274	.266	.801	.045	.057	.896	.127	.052	.723	.966
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
panasnegative	Pearson Correlation	.287	-.140	1	.223	.294	-.102	.119	.220	-.249	.113	.118	.138	-.023	-.234	-.247	.082	.011	.327
	Sig. (2-tailed)	.094	.422		.199	.087	.561	.497	.205	.149	.517	.498	.431	.894	.177	.153	.638	.949	.056
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
STAIstateanxiety	Pearson Correlation	.265	-.336*	.223	1	.345*	.089	-.232	-.230	-.396*	.131	.281	.120	.003	.225	-.233	.285	.113	.064
	Sig. (2-tailed)	.124	.049	.199		.043	.610	.179	.184	.018	.453	.102	.492	.988	.194	.178	.097	.517	.715
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
STAItraitanxiety	Pearson Correlation	.346*	.142	.294	.345*	1	-.135	-.199	.070	-.217	-.068	.728**	-.002	-.019	-.094	-.094	-.107	-.101	.026
	Sig. (2-tailed)	.042	.415	.087	.043		.438	.251	.691	.211	.697	.000	.990	.915	.591	.592	.540	.565	.880
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
Empathyquotient	Pearson Correlation	-.591**	.070	-.102	.089	-.135	1	-.006	-.214	.085	-.066	.075	.242	.545**	.496**	.253	.066	.025	-.017
	Sig. (2-tailed)	.000	.691	.561	.610	.438		.974	.216	.627	.707	.670	.162	.001	.002	.143	.705	.888	.921
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
crystallisediq	Pearson Correlation	-.323	-.089	.119	-.232	-.199	-.006	1	.258	-.115	.256	-.268	-.243	.304	-.357*	-.227	.303	.548**	.201
	Sig. (2-tailed)	.059	.611	.497	.179	.251	.974		.134	.512	.137	.119	.159	.075	.035	.190	.077	.001	.247
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
fluidiq	Pearson Correlation	.165	-.073	.220	-.230	.070	-.214	.258	1	.246	.469**	-.115	-.217	.060	-.270	-.007	.084	-.069	-.018
	Sig. (2-tailed)	.345	.678	.205	.184	.691	.216	.134		.155	.004	.510	.209	.732	.117	.967	.630	.692	.920
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
mmse	Pearson Correlation	-.364*	.190	-.249	-.396*	-.217	.085	-.115	.246	1	-.036	-.083	.160	-.236	.191	.167	-.098	-.116	-.004
	Sig. (2-tailed)	.032	.274	.149	.018	.211	.627	.512	.155		.838	.637	.358	.173	.272	.336	.576	.508	.981
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
sofprocessing	Pearson Correlation	-.059	-.193	.113	.131	-.068	-.066	.256	.469**	-.036	1	-.254	-.129	.021	-.097	-.167	.269	.260	-.094
	Sig. (2-tailed)	.736	.266	.517	.453	.697	.707	.137	.004	.838		.141	.459	.903	.580	.339	.118	.131	.590
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
neoneurotic	Pearson Correlation	.329	.044	.118	.281	.728**	.075	-.268	-.115	-.083	-.254	1	-.033	.038	.081	.001	-.050	-.083	-.021
	Sig. (2-tailed)	.053	.801	.498	.102	.000	.670	.119	.510	.637	.141		.850	.830	.644	.993	.774	.636	.906
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
neoextrovert	Pearson Correlation	-.213	.342*	.138	.120	-.002	.242	-.243	-.217	.160	-.129	-.033	1	.070	.127	.291	-.012	-.008	.239
	Sig. (2-tailed)	.218	.045	.431	.492	.990	.162	.159	.209	.358	.459	.850		.691	.467	.090	.944	.964	.167
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
neoopeness	Pearson Correlation	-.282	.324	-.023	.003	-.019	.545**	.304	.060	-.236	.021	.038	.070	1	.042	.037	.207	.146	.023
	Sig. (2-tailed)	.101	.057	.894	.988	.915	.001	.075	.732	.173	.903	.830	.691		.812	.831	.233	.403	.897
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
neoagreeableness	Pearson Correlation	-.155	-.023	-.234	.225	-.094	.496**	-.357*	-.270	.191	-.097	.081	.127	.042	1	.237	.042	-.089	.035
	Sig. (2-tailed)	.375	.896	.177	.194	.591	.002	.035	.117	.272	.580	.644	.467	.812		.170	.810	.611	.843
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
neoconscientious	Pearson Correlation	-.250	.263	-.247	-.233	-.094	.253	-.227	-.007	.167	-.167	.001	.291	.037	.237	1	-.555**	-.206	-.373*
	Sig. (2-tailed)	.147	.127	.153	.178	.592	.143	.190	.967	.336	.339	.993	.090	.831	.170		.001	.235	.027
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
totalemotionfacecorrect	Pearson Correlation	.065	-.332	.082	.285	-.107	.066	.303	.084	-.098	.269	-.050	-.012	.207	.042	-.555**	1	.392*	.485**
	Sig. (2-tailed)	.713	.052	.638	.097	.540	.705	.077	.630	.576	.118	.774	.944	.233	.810	.001		.020	.003
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
totalemotionsoundcorrect	Pearson Correlation	-.346*	-.062	.011	.113	-.101	.025	.548**	-.069	-.116	.260	-.083	-.008	.146	-.089	-.206	.392*	1	.264
	Sig. (2-tailed)	.042	.723	.949	.517	.565	.888	.001	.692	.508	.131	.636	.964	.403	.611	.235	.020		.126
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
totalemotionwordcorrect	Pearson Correlation	.083	-.008	.327	.064	.026	-.017	.201	-.018	-.004	-.094	-.021	.239	.023	.035	-.373*	.485**	.264	1
	Sig. (2-tailed)	.634	.966	.056	.715	.880	.921	.247	.920	.981	.590	.906	.167	.897	.843	.027	.003	.126	
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

a. agegroup = older

Correlation Analysis for Emotion Recognition Ability and Cognitive, Socio-emotional, Mood, and Personality Measures in Older Adults

Correlations[a]

		tas20	panaspositive	panasnegative	STAIstateanxiety	STAItraitanxiety	Empathyquotient	crystallisediq	fluidiq	mmse	sofprocessing	neoneurotic	neoextrovert	neoopeness	neoagreeableness	neoconscientious	totalemotionfacecorrect	totalemotionsoundcorrect	totalemotionwordcorrect
tas20	Pearson Correlation	1	-.409*	.303	.415*	.418*	-.618**	.063	-.213	-.034	.170	.464**	-.407*	-.106	-.366*	-.385*	.154	.200	.081
	Sig. (2-tailed)		.013	.073	.012	.011	.000	.715	.212	.843	.322	.004	.014	.540	.028	.020	.370	.242	.638
	N	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
panaspositive	Pearson Correlation	-.409*	1	-.367*	-.400*	-.609**	.250	.190	.194	-.021	.013	-.644**	.472**	.074	.297	.463**	.143	.047	-.070
	Sig. (2-tailed)	.013		.028	.016	.000	.142	.268	.256	.902	.938	.000	.004	.668	.079	.004	.406	.786	.687
	N	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
panasnegative	Pearson Correlation	.303	-.367*	1	.569**	.617**	-.124	.324	-.227	-.182	-.058	.572**	-.371*	.254	-.520**	-.432**	-.241	-.059	.047
	Sig. (2-tailed)	.073	.028		.000	.000	.472	.054	.184	.288	.738	.000	.026	.135	.001	.009	.156	.731	.783
	N	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
STAIstateanxiety	Pearson Correlation	.415*	-.400*	.569**	1	.659**	-.340*	.127	-.060	-.067	.033	.519**	-.402*	.242	-.318	-.128	-.131	.227	.047
	Sig. (2-tailed)	.012	.016	.000		.000	.042	.461	.729	.696	.848	.001	.015	.156	.058	.458	.446	.182	.786
	N	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
STAItraitanxiety	Pearson Correlation	.418*	-.609**	.617**	.659**	1	-.252	.120	-.208	-.067	-.098	.824**	-.483**	.101	-.483**	-.469**	-.191	.043	.071
	Sig. (2-tailed)	.011	.000	.000	.000		.138	.486	.224	.699	.568	.000	.003	.558	.003	.004	.265	.805	.680
	N	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
Empathyquotient	Pearson Correlation	-.618**	.250	-.124	-.340*	-.252	1	.176	.219	-.023	-.211	-.141	.489**	.164	.243	.119	-.189	-.223	-.216
	Sig. (2-tailed)	.000	.142	.472	.042	.138		.304	.200	.895	.217	.413	.003	.339	.154	.489	.271	.192	.205
	N	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
crystallisediq	Pearson Correlation	.063	.190	.324	.127	.120	.176	1	.300	.143	.211	.108	-.203	.470**	.026	-.021	.092	.021	.220
	Sig. (2-tailed)	.715	.268	.054	.461	.486	.304		.076	.404	.218	.532	.236	.004	.879	.902	.595	.903	.198
	N	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
fluidiq	Pearson Correlation	-.213	.194	-.227	-.060	-.208	.219	.300	1	.187	.360*	-.132	.022	.239	.276	.161	-.004	-.013	.107
	Sig. (2-tailed)	.212	.256	.184	.729	.224	.200	.076		.276	.031	.441	.899	.160	.103	.348	.979	.940	.533
	N	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
mmse	Pearson Correlation	-.034	-.021	-.182	-.067	-.067	-.023	.143	.187	1	-.254	-.012	-.243	-.129	.079	.137	.250	.142	.248
	Sig. (2-tailed)	.843	.902	.288	.696	.699	.895	.404	.276		.135	.943	.153	.454	.648	.424	.142	.410	.144
	N	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
sofprocessing	Pearson Correlation	.170	.013	-.058	.033	-.098	-.211	.211	.360*	-.254	1	-.096	-.049	.033	.099	.061	.137	-.070	-.073
	Sig. (2-tailed)	.322	.938	.738	.848	.568	.217	.218	.031	.135		.576	.777	.851	.564	.725	.426	.686	.674
	N	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
neoneurotic	Pearson Correlation	.464**	-.644**	.572**	.519**	.824**	-.141	.108	-.132	-.012	-.096	1	-.345*	.133	-.378*	-.569**	-.226	-.196	-.041
	Sig. (2-tailed)	.004	.000	.000	.001	.000	.413	.532	.441	.943	.576		.040	.440	.023	.000	.186	.252	.812
	N	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
neoextrovert	Pearson Correlation	-.407*	.472**	-.371*	-.402*	-.483**	.489**	-.203	.022	-.243	-.049	-.345*	1	-.043	.192	.024	-.206	.003	-.281
	Sig. (2-tailed)	.014	.004	.026	.015	.003	.003	.236	.899	.153	.777	.040		.804	.261	.888	.227	.985	.097
	N	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
neoopeness	Pearson Correlation	-.106	.074	.254	.242	.101	.164	.470**	.239	-.129	.033	.133	-.043	1	-.119	.048	-.209	-.128	.176
	Sig. (2-tailed)	.540	.668	.135	.156	.558	.339	.004	.160	.454	.851	.440	.804		.489	.781	.221	.459	.303
	N	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
neoagreeableness	Pearson Correlation	-.366*	.297	-.520**	-.318	-.483**	.243	.026	.276	.079	.099	-.378*	.192	-.119	1	.423*	.147	.115	.125
	Sig. (2-tailed)	.028	.079	.001	.058	.003	.154	.879	.103	.648	.564	.023	.261	.489		.010	.394	.503	.467
	N	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
neoconscientious	Pearson Correlation	-.385*	.463**	-.432**	-.128	-.469**	.119	-.021	.161	.137	.061	-.569**	.024	.048	.423*	1	.236	.215	.065
	Sig. (2-tailed)	.020	.004	.009	.458	.004	.489	.902	.348	.424	.725	.000	.888	.781	.010		.165	.209	.706
	N	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
totalemotionfacecorrect	Pearson Correlation	.154	.143	-.241	-.131	-.191	-.189	.092	-.004	.250	.137	-.226	-.206	-.209	.147	.236	1	.210	.204
	Sig. (2-tailed)	.370	.406	.156	.446	.265	.271	.595	.979	.142	.426	.186	.227	.221	.394	.165		.220	.232
	N	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
totalemotionsoundcorrect	Pearson Correlation	.200	.047	-.059	.227	.043	-.223	.021	-.013	.142	-.070	-.196	.003	-.128	.115	.215	.210	1	.397*
	Sig. (2-tailed)	.242	.786	.731	.182	.805	.192	.903	.940	.410	.686	.252	.985	.459	.503	.209	.220		.017
	N	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36
totalemotionwordcorrect	Pearson Correlation	.081	-.070	.047	.047	.071	-.216	.220	.107	.248	-.073	-.041	-.281	.176	.125	.065	.204	.397*	1
	Sig. (2-tailed)	.638	.687	.783	.786	.680	.205	.198	.533	.144	.674	.812	.097	.303	.467	.706	.232	.017	
	N	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

a. agegroup = young

Appendix 2.4

Demographic Questionnaire

Please place a tick next to the most appropriate response to the following questions or write an accurate answer (remember you do not need to provide information you feel uncomfortable disclosing):

1. What gender are you?

Male ☐ Female ☐

2. What is your age (please state in years)? ______________

3.1 Do you declare yourself to be in good health?

Yes ☐ No ☐

3.2 Do you live independently without reliance on carers?

Yes ☐ No ☐

4. From the list below please indicate your ethnicity.

White British ☐

Irish ☐

Any other white background ☐

Mixed

White and Black Caribbean ☐

White and Black African ☐

White and Asian ☐

Any other mixed background ☐

Asian or Asian British

Indian ☐

Bangladeshi ☐

Pakistani ☐

Any other Asian background ☐

Black or Black British

Caribbean ☐

African ☐

Any other Black background ☐

Any Other ethnic Groups

Chinese ☐

Any other ethnic group ☐

Prefer not to say ☐

5.1 Thinking about your education please tick your highest qualification achieved to date.

No qualifications ☐

O level/ CSE/ GCSE ☐

A level/ equivalent qualification ☐

Btech/ equivalent qualification ☐

Degree or equivalent qualification ☐

Masters / PGCE/equivalent ☐

PhD/ equivalent qualification ☐

Other (such as professional /vocational qualification) ☐ Please name ____________________

5.2 Please state below how many years you have spent in education. Please consider part time courses as if studied full time i.e. part time undergraduate degree of 6 years should be counted as a full time equivalent, 3 years. Also do not include gap years and periods of work between studying.

Number of years in education _______________

5.3 When was the last time you undertook an educational course whether it be for knowledge, work or pleasure?

Within last12 months ☐

1-2 years ago ☐

2-3 years ago ☐

3-4 years ago ☐

4-5 years ago ☐

Over 5 years ago ☐

6. Please state which of the following applies to you (You may tick more than one box).

Are you:

Student ☐	Retired ☐	Working full-time ☐	Working part-time ☐
Unemployed ☐	Homemaker ☐	Carer ☐	Other ☐

7. Please state which of the following best represents your main occupation, whether it is current or past.

- Professional occupations ☐
- Managerial and Technical occupation ☐
- Skilled occupations
  - non-manual ☐
  - manual ☐
- Partly-skilled occupations ☐
- Unskilled occupations ☐

7.1 Please specify what this occupation was/is ____

8. Please circle on the scale below how familiar you are with using a computer (1= not at all familiar - 5= extremely familiar):

1	2	3	4	5
not at all familiar	a little bit familiar	quite familiar	very familiar	extremely familiar

9.1 Do you consider your hearing to be normal or adjusted to normal using a hearing aid?

Yes ☐ No ☐

9.2 Do you consider your eyesight to be normal or adjusted to normal using glasses or contact lenses?

Yes ☐ No ☐

10. What types of pets, if any, do you have? ___________________________

Thank you for completing the questionnaire

Appendix 2.5

Descriptive and Inferential Statistics for the Characteristics of the Younger-older and Older-older Adults

	Younger -older	Older- older	Younger -older	Older- older			95% CI		
Measure	*M*		*SD*		*t* (34)	*p*	*LL*	*UL*	*d*
Alexithymia (100)	38.56	39.56	10.49	9.01	0.31	.761	-7.62	5.62	ns
Positive affect (50)	35.17	34.33	4.69	6.52	0.44	.663	-3.01	4.68	ns
Negative affect (50)	10.67	10.94	1.50	3.10	0.34	.734	-1.92	1.37	ns
State anxiety (80)	24.22	26.22	7.03	7.81	1.08	.289	-5.78	1.78	ns
Trait anxiety (80)	33.44	35.17	7.81	6.94	0.70	.489	-6.72	3.28	ns
Empathy (44)	24.50	25.78	7.68	6.04	0.56	.583	-5.95	3.40	ns
Verbal intelligence (44)	38.78	36.61	2.62	3.82	1.98	.056	-0.05	4.39	ns
Fluid intelligence (30)	21.11	16.67	2.93	4.91	3.30	**.002**	1.71	7.18	1.01
Cognitive processing (16)	15.44	14.72	0.70	1.23	2.17	**.039**	0.04	1.40	0.72
Speed of processing (35)	18.67	14.94	2.93	2.82	3.89	**<. 001**	1.77	5.67	1.30
Neuroticism (48)	13.72	16.83	7.27	8.45	1.18	.245	-8.45	2.23	ns
Extroversion (48)	27.94	28.39	5.99	4.73	0.25	.806	-4.10	3.21	ns
Openness (48)	30.83	29.50	6.53	7.30	0.58	.567	-3.35	6.03	ns
Agreeableness (48)	34.06	35.06	6.44	6.04	0.48	.634	-5.23	3.23	ns

Descriptive and Inferential Statistics for the Characteristics of the Older-older Adults and Younger Adults

Measure	Younger *M*	Older-older *M*	Younger *SD*	Older-older *SD*	*t* (52)	*p*	95% CI *LL*	95% CI *UL*	*d*
Alexithymia (100)	46.42	39.56	9.54	9.01	2.54	**.014**	1.43	12.29	0.74
Positive affect (50)	27.22	34.33	6.26	6.52	3.88	< **.001**	-10.79	-3.44	1.11
Negative affect (50)	12.56	10.94	3.60	3.10	1.62	.111	-0.38	3.60	ns
State anxiety (80)	33.31	26.22	7.13	7.81	3.46	**.001**	2.97	11.20	0.95
Trait anxiety (80)	43.89	35.17	10.77	6.94	3.59	**.001**	3.84	13.60	0.96
Empathy (44)	25.92	25.78	8.16	6.04	0.06	.949	-4.23	4.50	ns
Verbal intelligence (44)	26.81	36.61	3.98	3.82	8.64	< **.001**	-12.08	-7.53	2.51
Fluid intelligence (30)	18.53	16.67	2.60	4.91	1.83	.073	-0.18	3.90	ns
Cognitive processing (16)	15.03	14.72	0.91	1.23	1.03	.306	-0.29	0.90	ns
Speed of processing	21.75	14.94	4.18	2.82	6.23	< **.001**	4.61	9.00	1.91
Neuroticism (48)	25.33	16.83	8.48	8.45	3.48	**.001**	3.59	13.41	1.00
Extroversion (48)	28.50	28.39	6.78	4.73	0.06	.951	-3.47	3.69	ns
Openness (48)	27.17	29.50	5.41	7.30	1.33	.240	-5.86	-6.32	ns
Agreeableness (48)	30.06	35.06	6.36	6.04	2.77	**.008**	-8.63	-1.37	0.81
Conscientiousness (48)	28.08	38.61	8.21	5.51	4.90	< **.001**	-14.84	-6.22	1.51

Descriptive and Inferential Statistics for the Characteristics of the Younger-older Adults and Younger Adults

Measure	Younger	Younger-older	Younger	Younger-older			95% CI		
	M		*SD*		*t* (52)	*p*	*LL*	*UL*	*d*
Alexithymia (100)	46.42	38.56	9.54	10.49	2.76	**.008**	2.15	13.57	0.78
Positive affect (50)	27.22	35.17	6.26	4.69	4.75	**< .001**	-11.30	-4.59	1.44
Negative affect (50)	12.56	10.67	3.60	1.50	2.72	**.009**	0.11	3.67	0.69
State anxiety (80)	33.31	24.22	7.13	7.03	6.23	**< .001**	5.49	12.67	1.28
Trait anxiety (80)	43.89	33.44	10.77	7.81	3.66	**.001**	4.71	16.18	1.11
Empathy (44)	25.92	24.50	8.16	7.68	0.61	.543	-3.22	6.05	ns
Verbal intelligence (44)	26.81	38.78	3.98	2.62	11.53	**< .001**	-14.06	-9.89	ns
Fluid intelligence (30)	18.53	21.11	2.60	2.93	3.30	**.002**	-4.15	-1.01	0.93
Cognitive processing (16)	15.03	15.44	0.91	0.70	1.70	.095	-0.91	0.07	ns
Speed of processing	21.75	18.67	4.18	2.93	2.80	**.007**	0.87	5.29	0.85
Neuroticism (48)	25.33	13.72	8.48	7.27	4.96	**< .001**	6.91	16.31	1.47
Extroversion (48)	28.50	27.94	6.78	5.99	0.30	.769	-3.28	4.34	ns
Openness (48)	27.17	30.83	5.41	6.53	2.19	**.033**	-7.02	-0.31	0.61
Agreeableness (48)	30.06	34.06	6.36	6.44	2.17	**.035**	-7.70	-0.30	0.67
Conscientiousness (48)	28.08	35.28	8.21	6.43	3.25	**.002**	-11.64	-2.75	0.98

Appendix 2.6

Participant Information

Emotion Perception in Older Adults Across Three Modalities

Participant Information

I am a PhD research student at Sheffield Hallam University investigating the development of emotion perception in adulthood. We live in a social world where we continually receive information to process and respond to. A vital part of this processing system is our ability to recognise emotions from faces, voices and written words. This ability allows us to respond in an appropriate manner thus preserving our social competence. Evidence suggests that older adults perform differently to younger adults in their perception of emotion from facial expressions, sounds and written words. However, it is unclear if this is due to variations in general processing or emotion processing, moreover, the underlying contributing factors to these disparities in emotion perception are not well understood. My research aims to address these issues and increase our understanding of emotion perception development.

Who Can Take Part?

Any healthy adult can pilot the study

What will you have to do?

The researcher has designed her own experiments and needs to have these validated via piloting. This is an essential part of the research phase as the results help to validate and develop the materials used within it. Participants will be required to complete a demographic questionnaire and some computer- based tasks which require the participants to decide which of six given categories the presented stimuli belongs to. The stimuli will be presented on a computer screen in the form of facial pictures, written words and sounds.The session should last for approximately 20 minutes.

Ethics

The Faculty Research Ethics Committee, Sheffield Hallam University, has approved the research. All information is coded to protect anonymity of the data. Only the researcher and her supervisors will have access to the raw data. For security the collected data will be kept in a locked cupboard within the university In keeping with ethical regulations all participants have the right to withdraw their data up to two weeks post collection and have the right to refuse to answer any question, and may refuse to reveal information they feel uncomfortable disclosing. Furthermore, all participants have the right to stop the study at any time.

You are under no obligation to take part in this research.If you require more information please contact myself, Nicola Dimelow: Email slsnd@exchange.shu.ac.uk or phone 01142255734. Or if you are happy with the information provided please complete the following consent form.

Thank you for your interest.

Nicola Dimelow

Appendix 2.7

Consent Form

Emotion Perception on Older Adults across Three Modalities

Consent Form

By signing this form I agree that I understand:

1. The purpose of the research

2. What I will be required to do

3. That I have the right to withdraw my data up to 2 weeks post collection

4. All data will be anonymous and confidential

5. I do have the right to refuse to answer any question/s

6. The data may be used in other research

Name:

Signature:

Age:

Gender:

Date:

Appendix 2.8

Standardised Instructions for the Face Tasks

<u>Faces Experimental Task Standardised Instructions</u>

You will be shown some faces; they will be displayed one at a time. Looking at the facial expression you need to decide which primary emotion is being displayed: Happy, Sad, Fear, Anger or Disgust. Some faces display no emotion and these are called Neutral. The options will be presented to you on the screen so you do not need to try to remember them. Also the options will be presented with a corresponding number and this is the number you enter using the response box.

For example in the following display:

1	2	3	4	5	6
Happy	Sad	Fear	Anger	Disgust	Neutral

If you think the face is displaying anger you would enter 4.

Please note this is just an example and in the task you undertake the response keys for a particular category maybe different from this example so please look at the response options displayed on your task.

The task starts with some instructions and when you are ready you can start a practice trial at the end of this you may want to ask some questions before commencing with the actual real task. You have a four second time limit to enter your response and you are asked to answer as accurately and quickly as possible.

Do you have any questions?

Are you ready to begin?

Faces Control Task Standardised Instructions

You will be shown some faces; they will be displayed one at a time. You need to decide which category the person best belongs to as defined by their age group and gender. The options will be presented to you on the screen so you do not need to try to remember them. Also the options will be presented with a corresponding number and this is the number you enter using the response box.

For example:

1	2	3	4	5	6
Male/Young	Female/Young	Male/ Middle	Female/Middle	Male/Older	Female/Older

If you think the person is Female and Middle aged you would enter 4.
Please note this is just an example and in the task you undertake the response keys for a particular category maybe different from this example so please look at the response options displayed on your task.
The task starts with some instructions and when you are ready you can start a practice trial at the end of this you may want to ask some questions before commencing with the actual real task. You have a four second time limit to enter your response and you are asked to answer as accurately and quickly as possible.

Do you have any questions?
Are you ready to begin?

Appendix 2.9

Standardised Instructions for Sound Tasks

Sound Experimental Task Standardised Instructions

You will hear some short sound bursts which will be presented one at a time. You need to decide which of these emotions Happy, Sad, Fear, Anger or Disgust the sound is portraying. Some sounds may not relate to any emotion and these are called Neutral. The options will be presented to you on the screen so you do not need to try to remember them. Also the options will be presented with a corresponding number and this is the number you enter using the response box.

For example in the following display:

1	2	3	4	5	6
Happy	Sad	Fear	Anger	Disgust	Neutral

If you think the sound denotes fear you would enter 3.
Please note this is just an example and in the task you undertake the response keys for a particular category maybe different from this example so please look at the response options displayed on your task.

The task starts with some instructions and when you are ready you can start a practice trial at the end of this you may want to ask some questions before commencing with the actual real task. You have a four second time limit to enter your response and you are asked to answer as accurately and quickly as possible. Please let the researcher know if the sound is okay during the practice tasks.

Do you have any questions?
Are you ready to begin?

Non-emotion Sound Task Standardised Instructions

You will hear some short sound bursts; they will be presented one at a time. You need to decide which animal category the sound primarily belongs to either: horse, insect, dog, cat, bird. Some sounds will not belong to any of these categories and these are classified as" Non-animal" sounds. The options will be presented to you on the screen so you do not need to try to remember them. Also the options will be presented with a corresponding number and this is the number you enter using the response box.

For example in the following display:

1	2	3	4	5	6
Horse	Insect	Dog	Cat	Bird	Non-animal

If you think the sound is made by a horse then you would enter 1.

Please note this is just an example and in the task you undertake the response keys for a particular category maybe different from this example so please look at the response options displayed on your task.

The task starts with some instructions and when you are ready you can start a practice trial at the end of this you may want to ask some questions before commencing with the actual real task. You have a four second time limit to enter your response and you are asked to answer as accurately and quickly as possible.

Please tell the researcher if the sound volume is ok after the practice task.

Do you have any questions?

Are you ready to begin?

Appendix 2.10

Standardised Instructions for the Word Tasks

Lexical Experimental Task Standardised Instructions

You will be shown some words on the computer screen; they will be displayed one at a time. You need to decide which of these emotions Happy, Sad, Fear, Anger or Disgust the word primarily represents. Some words may not relate to any emotion and these are called Neutral. The options will be presented to you on the screen so you do not need to try to remember them. Also the options will be presented with a corresponding number and this is the number you enter using the response box.

For example in the following display:

1	2	3	4	5	6
Happy	Sad	Fear	Anger	Disgust	Neutral

If you think the word **"weep "**is related to sad you would enter 2.

Please note this is just an example and in the task you undertake the response keys for a particular category maybe different from this example so please look at the response options displayed on your task.

The task starts with some instructions and when you are ready you can start a practice trial, at the end of this you may want to ask some questions before commencing with the actual real task. You have a four second time limit to enter your response and you are asked to answer as accurately and quickly as possible.

Do you have any questions?

Are you ready to begin?

Non-emotion Word Task Standardised Instructions

You will be shown some words; they will be displayed one at a time. You need to decide which category the word primarily belongs to either related to the hand, eyes, hair, body, and teeth. Some words will not belong to any of these categories and these are classified as" None". The options will be presented to you on the screen so you do not need to try to remember them. Also the options will be presented with a corresponding number and this is the number you enter using the response box.

For example:

1	2	3	4	5	6
Hand	Eyes	Hair	Body	Teeth	None

If you think the word **"manicure"** relates to the hand then you would enter 1.
Please note this is just an example and in the task you undertake the response keys for a particular category maybe different from this example so please look at the response options displayed on your task.

The task starts with some instructions and when you are ready you can start a practice trial, at the end of this you may want to ask some questions before commencing with the actual real task. You have a four second time limit to enter your response and you are asked to answer as accurately and quickly as possible.

Do you have any questions?
Are you ready to begin?

Appendix 2.11

Debrief

Participant Debrief for Study: Age-related Differences in Emotion Perception.

Thank you for participating in this research. If you have any questions regarding what you have done please do not hesitate to ask.

The purpose of the study is to investigate if age affects the way people perceive emotion when the information is provided either by facial expressions, written word or via sound. Each of these presentations was matched in the experiment with a control task, i.e. a similar task but without any emotion element. This was important to understand if any age-related differences were the result of differences in the way information in general is processed or if it is the emotional element of the information that results in processing differences. Finally, a number of tasks were undertaken to measure cognitive behaviours such as speed of processing and intelligence, as well as measures of individual differences including anxiety and mood. The purpose for this was to try to establish if any of these skills contribute to any age-related differences in emotion perception.

If you would like to contact the research team at any point to talk about the research or if you would like a copy of the results then please email:

Nicola Dimelow; email: slsnd1@exchange.shu.ac.uk ; or phone 01142255734.

Once again thank you for your assistance.

Yours Sincerely

Nicola Dimelow BSc Msc

Appendix 2.12

Time Outs, Errors and Accuracy

Table 2.1

Time Outs, Errors and Accuracy for the Three Emotion Recognition Tasks by Emotion Type for Older Adults

Presentation Type	Faces						Sounds						Words					
	Missing RT		Errors		Accuracy		Missing RT		Errors		Accuracy		Missing RT		Errors		Accuracy	
	N	**%**	N	**%**	N	**%**	N	**%**	**N**	**%**	**N**	**%**	N	**%**	N	**%**	N	**%**
Emotion Type																		
Happy	1	**0**	7	**3**	208	**96**	1	**0**	3	**1**	206	**98**	0	**0**	14	**6**	202	**94**
Sad	10	**5**	86	**38**	120	**56**	8	**4**	17	**8**	185	**88**	8	**4**	14	**6**	194	**90**
Fear	30	**14**	62	**29**	124	**57**	7	**3**	62	**30**	141	**67**	3	**1**	27	**13**	186	**86**
Anger	11	**5**	99	**46**	106	**49**	15	**7**	119	**57**	76	**36**	7	**3**	18	**9**	191	**88**
Disgust	10	**5**	30	**14**	176	**81**	10	**5**	43	**20**	157	**75**	6	**3**	35	**16**	175	**81**
Neutral	2	**1**	33	**15**	181	**84**	2	**1**	27	**13**	181	**86**	18	**9**	16	**7**	182	**84**
Total	64	**5**	317	**24**	915	**71**	43	**3**	271	**22**	946	**75**	42	**3**	124	**10**	1130	**87**

Note. Maximum total accuracy for each emotion type within a presentation type = 216 (210 for sounds), with a maximum total for each presentation type = 1296 (1260 for sounds)

Table 2.2

Time Outs, Errors and Accuracy for the Three Emotion Recognition Tasks by Emotion Type for Younger Adults

Presentation Type	Faces						Sounds						Words					
	Missing RT		Errors		Accuracy		Missing RT		Errors		Accuracy		Missing RT		Errors		Accuracy	
	N	**%**	N	**%**	N	**%**	N	**%**	**N**	**%**	**N**	**%**	N	**%**	N	**%**	N	**%**
Emotion Type																		
Happy	0	**0**	2	**1**	214	**99**	0	**0**	1	**0**	215	**99**	0	**0**	17	**8**	199	**92**
Sad	5	**2**	71	**33**	140	**65**	1	**0**	12	**5**	203	**94**	0	**0**	43	**20**	173	**80**
Fear	9	**4**	60	**29**	147	**68**	1	**0**	50	**23**	165	**76**	0	**0**	40	**19**	176	**81**
Anger	3	**1**	71	**33**	142	**66**	6	**3**	115	**53**	95	**44**	0	**0**	18	**8**	198	**92**
Disgust	1	**0**	60	**29**	155	**72**	5	**2**	52	**24**	159	**74**	0	**0**	66	**31**	150	**69**
Neutral	0	**0**	40	**19**	176	**81**	0	**0**	7	**3**	209	**97**	0	**0**	51	**24**	165	**76**
Total	18	**1**	304	**23**	974	**75**	13	**1**	237	**18**	1046	**81**	0	**0**	235	**18**	1061	**82**

Note. Maximum total accuracy for each emotion type within a presentation type = 216, with a maximum total for each presentation type = 1296

Table 2.3

Time Outs, Errors and Accuracy for the Three Non-emotion Tasks for Older and Younger Adults

Presentation Type	Faces						Sounds						Words					
Non-emotion	Missing RT		Errors		Accuracy		Missing RT		Errors		Accuracy		Missing RT		Errors		Accuracy	
	N	%	N	%	N	%	N	%	**N**	%	**N**	%	N	%	N	%	N	%
OAs	20	**2**	112	**9**	1164	**90**	36	**3**	247	**19**	1013	**78**	10	**1**	67	**5**	1219	**94**
YAs	3	**0**	137	**11**	1156	**89**	9	**1**	175	**14**	1112	**86**	5	**0**	137	**11**	1118	**89**

Note. Maximum total accuracy for the non-emotion task for each presentation type = 1296 (1260 for YAs word)

Appendix 2.13 Appendix 2.14

Skew and Normality Tests

YAs' Accuracy for Emotion Recognition of Facial Expressions by Emotion Type (n = 36).

Emotion	Min	Max	Mean	SDs	Skew	Kurtosis	Shapiro Wilk
Happy	4	6	5.86	0.42	-3.27	11.00	<.001
Sad	0	6	3.89	1.45	0.51	0.21	.033
Fear	0	6	4.08	1.66	-0.61	-0.59	.002
Anger	1	6	3.94	1.24	-0.55	0.29	.012
Disgust	0	6	4.31	1.33	-0.91	1.67	.002
Neutral	0	6	4.94	1.43	-2.36	6.53	<.001
Total	20	33	27.03	3.77	-0.16	-1.27	0.42

OAs' Accuracy by Emotion Type on the Emotion Face Task (n = 35).

Emotion	Min	Max	Mean	SDs	Skew	Kurtosis	Shapiro Wilk
Happy	4	6	5.80	0.48	-2.41	5.56	<.001
Sad	0	6	3.43	1.91	-0.23	-1.19	.012
Fear	0	6	3.54	1.88	-0.32	-0.86	.018
Anger	0	6	2.97	1.89	0.71	-0.92	.037
Disgust	1	6	4.91	1.22	-1.27	1.62	<.001
Neutral	3	6	5.09	0.92	-0.66	0.47	<.001
Total	16	34	25.74	4.38	-0.22	-0.45	.900

YAs' Accuracy by Emotion Type on the Emotion Sound Task ($n = 36$).

Emotion	Min	Max	Mean	SDs	Skew	Kurtosis	Shapiro Wilk
Happy	5	6	5.97	0.17	-6.00	36.00	<.001
Sad	4	6	5.63	0.54	-1.16	0.42	<.001
Fear	0	6	4.58	1.68	-1.36	1.35	. <.001
Anger	0	5	2.64	1.19	-0.08	-0.38	.036
Disgust	2	6	4.44	0.97	-0.63	-0.15	<.001
Neutral	4	6	5.83	0.45	-2.82	7.96	<.001
Total	21	33	29.11	2.64	-1.19	1.99	.003

OAs' Accuracy by Emotion Type on the Emotion Sound Task ($n = 35$).

Emotion	Min	Max	Mean	SDs	Skew	Kurtosis	Shapiro Wilk
Happy	5	6	5.81	0.36	-2.13	2.71	<.001
Sad	3	6	5.34	0.80	-1.08	0.67	<.001
Fear	1	6	4.03	1.20	-0.38	0.22	.012
Anger	0	5	2.17	1.25	-0.06	-0.35	.033
Disgust	3	6	4.49	0.74	0.28	-0.12	<.001
Neutral	1	6	5.17	1.29	-1.72	2.54	<.001
Total	18	31	27	2.75	-1.97	1.97	.015

YAs' Accuracy by Emotion Type on the Emotion Word Task (*n* = 36).

Emotion	Min	Max	Mean	SDs	Skew	Kurtosis	Shapiro Wilk
Happy	3	6	5.53	0.70	-1.72	3.69	<.001
Sad	3	6	4.81	0.86	-1.18	-0.61	.001
Fear	2	6	4.89	1.04	-0.91	0.51	<.001
Anger	3	6	5.50	0.81	-1.53	1.54	<.001
Disgust	1	6	4.12	1.16	-0.46	0.26	0.12
Neutral	2	6	4.58	1.25	-0.43	-0.89	.001
Total	18	35	29.47	3.99	-1.13	1.26	.006

OAs' Accuracy by Emotion Type on the Emotion Word Task (*n* = 35).

Emotion	Min	Max	Mean	SDs	Skew	Kurtosis	Shapiro Wilk
Happy	5	6	5.63	0.49	-0.56	5.43	<.001
Sad	2	6	5.43	0.88	-2.07	5.52	<.001
Fear	3	6	5.17	0.95	-0.79	-0.51	<.001
Anger	3	6	5.31	0.80	-1.01	0.61	<.001
Disgust	1	6	4.89	1.35	-1.55	2.26	<.001
Neutral	2	6	5.14	1.19	-1.18	0.19	<.001
Total	24	36	31.57	3.24	-0.47	0.60	.073

Appendix 3.1 Table 3.1 Sample Characteristics Measured in the Emotion Recognition Experiments based on Faces

Study	Age Group	Sample size	Mean Age or Age Range (years)	Education (years)	Fluid Intelligence	Crystallised Intelligence	Processing Speed	Memory	Executive Function	Positive Affect	Negative Affect	Alexithymia/ Empathy	Personality Traits	Other
Calder et al. (2003a)	YAs OAs	24 24	25.00 65.08			NART-R 113.21 114.08 ns								
Chaby, Boullay, Chetouani, & Plaza (2015)	YAs OAs	31 31	25.80 67.20	14.18 13.55		Mill Hill 36.87 37.48 ns					BDI 5.65 5.25			MMSE
Circelli, Clark, & Cronin-Golomb (2013)	YAs OAs	16 16	19.20 68.90	13.90 16.40 sig							BDI 3.70 4.20 ns			BAI 3.60 2.80 ns
Demenescu, Mathiak, & Mathiak (2014)	YAs MAs OAs	60 in total assume 20 in each age group.	25.76 45.76 63.80	13.81 12.90 11.87						PANAS 27.38 27.57 27.13	BDI/ PANAS 5.10/13.90 9.57/14.43 7.40/12.87			DSM-IV Axis 1 disorders
Di Domenico, Palumbo, Mammarella, & Fairfield (2015)	YAs OAs	40 40	23.63 70.25	12.10 11.43										
Grainger et al. (2015)	YAs OAs	40 44	Not reported	13.11 14.30 ns		NART 109.80 116.40 sig					HADS 17.00 13.17 sig			ACE-R cognitive impairme nt
Horning, Cornwell, & Davis (2012)		62 68 288 151 162	8.39 14.25 23.31 52.32 74.48	2.95 8.87 14.21 15.08 14.72	WAIS Matrix reasoning		Computer test (Teng, 1990)	RAVLT						
Hunter, Phillips, & MacPherson (2010a)	YAs OAs	25 25	22.64 66.96	15.08 15.40 ns		WTAR 111.24 113.88 ns	DSST 67.76 51.20 sig							
Hunter, Phillips, & MacPherson (2010b)	YAs OAs	20 20	20.00 70.55			WTAR 108.50 111.15 ns	DSST 64.35 44.60 sig							
Isaacowitz et al. (2007) (initial analysis)	YAs MAs OAs	189 90 78	27.05 48.01 71.90	Collegdegree 34.9(%) 55.6(%) 42.1(%)										SES 2.03 1.98 2.06 ns

Study	Age Group	Sample size	Mean Age or Age Range (years)	Education (years)	Fluid Intelligence	Crystallised Intelligence	Processing Speed	Memory	Executive Function	Positive Affect	Negative Affect	Alexithymia/ Empathy	Personality Traits	Other
Kessels et al. (2014)			8 years-75 years Total 373 pts (210 adults) including:			WAIS And/or NART or WTAR								
	YAs	59	18-25	12.50										
	MAs	32	56-65	11.70		97.6								
	OAs	12	65-75	9.60		100.9 105.5								
Keightley et al. (2006)		30				Mill Hill		Letter number sequence from WAIS -working memory (OAs<YAs) memory-HVLT (YAs > OAs)				TAS-20	NEO-FFI ns differences	Inhibition - Stroop colour and word test Search ability- Trail Making Test (ns)
	YAs	30	25.70			19.90						40.4		
	OAs		72.50			23.40 sig						43.3 ns		
Krendl & Ambady (2010a)	YAs OAs	36 42	19.80 75.80						OAs only. Battery of tests					
Krendl, Rule & Ambady (2014)	YAs OAs	32 30	23.10 70.70	16.20 16.70 ns					OAs < YAs Battery of tests					
Lambrecht, Kriefelts, & Wildgruber (2012)		16 16 18 17 17	20-30 31-40 41-50 51-60 61-70	Data not given by age groups		Data not given by age groups				Data not given by age groups			Arousal Data not given by age groups	
Mill et al. (2009)	YAs	147	18-20	91% secondary									NEO-FFI	
	MAs	208	21-30	75% seconday/22 % higher										
	OAs	37	61-84	41%secondary /45% higher										
Orgeta & Phillips (2008)	YAs OAs	40 40		14.30 12.70 sig		NART 26.98 16.05 (errors) sig	WAIS-R (DSST) YAs faster than OAs							
Phillips, MacLean, & Allen (2002)					WAIS-III	WAIS-III						Mehrabian & Epstein		TOM Eyes test
	YAs	30	29.90	14.45	20.00	52.60								
	OAs	30	69.20	12.20 sig	15.67 sig	55.37 ns						OA < YA		ns

Study	Age Group	Sample size	Mean Age or Age Range (years)	Education (years)	Fluid Intelligence	Crystallised Intelligence	Processing Speed	Memory	Executive Function	Positive Affect	Negative Affect	Alexithymia/ Empathy	Personality Traits	Other
Sasson et al. (2010)		719	18-24	Information										
	YAs	1673	25-34	given by										
		1548	35-44	gender not age										
		1859	45-54	group										
		1203	55-64											
	OAs	286	65-74											
		32	75+											
Sze, Goodkind,	YAs	76	22.99	Middle aged									Trait	Income
Gyurak, & Levenson	MAs	73	44.54	and OAs > YAs									perspective	Middle
(2012)	OAs	74	66.38										taking (IRI)	aged and
														OAs > YAs
Sullivan & Ruffman					CFIT	WAIS-SR (1981)					GDS			
(2004a)	YAs	31	26.00		25.45	49.84					screening			
	OAs	30	72.00		17.63	50.40								
					sig	ns								
Schaffer,				College or post	WAIS-III	WAIS-III					BDI			DSM-Axis
Wisniewski,				grads.							screening			1
Dahdah, & Froming		10	20-29	5	115	118								
(2009)		10	30-39	5	117	113								
		10	40-49	2	114	105								
		10	50-59	3	105	109								
		10	60-69	4	115	111								
		10	70-79	4	111	115								
					ns age differences	ns age differences								
Stanley &														Future
Isaacowitz (2015)						SVT					CESDS			time
	YAs	52	21.35	14.67		13.29					10.48			5.46/7
	OAs	55	74.96	16.48		14.80					7.63			3.52/7
						sig					ns			sig
Suzuki, Hoshino,				Matched	WAIS-R	WAIS-R				GAS	GAS			MMSE
Shigemasu, &	YAs	34	20.60	13.60	14.53	19.65				25.76	19.12			
Kawamura (2007)	OAs	34	69.70	13.20	11.53	17.85				26.03 ns	16.00			
				ns	sig.	ns					sig			
West et al. (2012)						WAIS-III								
		110	20-29	14.65		112.09								
		36	30-39	15.17		119.33								
		46	40-49	14.80		120.57								
		52	50-59	15.40		122.63								
		90	60-69	15.71		120.09								
		109	70-79	15.38		124.25								
		38	80-89	15.10		124.32								
				ns										
						40,50,60,70, & 80 > 20								

Study	Age Group	Sample size	Mean Age or Age Range	Education (years)	Fluid Intelligence	Crystallised Intelligence	Processing Speed	Memory	Executive Function	Positive Affect	Negative Affect	Alexithymia/ Empathy	Personality Traits	Other

			(years)				
Williams et al. (2009)		83 163 176 76 56 276 74 10	6-9 10-19 20-29 30-39 40-49 60-69 70-79 80-91		IQ within expected norms		AXIS-1 disorder Alcohol and Tabacco dependnecy
Wong, Cronin-Golomb, Neargarder (2005)	YAs OAs	20 20	19.20 69.50	14.40 16.30		GDS/ BDI screening tool.	

Appendix 3.2

The Files used in the Emotion Face Task taken from the FACES Dataset

004_o_m_a_a_web_resolution (2).jpg
004_o_m_d_a_web_resolution.jpg
004_o_m_f_a_web_resolution (2).jpg
004_o_m_n_b_web_resolution (2).jpg
004_o_m_n_b_web_resolution.jpg
004_o_m_s_a_web_resolution (2).jpg
004_o_m_s_a_web_resolution.jpg
005_o_f_a_a_web_resolution (2).jpg
005_o_f_a_a_web_resolution.jpg
005_o_f_d_b_web_resolution (2).jpg
005_o_f_d_b_web_resolution.jpg
005_o_f_f_b_web_resolution (2).jpg
005_o_f_f_b_web_resolution.jpg
005_o_f_h_b_web_resolution (2).jpg
005_o_f_h_b_web_resolution.jpg
005_o_f_n_b_web_resolution (2).jpg
005_o_f_n_b_web_resolution.jpg
005_o_f_s_b_web_resolution (2).jpg
005_o_f_s_b_web_resolution.jpg
008_y_m_a_a_web_resolution (2).jpg
008_y_m_a_a_web_resolution.jpg
008_y_m_d_a_web_resolution (2).jpg
008_y_m_d_a_web_resolution.jpg
008_y_m_f_a_web_resolution (2).jpg
008_y_m_h_a_web_resolution (2).jpg
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008_y_m_n_a_web_resolution (2).jpg
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008_y_m_s_b_web_resolution (2).jpg
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012_o_f_h_a_web_resolution.jpg
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012_o_f_n_a_web_resolution.jpg
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013_y_m_a_b_web_resolution (2).jpg
013_y_m_a_b_web_resolution.jpg
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013_y_m_h_a_web_resolution (2).jpg
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013_y_m_n_a_web_resolution.jpg
013_y_m_s_b_web_resolution (2).jpg
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030_o_f_h_a_web_resolution.jpg
030_o_f_n_b_web_resolution.jpg
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039_o_m_a_a_web_resolution.jpg
039_o_m_d_a_web_resolution.jpg
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039_o_m_h_a_web_resolution.jpg
039_o_m_n_a_web_resolution.jpg
039_o_m_s_b_web_resolution.jpg
040_y_f_a_a_web_resolution.jpg
040_y_f_d_b_web_resolution.jpg
040_y_f_f_b_web_resolution.jpg
040_y_f_h_a_web_resolution.jpg
040_y_f_n_b_web_resolution.jpg
040_y_f_s_a_web_resolution.jpg
057_y_m_a_a_web_resolution.jpg
057_y_m_d_b_web_resolution.jpg
057_y_m_f_b_web_resolution.jpg
057_y_m_h_a_web_resolution.jpg
057_y_m_n_b_web_resolution.jpg
057_y_m_s_a_web_resolution.jpg

The Files used in the Non-emotion Face Task taken from the FACES Dataset

Practice task

109_y_m_n_a_web_resolution.jpg

125_y_f_n_a_web_resolution.jpg

139_m_f_n_a_web_resolution.jpg

141_o_m_n_a_web_resolution.jpg

155_m_m_n_a_web_resolution.jpg

158_o_f_n_a_web_resolution.jpg

011_m_f_n_a_web_resolution.jpg

026_m_m_n_a_web_resolution.jpg

Experimental task

076_o_m_n_a_web_resolution.jpg

083_o_m_n_a_web_resolution.jpg

094_m_m_n_a_web_resolution.jpg

096_o_f_n_a_web_resolution.jpg

098_y_f_n_a_web_resolution.jpg

100_o_f_n_a_web_resolution.jpg

104_m_m_n_a_web_resolution.jpg

119_y_m_n_a_web_resolution.jpg

107_o_m_n_a_web_resolution.jpg

108_m_m_n_a_web_resolution.jpg

111_m_f_n_a_web_resolution.jpg

113_m_f_n_a_web_resolution.jpg

114_y_m_n_a_web_resolution.jpg

115_y_f_n_a_web_resolution.jpg

117_m_f_n_a_web_resolution.jpg

120_o_f_n_a_web_resolution.jpg

121_o_m_n_a_web_resolution.jpg

122_m_f_n_a_web_resolution.jpg

123_y_m_n_a_web_resolution.jpg

124_o_f_n_a_web_resolution.jpg

126_m_m_n_a_web_resolution.jpg

128_m_f_n_a_web_resolution.jpg

130_o_f_n_a_web_resolution.jpg

132_y_f_n_a_web_resolution.jpg

133_o_f_n_a_web_resolution.jpg

177_y_f_n_a_web_resolution.jpg

135_y_m_n_a_web_resolution.jpg

136_m_m_n_a_web_resolution.jpg

138_m_f_n_a_web_resolution.jpg

144_y_m_n_a_web_resolution.jpg

146_o_m_n_a_web_resolution.jpg

147_y_m_n_a_web_resolution.jpg

149_m_m_n_a_web_resolution.jpg

150_y_f_n_a_web_resolution.jpg

162_y_f_n_a_web_resolution.jpg
172_o_m_n_a_web_resolution.jpg

Appendix 3.3

Definitions of the Age Groups used in the Non-emotion Face Task

Face Task: Age and Gender Categorisation

Age range definitions:

Young	20-30 years old
Middle-aged	45-55 years old
Older	70-80 years old

Appendix 3.4

SPSS output for the Face Task in Phase 1

Comparing Accuracy on the Emotion Face Task between YAs and OAs

Descriptive Statistics

	agegroup	Mean	Std. Deviation	N
happyfacecorrect	young	5.8611	.42445	36
	older	5.8000	.47279	35
	Total	5.8310	.44676	71
sadfacecorrect	young	3.8889	1.44969	36
	older	3.4286	1.91412	35
	Total	3.6620	1.69827	71
fearfacecorrect	young	4.0833	1.66261	36
	older	3.5429	1.88403	35
	Total	3.8169	1.78333	71
angerfacecorrect	young	3.9444	1.24084	36
	older	2.9714	1.88626	35
	Total	3.4648	1.65470	71
disgustfacecorrect	young	4.3056	1.32707	36
	older	4.9143	1.22165	35
	Total	4.6056	1.30361	71
neutralfacecorrect	young	4.9444	1.43317	36
	older	5.0857	.91944	35
	Total	5.0141	1.20111	71

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
EmotionType	.458	52.340	14	.000	.825	.896	.200

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + agegroup
Within Subjects Design: EmotionType

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
EmotionType	Sphericity Assumed	301.709	5	60.342	33.270	.000	.325	166.348	1.000
	Greenhouse-Geisser	301.709	4.124	73.162	33.270	.000	.325	137.199	1.000
	Huynh-Feldt	301.709	4.482	67.311	33.270	.000	.325	149.124	1.000
	Lower-bound	301.709	1.000	301.709	33.270	.000	.325	33.270	1.000
EmotionType * agegroup	Sphericity Assumed	27.859	5	5.572	3.072	.010	.043	15.360	.869
	Greenhouse-Geisser	27.859	4.124	6.756	3.072	.016	.043	12.669	.815
	Huynh-Feldt	27.859	4.482	6.215	3.072	.013	.043	13.770	.839
	Lower-bound	27.859	1.000	27.859	3.072	.084	.043	3.072	.409
Error(EmotionType)	Sphericity Assumed	625.732	345	1.814					
	Greenhouse-Geisser	625.732	284.546	2.199					
	Huynh-Feldt	625.732	309.278	2.023					
	Lower-bound	625.732	69.000	9.069					

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	8236.555	1	8236.555	2966.042	.000	.977	2966.042	1.000
agegroup	4.883	1	4.883	1.759	.189	.025	1.759	.258
Error	191.610	69	2.777					

a. Computed using alpha = .05

1. agegroup

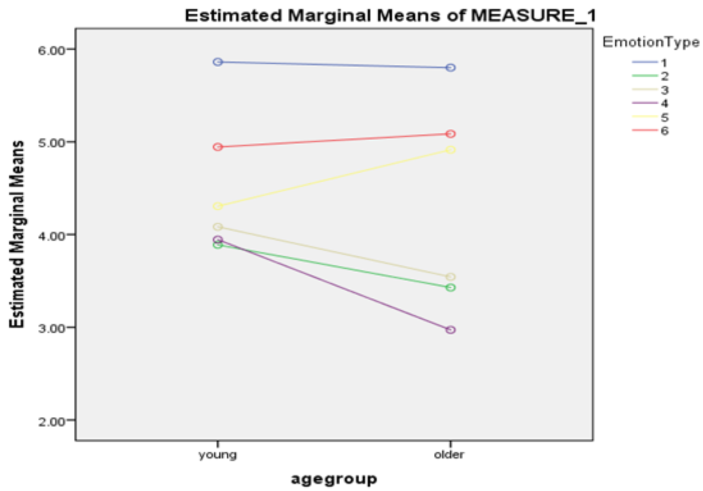
Measure: MEASURE_1

agegroup	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
young	4.505	.113	4.278	4.731
older	4.290	.115	4.061	4.520

2. EmotionType

Measure: MEASURE_1

EmotionType	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
1	5.831	.053	5.724	5.937
2	3.659	.201	3.258	4.060
3	3.813	.211	3.393	4.233
4	3.458	.189	3.081	3.835
5	4.610	.151	4.308	4.912
6	5.015	.143	4.729	5.301



Post hoc Tests Investigating Main Effect of Emotion Type

Paired Samples Test

		Paired Differences Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	happyfacecorrect - sadfacecorrect	2.16901	1.74835	.20749	1.75519	2.58284	10.454	70	.000
Pair 2	happyfacecorrect - fearfacecorrect	2.01408	1.73611	.20604	1.60315	2.42502	9.775	70	.000
Pair 3	happyfacecorrect - angerfacecorrect	2.36620	1.70913	.20284	1.96165	2.77074	11.666	70	.000
Pair 4	happyfacecorrect - disgustfacecorrect	1.22535	1.40608	.16687	.89254	1.55817	7.343	70	.000
Pair 5	happyfacecorrect - neutralfacecorrect	.81690	1.24568	.14783	.52205	1.11175	5.526	70	.000
Pair 6	sadfacecorrect - fearfacecorrect	-.15493	2.05390	.24375	-.64108	.33122	-.636	70	.527
Pair 7	sadfacecorrect - angerfacecorrect	.19718	2.02569	.24041	-.28229	.67666	.820	70	.415
Pair 8	sadfacecorrect - disgustfacecorrect	-.94366	2.16391	.25681	-1.45585	-.43147	-3.675	70	.000
Pair 9	sadfacecorrect - neutralfacecorrect	-1.35211	2.28097	.27070	-1.89201	-.81222	-4.995	70	.000
Pair 10	fearfacecorrect - angerfacecorrect	.35211	2.00070	.23744	-.12145	.82567	1.483	70	.143
Pair 11	fearfacecorrect - disgustfacecorrect	-.78873	2.09704	.24887	-1.28509	-.29237	-3.169	70	.002
Pair 12	fearfacecorrect - neutralfacecorrect	-1.19718	2.16874	.25738	-1.71051	-.68385	-4.651	70	.000
Pair 13	angerfacecorrect - disgustfacecorrect	-1.14085	2.11320	.25079	-1.64103	-.64066	-4.549	70	.000
Pair 14	angerfacecorrect - neutralfacecorrect	-1.54930	2.17642	.25829	-2.06445	-1.03414	-5.998	70	.000
Pair 15	disgustfacecorrect - neutralfacecorrect	-.40845	1.72856	.20514	-.81759	.00069	-1.991	70	.050

*Post hoc Tests Investigating Age Group*Emotion Type Interaction*

Comparing Accuracy by Emotion Type Between OAs and YAs

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
happyfacecorrect	Equal variances assumed	1.112	.295	.573	69	.568	.06111	.10656	-.15148	.27370
	Equal variances not assumed			.573	67.750	.569	.06111	.10673	-.15188	.27410
sadfacecorrect	Equal variances assumed	5.706	.020	1.144	69	.256	.46032	.40225	-.34214	1.26278
	Equal variances not assumed			1.140	63.355	.259	.46032	.40381	-.34654	1.26717
fearfacecorrect	Equal variances assumed	.610	.438	1.283	69	.204	.54048	.42139	-.30017	1.38113
	Equal variances not assumed			1.280	67.427	.205	.54048	.42214	-.30202	1.38297
angerfacecorrect	Equal variances assumed	7.091	.010	2.575	69	.012	.97302	.37789	.21915	1.72689
	Equal variances not assumed			2.560	58.558	.013	.97302	.38003	.21245	1.73358
disgustfacecorrect	Equal variances assumed	.423	.518	-2.009	69	.048	-.60873	.30295	-1.21309	-.00437
	Equal variances not assumed			-2.012	68.799	.048	-.60873	.30259	-1.21241	-.00505
neutralfacecorrect	Equal variances assumed	.813	.370	-.493	69	.624	-.14127	.28667	-.71317	.43063
	Equal variances not assumed			-.496	59.863	.622	-.14127	.28497	-.71132	.42878
totalemotionfacecorrect	Equal variances assumed	.115	.736	1.326	69	.189	1.28492	.96896	-.64809	3.21793
	Equal variances not assumed			1.323	66.883	.190	1.28492	.97103	-.65332	3.22317

The Pattern of Recognition Accuracy across Emotion Types in YAs

Paired Samples Test[a]

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	happyfacecorrect - sadfacecorrect	1.97222	1.52102	.25350	1.45758	2.48686	7.780	35	.000
Pair 2	happyfacecorrect - fearfacecorrect	1.77778	1.62324	.27054	1.22855	2.32700	6.571	35	.000
Pair 3	happyfacecorrect - angerfacecorrect	1.91667	1.25071	.20845	1.49349	2.33985	9.195	35	.000
Pair 4	happyfacecorrect - disgustfacecorrect	1.55556	1.36161	.22693	1.09485	2.01626	6.855	35	.000
Pair 5	happyfacecorrect - neutralfacecorrect	.91667	1.44173	.24029	.42886	1.40448	3.815	35	.001
Pair 6	sadfacecorrect - fearfacecorrect	-.19444	1.87951	.31325	-.83038	.44149	-.621	35	.539
Pair 7	sadfacecorrect - angerfacecorrect	-.05556	1.83528	.30588	-.67653	.56541	-.182	35	.857
Pair 8	sadfacecorrect - disgustfacecorrect	-.41667	1.93280	.32213	-1.07063	.23730	-1.293	35	.204
Pair 9	sadfacecorrect - neutralfacecorrect	-1.05556	2.30458	.38410	-1.83531	-.27580	-2.748	35	.009
Pair 10	fearfacecorrect - angerfacecorrect	.13889	1.83852	.30642	-.48318	.76095	.453	35	.653
Pair 11	fearfacecorrect - disgustfacecorrect	-.22222	1.85335	.30889	-.84931	.40486	-.719	35	.477
Pair 12	fearfacecorrect - neutralfacecorrect	-.86111	1.94426	.32404	-1.51896	-.20327	-2.657	35	.012
Pair 13	angerfacecorrect - disgustfacecorrect	-.36111	1.85400	.30900	-.98841	.26619	-1.169	35	.250
Pair 14	angerfacecorrect - neutralfacecorrect	-1.00000	1.95667	.32611	-1.66204	-.33796	-3.066	35	.004
Pair 15	disgustfacecorrect - neutralfacecorrect	-.63889	1.98786	.33131	-1.31148	.03371	-1.928	35	.062

a. agegroup = young

The Pattern of Recognition Accuracy across Emotion Types in OAs

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	happyfacecorrect - sadfacecorrect	2.37143	1.95667	.33074	1.69929	3.04357	7.170	34	.000
Pair 2	happyfacecorrect - fearfacecorrect	2.25714	1.83660	.31044	1.62625	2.88804	7.271	34	.000
Pair 3	happyfacecorrect - angerfacecorrect	2.82857	1.99242	.33678	2.14415	3.51299	8.399	34	.000
Pair 4	happyfacecorrect - disgustfacecorrect	.88571	1.38843	.23469	.40877	1.36266	3.774	34	.001
Pair 5	happyfacecorrect - neutralfacecorrect	.71429	1.01667	.17185	.36505	1.06352	4.156	34	.000
Pair 6	sadfacecorrect - fearfacecorrect	-.11429	2.24619	.37968	-.88588	.65731	-.301	34	.765
Pair 7	sadfacecorrect - angerfacecorrect	.45714	2.20084	.37201	-.29887	1.21316	1.229	34	.228
Pair 8	sadfacecorrect - disgustfacecorrect	-1.48571	2.27998	.38539	-2.26892	-.70251	-3.855	34	.000
Pair 9	sadfacecorrect - neutralfacecorrect	-1.65714	2.24844	.38005	-2.42951	-.88478	-4.360	34	.000
Pair 10	fearfacecorrect - angerfacecorrect	.57143	2.15960	.36504	-.17042	1.31328	1.565	34	.127
Pair 11	fearfacecorrect - disgustfacecorrect	-1.37143	2.19740	.37143	-2.12626	-.61659	-3.692	34	.001
Pair 12	fearfacecorrect - neutralfacecorrect	-1.54286	2.35575	.39820	-2.35209	-.73363	-3.875	34	.000
Pair 13	angerfacecorrect - disgustfacecorrect	-1.94286	2.08556	.35252	-2.65927	-1.22644	-5.511	34	.000
Pair 14	angerfacecorrect - neutralfacecorrect	-2.11429	2.27223	.38408	-2.89482	-1.33375	-5.505	34	.000
Pair 15	disgustfacecorrect - neutralfacecorrect	-.17143	1.40348	.23723	-.65354	.31068	-.723	34	.475

a. agegroup = older

3*6 ANOVA Comparing Accuracy Between Three Age Groups

Descriptive Statistics

	agegroup	Mean	Std. Deviation	N
happyfacecorrect	young	5.8611	.42445	36
	older	5.8333	.38348	18
	veryold	5.7222	.57451	18
	Total	5.8194	.45429	72
sadfacecorrect	young	3.8889	1.44969	36
	older	4.2222	1.80051	18
	veryold	2.4444	1.75641	18
	Total	3.6111	1.74061	72
fearfacecorrect	young	4.0833	1.66261	36
	older	3.9444	1.92422	18
	veryold	2.9444	1.89340	18
	Total	3.7639	1.82697	72
angerfacecorrect	young	3.9444	1.24084	36
	older	3.2778	1.67352	18
	veryold	2.6111	2.03322	18
	Total	3.4444	1.65205	72
disgustfacecorrect	young	4.3056	1.32707	36
	older	4.9444	.93760	18
	veryold	4.8333	1.46528	18
	Total	4.5972	1.29636	72
neutralfacecorrect	young	4.9444	1.43317	36
	older	4.9444	1.05564	18
	veryold	5.0556	1.05564	18
	Total	4.9722	1.24439	72

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
emotiontypeface	.502	46.205	14	.000	.847	.936	.200

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + agegroup
Within Subjects Design: emotiontypeface

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
emotiontypeface	Sphericity Assumed	320.905	5	64.181	36.189	.000	.344	180.947	1.000
	Greenhouse-Geisser	320.905	4.237	75.736	36.189	.000	.344	153.340	1.000
	Huynh-Feldt	320.905	4.680	68.573	36.189	.000	.344	169.358	1.000
	Lower-bound	320.905	1.000	320.905	36.189	.000	.344	36.189	1.000
emotiontypeface * agegroup	Sphericity Assumed	51.965	10	5.197	2.930	.002	.078	29.301	.978
	Greenhouse-Geisser	51.965	8.474	6.132	2.930	.003	.078	24.831	.959
	Huynh-Feldt	51.965	9.360	5.552	2.930	.002	.078	27.425	.971
	Lower-bound	51.965	2.000	25.983	2.930	.060	.078	5.860	.554
Error(emotiontypeface)	Sphericity Assumed	611.847	345	1.773					
	Greenhouse-Geisser	611.847	292.363	2.093					
	Huynh-Feldt	611.847	322.904	1.895					
	Lower-bound	611.847	69.000	8.867					

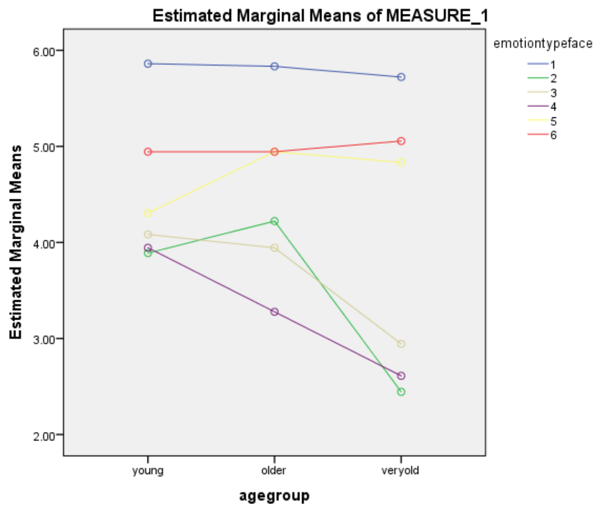
a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	7264.445	1	7264.445	2519.355	.000	.973	2519.355	1.000
agegroup	27.021	2	13.510	4.685	.012	.120	9.371	.769
Error	198.958	69	2.883					

a. Computed using alpha = .05



Post hoc Tests for Investigating the Main Effect of Age Group

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
totalemotionfacecorrect	young	36	27.0278	3.76818	.62803
	older	18	27.1667	3.89947	.91911

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
totalemotionfacecorrect	Equal variances assumed	.629	.431	-.126	52	.900	-.13889	1.10031	-2.34683	2.06905
	Equal variances not assumed			-.125	33.078	.901	-.13889	1.11319	-2.40349	2.12571

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
totalemotionfacecorrect	young	36	27.0278	3.76818	.62803
	veryold	18	23.6111	5.07750	1.19678

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
totalemotionfacecorrect	Equal variances assumed	.979	.327	2.791	52	.007	3.41667	1.22425	.96002	5.87331
	Equal variances not assumed			2.528	26.670	.018	3.41667	1.35156	.64190	6.19144

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
totalemotionfacecorrect	older	18	27.1667	3.89947	.91911
	veryold	18	23.6111	5.07750	1.19678

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
totalemotionfacecorrect	Equal variances assumed	1.388	.247	2.356	34	.024	3.55556	1.50899	.48892	6.62219
	Equal variances not assumed			2.356	31.878	.025	3.55556	1.50899	.48138	6.62973

*Post hoc Tests Investigating the Age Group*Emotion Type Interaction*

Comparing Accuracy for Emotion Type Between YAs and Older-older Adults

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
happyfacecorrect	young	36	5.8611	.42445	.07074
	veryold	18	5.7222	.57451	.13541
sadfacecorrect	young	36	3.8889	1.44969	.24161
	veryold	18	2.4444	1.75641	.41399
fearfacecorrect	young	36	4.0833	1.66261	.27710
	veryold	18	2.9444	1.89340	.44628
angerfacecorrect	young	36	3.9444	1.24084	.20681
	veryold	18	2.6111	2.03322	.47923
disgustfacecorrect	young	36	4.3056	1.32707	.22118
	veryold	18	4.8333	1.46528	.34537
neutralfacecorrect	young	36	4.9444	1.43317	.23886
	veryold	18	5.0556	1.05564	.24882

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
happyfacecorrect	Equal variances assumed	3.364	.072	1.005	52	.320	.13889	.13819	-.13842	.41619
	Equal variances not assumed			.909	26.584	.371	.13889	.15278	-.17482	.45260
sadfacecorrect	Equal variances assumed	2.031	.160	3.214	52	.002	1.44444	.44936	.54274	2.34615
	Equal variances not assumed			3.013	28.923	.005	1.44444	.47934	.46398	2.42491
fearfacecorrect	Equal variances assumed	.123	.728	2.266	52	.028	1.13889	.50271	.13013	2.14765
	Equal variances not assumed			2.168	30.438	.038	1.13889	.52531	.06671	2.21107
angerfacecorrect	Equal variances assumed	8.457	.005	2.989	52	.004	1.33333	.44608	.43821	2.22845
	Equal variances not assumed			2.555	23.525	.018	1.33333	.52195	.25492	2.41174
disgustfacecorrect	Equal variances assumed	.125	.725	-1.331	52	.189	-.52778	.39658	-1.32357	.26801
	Equal variances not assumed			-1.287	31.250	.208	-.52778	.41012	-1.36396	.30840
neutralfacecorrect	Equal variances assumed	.407	.526	-.291	52	.772	-.11111	.38153	-.87671	.65449
	Equal variances not assumed			-.322	44.440	.749	-.11111	.34491	-.80604	.58382

Comparing Accuracy for Emotion Type Between Younger-older and Older-older Adults

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
happyfacecorrect	older	18	5.8333	.38348	.09039
	veryold	18	5.7222	.57451	.13541
sadfacecorrect	older	18	4.2222	1.80051	.42438
	veryold	18	2.4444	1.75641	.41399
fearfacecorrect	older	18	3.9444	1.92422	.45354
	veryold	18	2.9444	1.89340	.44628
angerfacecorrect	older	18	3.2778	1.67352	.39445
	veryold	18	2.6111	2.03322	.47923
disgustfacecorrect	older	18	4.9444	.93760	.22099
	veryold	18	4.8333	1.46528	.34537
neutralfacecorrect	older	18	4.9444	1.05564	.24882
	veryold	18	5.0556	1.05564	.24882

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
happyfacecorrect	Equal variances assumed	2.168	.150	.682	34	.500	.11111	.16281	-.21976	.44198
	Equal variances not assumed			.682	29.639	.500	.11111	.16281	-.22156	.44378
sadfacecorrect	Equal variances assumed	.054	.818	2.999	34	.005	1.77778	.59286	.57293	2.98262
	Equal variances not assumed			2.999	33.979	.005	1.77778	.59286	.57290	2.98265
fearfacecorrect	Equal variances assumed	.001	.973	1.572	34	.125	1.00000	.63629	-.29310	2.29310
	Equal variances not assumed			1.572	33.991	.125	1.00000	.63629	-.29311	2.29311
angerfacecorrect	Equal variances assumed	1.156	.290	1.074	34	.290	.66667	.62069	-.59473	1.92806
	Equal variances not assumed			1.074	32.788	.291	.66667	.62069	-.59645	1.92978
disgustfacecorrect	Equal variances assumed	2.488	.124	.271	34	.788	.11111	.41002	-.72216	.94438
	Equal variances not assumed			.271	28.922	.788	.11111	.41002	-.72758	.94980
neutralfacecorrect	Equal variances assumed	.278	.601	-.316	34	.754	-.11111	.35188	-.82622	.60400
	Equal variances not assumed			-.316	34.000	.754	-.11111	.35188	-.82622	.60400

Comparing Accuracy for Emotion Type Between Young and Younger-older Adults

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
happyfacecorrect	young	36	5.8611	.42445	.07074
	older	18	5.8333	.38348	.09039
sadfacecorrect	young	36	3.8889	1.44969	.24161
	older	18	4.2222	1.80051	.42438
fearfacecorrect	young	36	4.0833	1.66261	.27710
	older	18	3.9444	1.92422	.45354
angerfacecorrect	young	36	3.9444	1.24084	.20681
	older	18	3.2778	1.67352	.39445
disgustfacecorrect	young	36	4.3056	1.32707	.22118
	older	18	4.9444	.93760	.22099
neutralfacecorrect	young	36	4.9444	1.43317	.23886
	older	18	4.9444	1.05564	.24882

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
happyfacecorrect	Equal variances assumed	.114	.737	.234	52	.816	.02778	.11879	-.21060	.26615
	Equal variances not assumed			.242	37.391	.810	.02778	.11478	-.20471	.26026
sadfacecorrect	Equal variances assumed	1.095	.300	-.734	52	.466	-.33333	.45409	-1.24453	.57786
	Equal variances not assumed			-.683	28.359	.500	-.33333	.48834	-1.33309	.66642
fearfacecorrect	Equal variances assumed	.152	.698	.275	52	.785	.13889	.50589	-.87625	1.15402
	Equal variances not assumed			.261	30.028	.796	.13889	.53149	-.94653	1.22430
angerfacecorrect	Equal variances assumed	2.423	.126	1.653	52	.104	.66667	.40331	-.14264	1.47597
	Equal variances not assumed			1.497	26.652	.146	.66667	.44538	-.24773	1.58106
disgustfacecorrect	Equal variances assumed	2.104	.153	-1.824	52	.074	-.63889	.35033	-1.34187	.06410
	Equal variances not assumed			-2.043	45.796	.047	-.63889	.31266	-1.26832	-.00946
neutralfacecorrect	Equal variances assumed	.055	.815	.000	52	1.000	.00000	.38153	-.76560	.76560
	Equal variances not assumed			.000	44.440	1.000	.00000	.34491	-.69493	.69493

The Pattern of Recognition Accuracy across Emotion Type for Younger-older Adults

Paired Samples Test[a]

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	happyfacecorrect - sadfacecorrect	1.61111	1.68519	.39720	.77309	2.44914	4.056	17	.001
Pair 2	happyfacecorrect - fearfacecorrect	1.88889	1.84355	.43453	.97211	2.80567	4.347	17	.000
Pair 3	happyfacecorrect - angerfacecorrect	2.55556	1.58011	.37243	1.76979	3.34132	6.862	17	.000
Pair 4	happyfacecorrect - disgustfacecorrect	.88889	.96338	.22707	.40981	1.36797	3.915	17	.001
Pair 5	happyfacecorrect - neutralfacecorrect	.88889	1.07861	.25423	.35251	1.42527	3.496	17	.003
Pair 6	sadfacecorrect - fearfacecorrect	.27778	2.32140	.54716	-.87663	1.43218	.508	17	.618
Pair 7	sadfacecorrect - angerfacecorrect	.94444	2.09964	.49489	-.09968	1.98857	1.908	17	.073
Pair 8	sadfacecorrect - disgustfacecorrect	-.72222	2.16403	.51007	-1.79837	.35392	-1.416	17	.175
Pair 9	sadfacecorrect - neutralfacecorrect	-.72222	2.21772	.52272	-1.82507	.38063	-1.382	17	.185
Pair 10	fearfacecorrect - angerfacecorrect	.66667	2.11438	.49836	-.38479	1.71812	1.338	17	.199
Pair 11	fearfacecorrect - disgustfacecorrect	-1.00000	2.08637	.49176	-2.03753	.03753	-2.034	17	.058
Pair 12	fearfacecorrect - neutralfacecorrect	-1.00000	2.42536	.57166	-2.20610	.20610	-1.749	17	.098
Pair 13	angerfacecorrect - disgustfacecorrect	-1.66667	1.90973	.45013	-2.61635	-.71698	-3.703	17	.002
Pair 14	angerfacecorrect - neutralfacecorrect	-1.66667	2.30089	.54233	-2.81087	-.52246	-3.073	17	.007
Pair 15	disgustfacecorrect - neutralfacecorrect	.00000	1.49509	.35240	-.74349	.74349	.000	17	1.000

a. agegroup = older

The Pattern of Recognition Accuracy across Emotion Type for Older-older adults

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper			
Pair 1	happyfacecorrect - sadfacecorrect	3.27778	1.93438	.45594	2.31583	4.23972	7.189	17	.000
Pair 2	happyfacecorrect - fearfacecorrect	2.77778	1.83289	.43202	1.86630	3.68925	6.430	17	.000
Pair 3	happyfacecorrect - angerfacecorrect	3.11111	2.29805	.54166	1.96832	4.25391	5.744	17	.000
Pair 4	happyfacecorrect - disgustfacecorrect	.88889	1.71117	.40333	.03794	1.73983	2.204	17	.042
Pair 5	happyfacecorrect - neutralfacecorrect	.66667	1.08465	.25565	.12728	1.20605	2.608	17	.018
Pair 6	sadfacecorrect - fearfacecorrect	-.50000	2.09341	.49342	-1.54103	.54103	-1.013	17	.325
Pair 7	sadfacecorrect - angerfacecorrect	-.16667	2.22948	.52549	-1.27536	.94203	-.317	17	.755
Pair 8	sadfacecorrect - disgustfacecorrect	-2.38889	2.14583	.50578	-3.45598	-1.32179	-4.723	17	.000
Pair 9	sadfacecorrect - neutralfacecorrect	-2.61111	1.81947	.42885	-3.51591	-1.70631	-6.089	17	.000
Pair 10	fearfacecorrect - angerfacecorrect	.33333	2.27519	.53627	-.79809	1.46476	.622	17	.542
Pair 11	fearfacecorrect - disgustfacecorrect	-1.88889	2.29805	.54166	-3.03168	-.74609	-3.487	17	.003
Pair 12	fearfacecorrect - neutralfacecorrect	-2.11111	2.13896	.50416	-3.17479	-1.04743	-4.187	17	.001
Pair 13	angerfacecorrect - disgustfacecorrect	-2.22222	2.21108	.52116	-3.32177	-1.12268	-4.264	17	.001
Pair 14	angerfacecorrect - neutralfacecorrect	-2.44444	2.22875	.52532	-3.55278	-1.33611	-4.653	17	.000
Pair 15	disgustfacecorrect - neutralfacecorrect	-.22222	1.39560	.32895	-.91624	.47180	-.676	17	.508

a. agegroup = veryold

Comparing Accuracy across Emotion and Non-emotion Face Tasks Between YAs and OAs

Within-Subjects Factors

Measure: MEASURE_1

stimulitypes	Dependent Variable
1	totalcontrolfacecorrect
2	totalemotionfacecorrect

Descriptive Statistics

	agegroup	Mean	Std. Deviation	N
totalcontrolfacecorrect	young	32.1111	1.73663	36
	older	32.4000	2.46386	35
	Total	32.2535	2.11605	71
totalemotionfacecorrect	young	27.0278	3.76818	36
	older	25.7429	4.38140	35
	Total	26.3944	4.10393	71

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
stimulitypes	Sphericity Assumed	1223.077	1	1223.077	128.584	.000	.651	128.584	1.000
	Greenhouse-Geisser	1223.077	1.000	1223.077	128.584	.000	.651	128.584	1.000
	Huynh-Feldt	1223.077	1.000	1223.077	128.584	.000	.651	128.584	1.000
	Lower-bound	1223.077	1.000	1223.077	128.584	.000	.651	128.584	1.000
stimulitypes * agegroup	Sphericity Assumed	21.978	1	21.978	2.311	.133	.032	2.311	.323
	Greenhouse-Geisser	21.978	1.000	21.978	2.311	.133	.032	2.311	.323
	Huynh-Feldt	21.978	1.000	21.978	2.311	.133	.032	2.311	.323
	Lower-bound	21.978	1.000	21.978	2.311	.133	.032	2.311	.323
Error(stimulitypes)	Sphericity Assumed	656.318	69	9.512					
	Greenhouse-Geisser	656.318	69.000	9.512					
	Huynh-Feldt	656.318	69.000	9.512					
	Lower-bound	656.318	69.000	9.512					

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	122051.479	1	122051.479	10457.715	.000	.993	10457.715	1.000
agegroup	8.803	1	8.803	.754	.388	.011	.754	.137
Error	805.296	69	11.671					

a. Computed using alpha = .05

1. agegroup

Measure: MEASURE_1

agegroup	Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
young	29.569	.403	28.766	30.373
older	29.071	.408	28.257	29.886

2. stimulitypes

Measure: MEASURE_1

stimulitypes	Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
1	32.256	.252	31.752	32.759
2	26.385	.484	25.419	27.352

Comparing Accuracy for Emotion and Non-emotion Tasks for Three Age Groups

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Content_type	Sphericity Assumed	1288.225	1	1288.225	130.024	.000	.653
	Greenhouse-Geisser	1288.225	1.000	1288.225	130.024	.000	.653
	Huynh-Feldt	1288.225	1.000	1288.225	130.024	.000	.653
	Lower-bound	1288.225	1.000	1288.225	130.024	.000	.653
Content_type * agegroup	Sphericity Assumed	45.375	2	22.688	2.290	.109	.062
	Greenhouse-Geisser	45.375	2.000	22.688	2.290	.109	.062
	Huynh-Feldt	45.375	2.000	22.688	2.290	.109	.062
	Lower-bound	45.375	2.000	22.688	2.290	.109	.062
Error(Content_type)	Sphericity Assumed	683.625	69	9.908			
	Greenhouse-Geisser	683.625	69.000	9.908			
	Huynh-Feldt	683.625	69.000	9.908			
	Lower-bound	683.625	69.000	9.908			

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	109655.803	1	109655.803	9380.134	.000	.993
agegroup	144.125	2	72.063	6.164	.003	.152
Error	806.625	69	11.690			

1. agegroup

Measure: MEASURE_1

agegroup	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
young	29.569	.403	28.766	30.373
older	30.167	.570	29.030	31.303
veryold	27.528	.570	26.391	28.665

2. Content_type

Measure: MEASURE_1

Content_type	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
1	32.241	.258	31.727	32.754
2	25.935	.517	24.904	26.966

Post hoc Tests Investigating Main Effect of Age Group

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
bothfacetasksaccuracy	young	36	59.1389	4.33031	.72172
	older	18	60.3333	4.36564	1.02899

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
bothfacetasksaccuracy	Equal variances assumed	.071	.791	-.953	52	.345	-1.19444	1.25340	-3.70957	1.32068
	Equal variances not assumed			-.950	33.860	.349	-1.19444	1.25686	-3.74908	1.36019

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
bothfacetasksaccuracy	young	36	59.1389	4.33031	.72172
	veryold	18	55.0556	6.10181	1.43821

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
bothfacetasksaccuracy	Equal variances assumed	1.161	.286	2.841	52	.006	4.08333	1.43740	1.19899	6.96768
	Equal variances not assumed			2.538	25.844	.018	4.08333	1.60914	.77473	7.39194

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
bothfacetasksaccuracy	older	18	60.3333	4.36564	1.02899
	veryold	18	55.0556	6.10181	1.43821

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
bothfacetasksaccuracy	Equal variances assumed	.943	.338	2.984	34	.005	5.27778	1.76841	1.68394	8.87162
	Equal variances not assumed			2.984	30.791	.006	5.27778	1.76841	1.67009	8.88546

Appendix 4.1

Table 4.1

Sample Characteristics in Studies Measuring Auditory Emotion Recognition Ability in OAs and YAs

Study	Age Group	Sample Size	Mean Age or Age Range (years)	Education (years)	Fluid Intelligence	Crystallised Intelligence	Processing speed	Memory	Executive Function	Positive Affect	Negative Affect	Alexithymia/ Empathy	Personality Traits	Other
Chaby, Boullay, Chetouani, & Plaza (2015)	YAs OAs	25 25	25.80 67.20	14.18 13.55		Mill Hill 36.87 37.48 ns					BDI 5.65 5.25			
Demenescu, Mathiak, & Mathiak (2014)	YAs MAs OAs	60 in total assume 20 in each age group.	25.76 45.76 63.80	13.81 12.90 11.87						PANAS 27.38 27.57 27.13	PANAS BDI 13.90 5.10 14.43 9.57 12.87 7.40			DSM-IV Axis 1 disorders
Dupuis & Pichora-Fuller (2010a)	YAs OAs	12 12	20.60 72.10	15.33 15.21 ns		Mill Hill 13.17 15.42 sig,								
Fecteau, Armony, Joanette, & Belin (2005)	YAs OAs	30 30	YFemale 22.5 YMale 23.70 MA/OA Female 54.60 MA/OAMale 54.50	15.30 16.10 16.50 15.30 ns										
Hunter, Phillips, & MacPherson (2010a)	YAs OAs	25 25	22.64 66.96	15.08 15.40 ns		WTAR 111.24 113.88 ns	DSST 67.76 51.20 YAs faster							
Hunter, Phillips, & MacPherson (2010b)	YAs OAs	20 20	20.00 70.55			WTAR 108.5 111.15 ns	DSST 64.35 44.60 YAs faster OAs							

Study	Age Group	Sample Size	Mean Age or Age Range (years)	Education (years)	Fluid Intelligence	Crystallised Intelligence	Processing speed	Memory	Executive Function	Positive Affect	Negative Affect	Alexithymia/ Empathy	Personality Traits	Other
Kiss & Ennis (2001)	YAs OAs	40 40	36-44 71-88		WAIS-R 111.80 108.70 ns	WAIS-R 111.40 110.30 ns		WAIS-R OAs sig lower memory than YAs across all tasks except Visual Paired associated delay condition, Digit Span forward.						
Lambrecht, Kriefelts, & Wildgruber (2012)		16 16 18 17 17	20-30 31-40 41-50 51-60 61-70	Data not given by age groups		Data not given by age groups				Data not given by age groups				Arousal Data not given by age groups
Lima, Alves, Scott, & Castro (2014)	YAs OAs		22.00 61.40	15.40 14.40		WAIS-III 27.40 26.00 ns		WAIS-III Digit span OAs lower than YAs on backward condition	Stroop test Baseline ns Conflicting OAs less able than YAs	PANAS 26.7 31.3 sig	PANAS 13.3 11.2 sig		NEO-FFI OAs lower neuroticism and extraversion than YAs but higher conscientiousness	Hearing loss Emotion regulation OAs higher than YAs for nonacceptance and lower on impulse Future time perspective OAs lower than YAs
Mill et al. (2009)	YAs MAs OAs	147 208 37	18-20 21-30 61-84	91% secondary 75% seconday/22% higher 41%secondary/45% higher									NEO-FFI	
Mitchell (2007)	YAs OAs	40 40	19.60 70.50	ns		NART 119.90 121.30		Verbalwm[1] 3 2.9s			BDI 6.6 5.9			Hearing loss

Study	Age Group	Sample Size	Mean Age or Age Range (years)	Education (years)	Fluid Intelligence	Crystallised Intelligence	Processing speed	Memory	Executive Function	Positive Affect	Negative Affect	Alexithymia/ Empathy	Personality Traits	Other
Orbelo,	YAs	38 11	30 .00	15.00										MMSE
Testa, & Ross	MAs	20	55 .00	13.00										
(2003)	OAs		74.00	13.00										
Orbelo, Grim,						RBANS – several tests including memory,								MMSE
Talbott &	YAs	30	24.00	17.00		picture labelling, list recall, story recall amongst					17.00			29.80
Ross (2005)	OAs	62	72.00	15.00		others. OAs performed less well than YAs across					15.00			28.60
				sig		most tasks except picture naming, and figure								hearing
						copy. Also OAs had lower scores on stroop task								
						than YAs								
Raithel &	YAs	12	25.8 0											hearing
Hielscher-	OAs	12	54.60											
Festabend														
(2004)														
Ryan,					CFIT	WAIS-R								Visual acuity
Murray, &	YAs	40	21.63		27.08	50.34								
Ruffman	OAs	40	65.60		18.98	57.70								
(2010)					sig.	sig.								
Schaffer,				College or post grads.	WAIS-III	WAIS-III					BDI screening			DSM-Axis 1
Wisniewski,		10	20-29	5	115	118								
Dahdah, &		10	30-39	5	117	113								
Froming		10	40-49	2	114	105								
(2009)		10	50-59	3	105	109								
		10	60-69	4	115	111								
		10	70-79	4	111	115								
					ns	ns								
Sullivan &				Undergraduates	CFIT	WAIS-SR					GDS			
Ruffman	YAs	28	22.00	Graduates	26.68	44.86								
(2004b)	OAs	28	70.00		15.82	49.00								
					sig	sig								
Wong,	YAs	20 20	19.20	14.40							GDS/BDI			
Cronin-	OAs		69.50	16.30							screening tool.			
Golomb, &														
Neargarder														
(2005)														

Note. BDI (Beck Depression Inventory (2nd Edition); Beck, Steer, & Brown, 1996; CFIT (Culture Fair Intelligence Test; Cattell & Cattell, 1959); DSST (Digit Symbol Substitution Test; Wechsler Adult Intelligent Scale); Wechsler, 1997 GDS (Geriatric Depressive Scale; Yesavage et al., 1982); Mill Hill Vocabulary Scale (Raven, Raven, & Court, 1998a); NART-R (National Adult Reading Test; Nelson, 1991; MMSE (Mini Mental State Exam; Folstein, Folstein, & McHugh, 1975) NEO-FFI (NEO-Five Factor Inventory; Costa & McCrae, 1992) PANAS (Positive and Negative Affect Schedule; Watson, Clark, & Tellegen, 1988) RBANS (Repeatable Battery for the Assessment of Neuropsychological Status; Randolph, 1998) [1]Daneman & Carpenter (1980); WAIS (Wechsler Adult Intelligent Scale; Wechsler, 1997); WTAR (Wechsler Test of Adult Reading; Psychological Corporation, 2001)

Appendix 4.2

The Files used in the Emotion Sound Task taken from the MAV Database

6_anger.wav
6_disgust.wav
6_fear.wav
6_happiness.wav
6_neutral.wav
6_sadness.wav
42_anger.wav
42_disgust.wav
42_fear.wav
42_happiness.wav
42_neutral.wav
42_sadness.wav
45_anger.wav
45_disgust.wav
45_fear.wav
45_happiness.wav
45_neutral.wav
45_sadness.wav
46_anger.wav
46_disgust.wav
46_fear.wav
46_happiness.wav
46_neutral.wav
46_sadness.wav
53_anger.wav
53_disgust.wav
53_fear.wav
53_happiness.wav
53_neutral.wav
53_sadness.wav
55_anger.wav
55_disgust.wav
55_fear.wav
55_happiness.wav
55_neutral.wav
55_sadness.wav

The Sound Files used in the Non-emotion Task

IC_D_008bbird2.wav
IC_D_008bird.wav
IC_D_012bird.wav
IC_D_bird15e.wav
IC_D_bird11.wav
IC_D_bird15e.wav
IC_D_011.cat.wav
IC_D_011d.cat3.wav
IC_D_22bcat.wav
dog2b.wav
dog3b.wav
dog4.wav
dog5.wav
doggy1b.wav
doggy5c.wav
horse2nvoc10.wav
horse3anvoc14.wav
horse4.wav
horse5a.wav
horse6a.wav
horse2a.wav
IC_C_kettle.wav
IC_D_extractorfan.wav
IC_D_hooverMP3.wav
IC_D_phone.wav
IC_D_tap.wav
IC_D_tap2.wav
insect2anvoc8.wav
insect3anvoc15.wav
insectwavnvoc16.wav
IC_cat3a.wav
IC_D_011e.cat.wav
IC_D_002a.bee.wav
IC_D_003.bee.wav
IC_D_011d.cat2.wav
IC_D_009bee.wav

Appendix 4.3

SPSS Output for the Sound Tasks in Phase 1

2*6 ANOVA Comparing Accuracy between Younger and Older Adults

Descriptive Statistics

	agegroup	Mean	Std. Deviation	N
happysoundcorrect	young	5.9722	.16667	36
	older	5.8571	.35504	35
	Total	5.9155	.28013	71
sadsoundcorrect	young	5.6389	.54263	36
	older	5.3429	.80231	35
	Total	5.4930	.69433	71
fearsoundcorrect	young	4.5833	1.67971	36
	older	4.0286	1.20014	35
	Total	4.3099	1.47930	71
angersoundcorrect	young	2.6389	1.19888	36
	older	2.1714	1.24819	35
	Total	2.4085	1.23725	71
disgustsoundcorrect	young	4.4444	.96937	36
	older	4.4857	.74247	35
	Total	4.4648	.85909	71
neutralsoundcorrect	young	5.8333	.44721	36
	older	5.1714	1.29446	35
	Total	5.5070	1.01240	71

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
agerelatedaccuracysounds	.276	86.373	14	.000	.699	.752	.200

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + agegroup
Within Subjects Design: agerelatedaccuracysounds

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
agerelatedaccuracysounds	Sphericity Assumed	583.452	5	116.690	123.563	.000	.642
	Greenhouse-Geisser	583.452	3.496	166.889	123.563	.000	.642
	Huynh-Feldt	583.452	3.759	155.221	123.563	.000	.642
	Lower-bound	583.452	1.000	583.452	123.563	.000	.642
agerelatedaccuracysounds * agegroup	Sphericity Assumed	6.457	5	1.291	1.367	.236	.019
	Greenhouse-Geisser	6.457	3.496	1.847	1.367	.250	.019
	Huynh-Feldt	6.457	3.759	1.718	1.367	.248	.019
	Lower-bound	6.457	1.000	6.457	1.367	.246	.019
Error (agerelatedaccuracysounds)	Sphericity Assumed	325.811	345	.944			
	Greenhouse-Geisser	325.811	241.227	1.351			
	Huynh-Feldt	325.811	259.361	1.256			
	Lower-bound	325.811	69.000	4.722			

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	9331.314	1	9331.314	8229.281	.000	.992
agegroup	12.478	1	12.478	11.004	.001	.138
Error	78.240	69	1.134			

1. agegroup

Measure: MEASURE_1

			95% Confidence Interval	
agegroup	Mean	Std. Error	Lower Bound	Upper Bound
young	4.852	.072	4.707	4.996
older	4.510	.073	4.363	4.656

Post hoc Tests Investigating the Main Effect of Emotion Type

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	happysoundcorrect - sadsoundcorrect	.42254	.73020	.08666	.24970	.59537	4.876	70	.000
Pair 2	happysoundcorrect - fearsoundcorrect	1.60563	1.49742	.17771	1.25120	1.96007	9.035	70	.000
Pair 3	happysoundcorrect - angersoundcorrect	3.50704	1.26348	.14995	3.20798	3.80610	23.388	70	.000
Pair 4	happysoundcorrect - disgustsoundcorrect	1.45070	.87487	.10383	1.24363	1.65778	13.972	70	.000
Pair 5	happysoundcorrect - neutralsoundcorrect	.40845	1.06338	.12620	.15675	.66015	3.237	70	.002
Pair 6	sadsoundcorrect - fearsoundcorrect	1.18310	1.60633	.19064	.80289	1.56331	6.206	70	.000
Pair 7	sadsoundcorrect - angersoundcorrect	3.08451	1.39126	.16511	2.75520	3.41381	18.681	70	.000
Pair 8	sadsoundcorrect - disgustsoundcorrect	1.02817	1.06867	.12683	.77522	1.28112	8.107	70	.000
Pair 9	sadsoundcorrect - neutralsoundcorrect	-.01408	1.11474	.13230	-.27794	.24977	-.106	70	.916
Pair 10	fearsoundcorrect - angersoundcorrect	1.90141	1.89099	.22442	1.45382	2.34900	8.473	70	.000
Pair 11	fearsoundcorrect - disgustsoundcorrect	-.15493	1.58247	.18781	-.52950	.21964	-.825	70	.412
Pair 12	fearsoundcorrect - neutralsoundcorrect	-1.19718	1.78581	.21194	-1.61988	-.77449	-5.649	70	.000
Pair 13	angersoundcorrect - disgustsoundcorrect	-2.05634	1.32974	.15781	-2.37108	-1.74159	-13.030	70	.000
Pair 14	angersoundcorrect - neutralsoundcorrect	-3.09859	1.55981	.18512	-3.46779	-2.72939	-16.739	70	.000
Pair 15	disgustsoundcorrect - neutralsoundcorrect	-1.04225	1.35685	.16103	-1.36342	-.72109	-6.472	70	.000

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
happysoundcorrect	Equal variances assumed	14.611	.000	1.756	69	.083	.11508	.06553	-.01565	.24580
	Equal variances not assumed			1.740	47.990	.088	.11508	.06613	-.01788	.24804
sadsoundcorrect	Equal variances assumed	5.893	.018	1.826	69	.072	.29603	.16214	-.02743	.61949
	Equal variances not assumed			1.816	59.528	.074	.29603	.16300	-.03008	.62214
fearsoundcorrect	Equal variances assumed	4.433	.039	1.597	69	.115	.55476	.34733	-.13814	1.24766
	Equal variances not assumed			1.605	63.409	.114	.55476	.34572	-.13603	1.24555
angersoundcorrect	Equal variances assumed	.013	.910	1.610	69	.112	.46746	.29042	-.11190	1.04683
	Equal variances not assumed			1.609	68.675	.112	.46746	.29058	-.11229	1.04721
disgustsoundcorrect	Equal variances assumed	2.757	.101	-.201	69	.841	-.04127	.20534	-.45092	.36838
	Equal variances not assumed			-.202	65.451	.841	-.04127	.20458	-.44979	.36725
neutralsoundcorrect	Equal variances assumed	23.197	.000	2.896	69	.005	.66190	.22857	.20593	1.11788
	Equal variances not assumed			2.864	41.802	.007	.66190	.23115	.19536	1.12845
totalemotionsoundcorrect	Equal variances assumed	.264	.609	3.299	69	.002	2.11111	.64000	.83435	3.38787
	Equal variances not assumed			3.297	68.646	.002	2.11111	.64039	.83344	3.38878

3*6 ANOVA Comparing Accuracy across the Three Age Groups

Descriptive Statistics

	agegroup	Mean	Std. Deviation	N
happysoundcorrect	young	5.9722	.16667	36
	older	5.8333	.38348	18
	veryold	5.8824	.33211	17
	Total	5.9155	.28013	71
sadsoundcorrect	young	5.6389	.54263	36
	older	5.3889	.69780	18
	veryold	5.2941	.91956	17
	Total	5.4930	.69433	71
fearsoundcorrect	young	4.5833	1.67971	36
	older	4.1111	.96338	18
	veryold	3.9412	1.43486	17
	Total	4.3099	1.47930	71
angersoundcorrect	young	2.6389	1.19888	36
	older	2.3333	1.28338	18
	veryold	2.0000	1.22474	17
	Total	2.4085	1.23725	71
disgustsoundcorrect	young	4.4444	.96937	36
	older	4.2222	.54832	18
	veryold	4.7647	.83137	17
	Total	4.4648	.85909	71
neutralsoundcorrect	young	5.8333	.44721	36
	older	5.2222	1.35280	18
	veryold	5.1176	1.26897	17
	Total	5.5070	1.01240	71

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
agerelatedsoundaccuracy	.268	87.086	14	.000	.691	.753	.200

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + agegroup
Within Subjects Design: agerelatedsoundaccuracy

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
agerelatedsoundaccuracy	Sphericity Assumed	528.911	5	105.782	111.752	.000	.622
	Greenhouse-Geisser	528.911	3.453	153.187	111.752	.000	.622
	Huynh-Feldt	528.911	3.767	140.410	111.752	.000	.622
	Lower-bound	528.911	1.000	528.911	111.752	.000	.622
agerelatedsoundaccuracy * agegroup	Sphericity Assumed	10.431	10	1.043	1.102	.360	.031
	Greenhouse-Geisser	10.431	6.905	1.511	1.102	.363	.031
	Huynh-Feldt	10.431	7.534	1.385	1.102	.362	.031
	Lower-bound	10.431	2.000	5.216	1.102	.338	.031
Error (agerelatedsoundaccuracy)	Sphericity Assumed	321.837	340	.947			
	Greenhouse-Geisser	321.837	234.785	1.371			
	Huynh-Feldt	321.837	256.150	1.256			
	Lower-bound	321.837	68.000	4.733			

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	8120.066	1	8120.066	7058.921	.000	.990
agegroup	12.496	2	6.248	5.432	.006	.138
Error	78.222	68	1.150			

1. agegroup

Measure: MEASURE_1

agegroup	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
young	4.852	.073	4.706	4.997
older	4.519	.103	4.313	4.724
veryold	4.500	.106	4.288	4.712

2. agerelatedsoundaccuracy

Measure: MEASURE_1

agerelatedsoundaccuracy	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	5.896	.035	5.826	5.966
2	5.441	.086	5.268	5.613
3	4.212	.185	3.843	4.581
4	2.324	.154	2.016	2.632
5	4.477	.107	4.264	4.690
6	5.391	.122	5.148	5.634

Post hoc Tests Investigating the Main Effect of Age Group

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
totalemotionsoundcorrect	young	36	29.1111	2.63794	.43966
	older	18	27.1111	2.29805	.54166

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference: Lower	Upper
totalemotionsoundcorrect	Equal variances assumed	.124	.727	2.736	52	.008	2.00000	.73088	.53338	3.46662
	Equal variances not assumed			2.867	38.634	.007	2.00000	.69763	.58848	3.41152

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
totalemotionsoundcorrect	young	36	29.1111	2.63794	.43966
	veryold	17	26.8824	3.23810	.78535

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference: Lower	Upper
totalemotionsoundcorrect	Equal variances assumed	.310	.580	2.667	51	.010	2.22876	.83573	.55096	3.90656
	Equal variances not assumed			2.476	26.414	.020	2.22876	.90004	.38010	4.07742

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
totalemotionsoundcorrect	older	18	27.1111	2.29805	.54166
	veryold	17	26.8824	3.23810	.78535

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference: Lower	Upper
totalemotionsoundcorrect	Equal variances assumed	.075	.786	.242	33	.810	.22876	.94480	-1.69346	2.15097
	Equal variances not assumed			.240	28.725	.812	.22876	.95403	-1.72326	2.18078

Comparing Accuracy on the Non-emotion and Emotion Sound Tasks between Younger and Older Adults

Descriptive Statistics

	agegroup	Mean	Std. Deviation	N
totalcontrolsoundcorrect	young	30.8889	2.30252	36
	older	28.8857	3.19716	35
	Total	29.9014	2.93820	71
totalemotionsoundcorrect	young	29.1111	2.63794	36
	older	27.0000	2.75468	35
	Total	28.0704	2.88010	71

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Content_type	Sphericity Assumed	119.089	1	119.089	20.245	.000	.227
	Greenhouse-Geisser	119.089	1.000	119.089	20.245	.000	.227
	Huynh-Feldt	119.089	1.000	119.089	20.245	.000	.227
	Lower-bound	119.089	1.000	119.089	20.245	.000	.227
Content_type * agegroup	Sphericity Assumed	.103	1	.103	.018	.895	.000
	Greenhouse-Geisser	.103	1.000	.103	.018	.895	.000
	Huynh-Feldt	.103	1.000	.103	.018	.895	.000
	Lower-bound	.103	1.000	.103	.018	.895	.000
Error(Content_type)	Sphericity Assumed	405.883	69	5.882			
	Greenhouse-Geisser	405.883	69.000	5.882			
	Huynh-Feldt	405.883	69.000	5.882			
	Lower-bound	405.883	69.000	5.882			

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	119163.158	1	119163.158	13076.704	.000	.995
agegroup	150.200	1	150.200	16.483	.000	.193
Error	628.771	69	9.113			

1. agegroup

Measure: MEASURE_1

agegroup	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
young	30.000	.356	29.290	30.710
older	27.943	.361	27.223	28.663

2. Content_type

Measure: MEASURE_1

Content_type	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	29.887	.330	29.229	30.545
2	28.056	.320	27.417	28.694

Comparing Accuracy on the Non-emotion and Emotion Sound Tasks across the Three Age Groups

Descriptive Statistics

	agegroup	Mean	Std. Deviation	N
totalcontrolsoundcorrect	young	30.8889	2.30252	36
	older	30.1667	2.68438	18
	veryold	27.5294	3.20386	17
	Total	29.9014	2.93820	71
totalemotionsoundcorrect	young	29.1111	2.63794	36
	older	27.1111	2.29805	18
	veryold	26.8824	3.23810	17
	Total	28.0704	2.88010	71

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
content	Sphericity Assumed	105.639	1	105.639	18.878	.000	.217	18.878	.990
	Greenhouse-Geisser	105.639	1.000	105.639	18.878	.000	.217	18.878	.990
	Huynh-Feldt	105.639	1.000	105.639	18.878	.000	.217	18.878	.990
	Lower-bound	105.639	1.000	105.639	18.878	.000	.217	18.878	.990
content * agegroup	Sphericity Assumed	25.461	2	12.731	2.275	.111	.063	4.550	.447
	Greenhouse-Geisser	25.461	2.000	12.731	2.275	.111	.063	4.550	.447
	Huynh-Feldt	25.461	2.000	12.731	2.275	.111	.063	4.550	.447
	Lower-bound	25.461	2.000	12.731	2.275	.111	.063	4.550	.447
Error(content)	Sphericity Assumed	380.525	68	5.596					
	Greenhouse-Geisser	380.525	68.000	5.596					
	Huynh-Feldt	380.525	68.000	5.596					
	Lower-bound	380.525	68.000	5.596					

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	103678.776	1	103678.776	11891.686	.000	.994	11891.686	1.000
agegroup	186.107	2	93.054	10.673	.000	.239	21.346	.987
Error	592.864	68	8.719					

a. Computed using alpha = .05

1. agegroup

Measure: MEASURE_1

agegroup	Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
young	30.000	.348	29.306	30.694
older	28.639	.492	27.657	29.621
veryold	27.206	.506	26.195	28.216

2. content

Measure: MEASURE_1

content	Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
1	29.528	.331	28.867	30.189
2	27.702	.341	27.021	28.382

Post hoc Tests Investigating the Main Effect of Age Group

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
totalsound2accuracy	young	36	60.0000	3.93519	.65586
	older	18	57.2778	3.59420	.84716

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
totalsound2accuracy	Equal variances assumed	.041	.841	2.464	52	.017	2.72222	1.10478	.50533	4.93912
	Equal variances not assumed			2.541	37.025	.015	2.72222	1.07137	.55146	4.89298

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
totalsound2accuracy	young	36	60.0000	3.93519	.65586
	veryold	17	54.4118	5.14853	1.24870

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
totalsound2accuracy	Equal variances assumed	.923	.341	4.363	51	.000	5.58824	1.28083	3.01686	8.15961
	Equal variances not assumed			3.962	25.170	.001	5.58824	1.41047	2.68432	8.49215

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
totalsound2accuracy	older	18	57.2778	3.59420	.84716
	veryold	17	54.4118	5.14853	1.24870

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
totalsound2accuracy	Equal variances assumed	.986	.328	1.919	33	.064	2.86601	1.49372	-.17297	5.90500
	Equal variances not assumed			1.899	28.446	.068	2.86601	1.50895	-.22275	5.95478

Appendix 5.1

The Words Included in the Emotion Recognition Task

Emotion	Happy	Sad	Fear	Anger	Disgust	Neutral
	ecstatic	despair	dreaded	mad	repugnance	haphazard
	jovial	sorrow	nightmare	fuming	appalled	nonsense
	giddy	grief	terror	furious	repulsion	vanity
	gleeful	forlorn	scared	livid	revolting	lazy
	merry	gloomy	phobic	infuriated	abhorrent	engine
	pleased	miserable	fright	outraged	nauseated	muddy

Appendix 5.2

t-tests for Word Frequency and Length for Emotion Word Categories

	Frequency/length	*t*	*p*
Happy-Sad	F	.072	.944
	L	.447	.664
Happy-Anger	F	.000	1.0
	L	.150	.883
Happy-Fear	F	.043	.967
	L	.082	.421
Happy-Disgust	F	.064	.951
	L	1.190	.262
Happy-Neutral	F	.175	.865
	L	.499	.629
Sad-Angry	F	.941	.076
	L	.146	.886
Sad-Fear	F	.032	.975
	L	.546	.597
Sad-Disgust	F	.019	.985
	L	.822	.430
Sad-Neutral	F	.489	.635
	L	.161	.875
Anger- Fear	F	.045	.965
	L	.727	.583
Anger-Disgust	F	.065	.949
	L	.767	.461
Anger-Neutral	F	.186	.856
	L	.252	.806
Fear-Disgust	F	.035	.972
	L	.121	.906
Fear-Neutral	F	.311	.762
	L	.359	.727
Disgust-Neutral	F	.215	.834
	L	.548	.595

Appendix 5.3

The Words used in the Non-emotion Recognition Task

Body Part	Hand	Eyes	Hair	Body	Teeth	None
	finger	sighted	highlights	rotund	crooked	obsession
	gloved	pupil	bob	chubby	drill	pamphlet
	varnish	lenses	conditioner	slight	chew	hide
	knuckles	blink	curly	skeleton	dentist	storm
	applause	visually	brunette	lithe	fillings	derelict
	clap	optical	shampoo	physique	dentures	obey

Appendix 5.4

t-tests for Word Frequency and Length for Non-emotion Word Categories

	Frequency/length	t	p
Hand-Hair	F	.108	.916
	L	.123	.904
Hand-Teeth	F	.409	.691
	L	.356	.729
Hand-Body	F	.122	.906
	L	.000	1
Hand-Eyes	F	.071	.833
	L	.452	.333
Hand-None	F	.143	.890
	L	.150	.883
Hair-Teeth	F	.309	.764
	L	.359	.727
Hair-Body	F	.032	.975
	L	.128	.901
Hair-Eyes	F	.015	.988
	L	.395	.701
Hair-None	F	.022	.983
	L	.220	.830
Teeth-Body	F	.190	.853
	L	.386	.707
Teeth-Eyes	F	.224	.827
	L	.000	1
Teeth-None	F	.376	.715
	L	.144	.888
Body-Eyes	F	.040	.969
	L	.520	.614
Body-None	F	.018	.986
	L	.159	.877
Eyes-None	F	.032	.975
	L	.166	.871

Appendix 5.5

SPSS output for the Word Tasks in Phase 1

Comparing Emotion Recognition between Younger and Older Adults

Descriptive Statistics

	agegroup	Mean	Std. Deviation	N
happywordcorrect	young	5.5278	.69636	36
	older	5.6286	.49024	35
	Total	5.5775	.60147	71
sadwordcorrect	young	4.8056	.85589	36
	older	5.4286	.88403	35
	Total	5.1127	.91884	71
fearwordcorrect	young	4.8889	1.03586	36
	older	5.1714	.95442	35
	Total	5.0282	.99960	71
angerwordcorrect	young	5.5000	.81064	36
	older	5.3143	.79600	35
	Total	5.4085	.80316	71
disgustwordcorrect	young	4.1667	1.15882	36
	older	4.8857	1.34539	35
	Total	4.5211	1.29680	71
neutralwordcorrect	young	4.5833	1.25071	36
	older	5.1429	1.19171	35
	Total	4.8592	1.24552	71

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Emotion_type	.471	50.577	14	.000	.783	.848	.200

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + agegroup
Within Subjects Design: Emotion_type

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Emotion_type	Sphericity Assumed	50.579	5	10.116	13.974	.000	.168
	Greenhouse-Geisser	50.579	3.913	12.926	13.974	.000	.168
	Huynh-Feldt	50.579	4.238	11.935	13.974	.000	.168
	Lower-bound	50.579	1.000	50.579	13.974	.000	.168
Emotion_type * agegroup	Sphericity Assumed	10.795	5	2.159	2.982	.012	.041
	Greenhouse-Geisser	10.795	3.913	2.759	2.982	.020	.041
	Huynh-Feldt	10.795	4.238	2.547	2.982	.017	.041
	Lower-bound	10.795	1.000	10.795	2.982	.089	.041
Error(Emotion_type)	Sphericity Assumed	249.745	345	.724			
	Greenhouse-Geisser	249.745	269.993	.925			
	Huynh-Feldt	249.745	292.400	.854			
	Lower-bound	249.745	69.000	3.619			

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	11021.531	1	11021.531	4994.741	.000	.986
agegroup	13.034	1	13.034	5.907	.018	.079
Error	152.257	69	2.207			

1. agegroup

Measure: MEASURE_1

			95% Confidence Interval	
agegroup	Mean	Std. Error	Lower Bound	Upper Bound
young	4.912	.101	4.710	5.114
older	5.262	.103	5.057	5.466

2. Emotion_type

Measure: MEASURE_1

			95% Confidence Interval	
Emotion_type	Mean	Std. Error	Lower Bound	Upper Bound
1	5.578	.072	5.435	5.721
2	5.117	.103	4.911	5.323
3	5.030	.118	4.794	5.266
4	5.407	.095	5.217	5.597
5	4.526	.149	4.229	4.823
6	4.863	.145	4.574	5.152

Post hoc Tests Investigating the Main Effect of Emotion Type

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	happywordcorrect & sadwordcorrect	71	.423	.000
Pair 2	happywordcorrect & fearwordcorrect	71	.234	.050
Pair 3	happywordcorrect & angerwordcorrect	71	.274	.021
Pair 4	happywordcorrect & disgustwordcorrect	71	.451	.000
Pair 5	happywordcorrect & neutralwordcorrect	71	.148	.217
Pair 6	sadwordcorrect & fearwordcorrect	71	.339	.004
Pair 7	sadwordcorrect & angerwordcorrect	71	.266	.025
Pair 8	sadwordcorrect & disgustwordcorrect	71	.394	.001
Pair 9	sadwordcorrect & neutralwordcorrect	71	.414	.000
Pair 10	fearwordcorrect & angerwordcorrect	71	.270	.023
Pair 11	fearwordcorrect & disgustwordcorrect	71	.132	.273
Pair 12	fearwordcorrect & neutralwordcorrect	71	.152	.205
Pair 13	angerwordcorrect & disgustwordcorrect	71	.273	.021
Pair 14	angerwordcorrect & neutralwordcorrect	71	.315	.007
Pair 15	disgustwordcorrect & neutralwordcorrect	71	.276	.020

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	happywordcorrect - sadwordcorrect	.46479	.85909	.10195	.26145	.66813	4.559	70	.000
Pair 2	happywordcorrect - fearwordcorrect	.54930	1.03908	.12332	.30335	.79524	4.454	70	.000
Pair 3	happywordcorrect - angerwordcorrect	.16901	.86166	.10226	-.03494	.37297	1.653	70	.103
Pair 4	happywordcorrect - disgustwordcorrect	1.05634	1.15743	.13736	.78238	1.33030	7.690	70	.000
Pair 5	happywordcorrect - neutralwordcorrect	.71831	1.30036	.15432	.41052	1.02610	4.655	70	.000
Pair 6	sadwordcorrect - fearwordcorrect	.08451	1.10514	.13116	-.17707	.34609	.644	70	.521
Pair 7	sadwordcorrect - angerwordcorrect	-.29577	1.04737	.12430	-.54368	-.04787	-2.380	70	.020
Pair 8	sadwordcorrect - disgustwordcorrect	.59155	1.26013	.14955	.29328	.88982	3.956	70	.000
Pair 9	sadwordcorrect - neutralwordcorrect	.25352	1.20378	.14286	-.03141	.53845	1.775	70	.080
Pair 10	fearwordcorrect - angerwordcorrect	-.38028	1.10021	.13057	-.64070	-.11987	-2.912	70	.005
Pair 11	fearwordcorrect - disgustwordcorrect	.50704	1.52946	.18151	.14503	.86906	2.793	70	.007
Pair 12	fearwordcorrect - neutralwordcorrect	.16901	1.47344	.17487	-.17974	.51777	.967	70	.337
Pair 13	angerwordcorrect - disgustwordcorrect	.88732	1.32610	.15738	.57344	1.20121	5.638	70	.000
Pair 14	angerwordcorrect - neutralwordcorrect	.54930	1.25116	.14848	.25315	.84544	3.699	70	.000
Pair 15	disgustwordcorrect - neutralwordcorrect	-.33803	1.53011	.18159	-.70020	.02414	-1.861	70	.067

*Post hoc Tests Investigating the Age Group*Emotion Type Interaction*

Comparing between YAs and OAs

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
happywordcorrect	Equal variances assumed	2.695	.105	-.703	69	.484	-.10079	.14330	-.38666	.18507
	Equal variances not assumed			-.707	62.942	.482	-.10079	.14261	-.38578	.18419
sadwordcorrect	Equal variances assumed	.003	.954	-3.017	69	.004	-.62302	.20649	-1.03495	-.21108
	Equal variances not assumed			-3.016	68.745	.004	-.62302	.20658	-1.03517	-.21086
fearwordcorrect	Equal variances assumed	.056	.814	-1.194	69	.236	-.28254	.23656	-.75447	.18939
	Equal variances not assumed			-1.196	68.805	.236	-.28254	.23629	-.75395	.18887
angerwordcorrect	Equal variances assumed	.000	.996	.974	69	.334	.18571	.19073	-.19477	.56620
	Equal variances not assumed			.974	68.993	.333	.18571	.19068	-.19467	.56610
disgustwordcorrect	Equal variances assumed	.076	.783	-2.415	69	.018	-.71905	.29773	-1.31300	-.12510
	Equal variances not assumed			-2.410	66.917	.019	-.71905	.29836	-1.31459	-.12351
neutralwordcorrect	Equal variances assumed	.392	.534	-1.929	69	.058	-.55952	.29008	-1.13821	.01916
	Equal variances not assumed			-1.930	68.973	.058	-.55952	.28988	-1.13782	.01877
totalemotionwordcorrect	Equal variances assumed	.356	.553	-2.430	69	.018	-2.09921	.86374	-3.82232	-.37609
	Equal variances not assumed			-2.438	66.892	.017	-2.09921	.86121	-3.81824	-.38017

The pattern of recognition accuracy across emotion types in YAs

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	happywordcorrect	5.5278	36	.69636	.11606
	sadwordcorrect	4.8056	36	.85589	.14265
Pair 2	happywordcorrect	5.5278	36	.69636	.11606
	fearwordcorrect	4.8889	36	1.03586	.17264
Pair 3	happywordcorrect	5.5278	36	.69636	.11606
	angerwordcorrect	5.5000	36	.81064	.13511
Pair 4	happywordcorrect	5.5278	36	.69636	.11606
	disgustwordcorrect	4.1667	36	1.15882	.19314
Pair 5	happywordcorrect	5.5278	36	.69636	.11606
	neutralwordcorrect	4.5833	36	1.25071	.20845
Pair 6	sadwordcorrect	4.8056	36	.85589	.14265
	fearwordcorrect	4.8889	36	1.03586	.17264
Pair 7	sadwordcorrect	4.8056	36	.85589	.14265
	angerwordcorrect	5.5000	36	.81064	.13511
Pair 8	sadwordcorrect	4.8056	36	.85589	.14265
	disgustwordcorrect	4.1667	36	1.15882	.19314
Pair 9	sadwordcorrect	4.8056	36	.85589	.14265
	neutralwordcorrect	4.5833	36	1.25071	.20845
Pair 10	fearwordcorrect	4.8889	36	1.03586	.17264
	angerwordcorrect	5.5000	36	.81064	.13511
Pair 11	fearwordcorrect	4.8889	36	1.03586	.17264
	disgustwordcorrect	4.1667	36	1.15882	.19314
Pair 12	fearwordcorrect	4.8889	36	1.03586	.17264
	neutralwordcorrect	4.5833	36	1.25071	.20845
Pair 13	angerwordcorrect	5.5000	36	.81064	.13511
	disgustwordcorrect	4.1667	36	1.15882	.19314
Pair 14	angerwordcorrect	5.5000	36	.81064	.13511
	neutralwordcorrect	4.5833	36	1.25071	.20845
Pair 15	disgustwordcorrect	4.1667	36	1.15882	.19314
	neutralwordcorrect	4.5833	36	1.25071	.20845

a. agegroup = young

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	happywordcorrect - sadwordcorrect	.72222	.77868	.12978	.45875	.98569	5.565	35	.000
Pair 2	happywordcorrect - fearwordcorrect	.63889	1.09942	.18324	.26690	1.01088	3.487	35	.001
Pair 3	happywordcorrect - angerwordcorrect	.02778	.87786	.14631	-.26925	.32480	.190	35	.851
Pair 4	happywordcorrect - disgustwordcorrect	1.36111	.93052	.15509	1.04627	1.67595	8.776	35	.000
Pair 5	happywordcorrect - neutralwordcorrect	.94444	1.24084	.20681	.52460	1.36428	4.567	35	.000
Pair 6	sadwordcorrect - fearwordcorrect	-.08333	1.15573	.19262	-.47438	.30771	-.433	35	.668
Pair 7	sadwordcorrect - angerwordcorrect	-.69444	.82183	.13697	-.97251	-.41638	-5.070	35	.000
Pair 8	sadwordcorrect - disgustwordcorrect	.63889	1.04616	.17436	.28492	.99286	3.664	35	.001
Pair 9	sadwordcorrect - neutralwordcorrect	.22222	1.07201	.17867	-.14049	.58494	1.244	35	.222
Pair 10	fearwordcorrect - angerwordcorrect	-.61111	1.15333	.19222	-1.00134	-.22088	-3.179	35	.003
Pair 11	fearwordcorrect - disgustwordcorrect	.72222	1.38587	.23098	.25331	1.19113	3.127	35	.004
Pair 12	fearwordcorrect - neutralwordcorrect	.30556	1.47007	.24501	-.19185	.80296	1.247	35	.221
Pair 13	angerwordcorrect - disgustwordcorrect	1.33333	.98561	.16427	.99985	1.66682	8.117	35	.000
Pair 14	angerwordcorrect - neutralwordcorrect	.91667	1.15573	.19262	.52562	1.30771	4.759	35	.000
Pair 15	disgustwordcorrect - neutralwordcorrect	-.41667	1.50000	.25000	-.92419	.09086	-1.667	35	.105

a. agegroup = young

The pattern of recognition accuracy across emotion types in OAs

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	happywordcorrect	5.6286	35	.49024	.08287
	sadwordcorrect	5.4286	35	.88403	.14943
Pair 2	happywordcorrect	5.6286	35	.49024	.08287
	fearwordcorrect	5.1714	35	.95442	.16133
Pair 3	happywordcorrect	5.6286	35	.49024	.08287
	angerwordcorrect	5.3143	35	.79600	.13455
Pair 4	happywordcorrect	5.6286	35	.49024	.08287
	disgustwordcorrect	4.8857	35	1.34539	.22741
Pair 5	happywordcorrect	5.6286	35	.49024	.08287
	neutralwordcorrect	5.1429	35	1.19171	.20144
Pair 6	sadwordcorrect	5.4286	35	.88403	.14943
	fearwordcorrect	5.1714	35	.95442	.16133
Pair 7	sadwordcorrect	5.4286	35	.88403	.14943
	angerwordcorrect	5.3143	35	.79600	.13455
Pair 8	sadwordcorrect	5.4286	35	.88403	.14943
	disgustwordcorrect	4.8857	35	1.34539	.22741
Pair 9	sadwordcorrect	5.4286	35	.88403	.14943
	neutralwordcorrect	5.1429	35	1.19171	.20144
Pair 10	fearwordcorrect	5.1714	35	.95442	.16133
	angerwordcorrect	5.3143	35	.79600	.13455
Pair 11	fearwordcorrect	5.1714	35	.95442	.16133
	disgustwordcorrect	4.8857	35	1.34539	.22741
Pair 12	fearwordcorrect	5.1714	35	.95442	.16133
	neutralwordcorrect	5.1429	35	1.19171	.20144
Pair 13	angerwordcorrect	5.3143	35	.79600	.13455
	disgustwordcorrect	4.8857	35	1.34539	.22741
Pair 14	angerwordcorrect	5.3143	35	.79600	.13455
	neutralwordcorrect	5.1429	35	1.19171	.20144
Pair 15	disgustwordcorrect	4.8857	35	1.34539	.22741
	neutralwordcorrect	5.1429	35	1.19171	.20144

a. agegroup = older

Paired Samples Test[a]

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	happywordcorrect - sadwordcorrect	.20000	.86772	.14667	-.09807	.49807	1.364	34	.182
Pair 2	happywordcorrect - fearwordcorrect	.45714	.98048	.16573	.12034	.79395	2.758	34	.009
Pair 3	happywordcorrect - angerwordcorrect	.31429	.83213	.14066	.02844	.60013	2.234	34	.032
Pair 4	happywordcorrect - disgustwordcorrect	.74286	1.29121	.21825	.29931	1.18640	3.404	34	.002
Pair 5	happywordcorrect - neutralwordcorrect	.48571	1.33662	.22593	.02657	.94486	2.150	34	.039
Pair 6	sadwordcorrect - fearwordcorrect	.25714	1.03875	.17558	-.09968	.61396	1.465	34	.152
Pair 7	sadwordcorrect - angerwordcorrect	.11429	1.10537	.18684	-.26542	.49399	.612	34	.545
Pair 8	sadwordcorrect - disgustwordcorrect	.54286	1.46213	.24714	.04060	1.04512	2.197	34	.035
Pair 9	sadwordcorrect - neutralwordcorrect	.28571	1.34101	.22667	-.17494	.74637	1.260	34	.216
Pair 10	fearwordcorrect - angerwordcorrect	-.14286	1.00419	.16974	-.48781	.20210	-.842	34	.406
Pair 11	fearwordcorrect - disgustwordcorrect	.28571	1.65514	.27977	-.28285	.85428	1.021	34	.314
Pair 12	fearwordcorrect - neutralwordcorrect	.02857	1.48494	.25100	-.48152	.53867	.114	34	.910
Pair 13	angerwordcorrect - disgustwordcorrect	.42857	1.48097	.25033	-.08016	.93730	1.712	34	.096
Pair 14	angerwordcorrect - neutralwordcorrect	.17143	1.24819	.21098	-.25734	.60020	.813	34	.422
Pair 15	disgustwordcorrect - neutralwordcorrect	-.25714	1.57821	.26677	-.79928	.28499	-.964	34	.342

a. agegroup = older

Run MATRIX procedure:

*************** PROCESS Procedure for SPSS Version 3.00 ****************

Written by Andrew F. Hayes, Ph.D. www.afhayes.com
Documentation available in Hayes (2018). www.guilford.com/p/hayes3

****

Model : 4
Y : totalemo
X : agegroup
M : crystall

Sample
Size: 71

****

OUTCOME VARIABLE:
Verbal intelligence

Model Summary

R	R-sq	MSE	F	df1	df2	p
.8415	.7082	13.0780	167.4557	1.0000	69.0000	.0000

Model

	coeff	se	t	p	LLCI	ULCI
constant	15.6968	1.3516	11.6137	.0000	13.0005	18.3932
agegroup	**11.1087**	**.8584**	**12.9405**	**.0000**	**9.3962**	**12.8213**

****

OUTCOME VARIABLE:
totalemo

Model Summary

R	R-sq	MSE	F	df1	df2	p
.3471	.1205	12.8273	4.6576	2.0000	68.0000	.0127

Model

	coeff	se	t	p	LLCI	ULCI
constant	24.0155	2.3009	10.4374	.0000	19.4240	28.6069
agegroup	-.2770	1.5738	-.1760	.8608	-3.4175	2.8636
crystall	.2139	.1192	1.7941	.0772	-.0240	.4518

************************* TOTAL EFFECT MODEL
****

OUTCOME VARIABLE:
Total emotion recognition

Model Summary

R	R-sq	MSE	F	df1	df2	p
.2808	.0789	13.2398	5.9067	1.0000	69.0000	.0177

Model

	coeff	se	t	p	LLCI	ULCI
constant	27.3730	1.3599	20.1285	.0000	24.6601	30.0860
agegroup	**2.0992**	**.8637**	**2.4304**	**.0177**	**.3761**	**3.8223**

************** TOTAL, DIRECT, AND INDIRECT EFFECTS OF X ON Y
****

Total effect of X on Y

Effect	se	t	p	LLCI	ULCI	c_ps
2.0992	.8637	2.4304	.0177	.3761	3.8223	.5577

Direct effect of X on Y

Effect	se	t	p	LLCI	ULCI	c'_ps
-.2770	1.5738	-.1760	.8608	-3.4175	2.8636	-.0736

Indirect effect(s) of X on Y:

	Effect	BootSE	BootLLCI	BootULCI
crystall	**2.3762**	**1.5438**	**-.9429**	**5.0412**

Partially standardized indirect effect(s) of X on Y:

	Effect	BootSE	BootLLCI	BootULCI
crystall	.6313	.4024	-.2436	1.3145

*********** BOOTSTRAP RESULTS FOR REGRESSION MODEL PARAMETERS
****

OUTCOME VARIABLE:
crystall

	Coeff	BootMean	BootSE	BootLLCI	BootULCI
constant	15.6968	15.7747	1.4136	12.8132	18.6516
agegroup	11.1087	11.0713	.8488	9.4258	12.7714

OUTCOME VARIABLE:
totalemo

	Coeff	BootMean	BootSE	BootLLCI	BootULCI
constant	24.0155	24.2408	2.6514	19.0192	29.2837
agegroup	-.2770	-.1727	1.6823	-3.3299	3.4067
crystall	.2139	.2023	.1362	-.0840	.4487

********************** ANALYSIS NOTES AND ERRORS
****

Level of confidence for all confidence intervals in output:
95.0000

Number of bootstrap samples for percentile bootstrap confidence intervals:
1000

NOTE: Variables names longer than eight characters can produce incorrect output.
Shorter variable names are recommended.

------ END MATRIX -----

3*6 ANOVA Comparing across the Three Age Groups

Between-Subjects Factors

		Value Label	N
agegroup	1.00	young	36
	2.00	older	18
	3.00	veryold	18

Descriptive Statistics

	agegroup	Mean	Std. Deviation	N
happywordcorrect	young	5.5278	.69636	36
	older	5.7222	.46089	18
	veryold	5.5000	.51450	18
	Total	5.5694	.60109	72
sadwordcorrect	young	4.8056	.85589	36
	older	5.6111	.50163	18
	veryold	5.1667	1.15045	18
	Total	5.0972	.92172	72
fearwordcorrect	young	4.8889	1.03586	36
	older	5.4444	.85559	18
	veryold	4.8889	.96338	18
	Total	5.0278	.99254	72
angerwordcorrect	young	5.5000	.81064	36
	older	5.5556	.61570	18
	veryold	5.0000	.90749	18
	Total	5.3889	.81458	72
disgustwordcorrect	young	4.1667	1.15882	36
	older	4.6667	1.57181	18
	veryold	5.0000	1.13759	18
	Total	4.5000	1.30005	72
neutralwordcorrect	young	4.5833	1.25071	36
	older	4.8889	1.36722	18
	veryold	5.2222	1.21537	18
	Total	4.8194	1.28179	72

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
emotion	.462	51.875	14	.000	.778	.854	.200

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + agegroup
Within Subjects Design: emotion

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
emotion	Sphericity Assumed	37.860	5	7.572	10.574	.000	.133	52.871	1.000
	Greenhouse-Geisser	37.860	3.890	9.732	10.574	.000	.133	41.135	1.000
	Huynh-Feldt	37.860	4.271	8.864	10.574	.000	.133	45.163	1.000
	Lower-bound	37.860	1.000	37.860	10.574	.002	.133	10.574	.894
emotion * agegroup	Sphericity Assumed	18.076	10	1.808	2.524	.006	.068	25.243	.952
	Greenhouse-Geisser	18.076	7.780	2.323	2.524	.012	.068	19.640	.903
	Huynh-Feldt	18.076	8.542	2.116	2.524	.010	.068	21.563	.924
	Lower-bound	18.076	2.000	9.038	2.524	.087	.068	5.049	.489
Error(emotion)	Sphericity Assumed	247.051	345	.716					
	Greenhouse-Geisser	247.051	268.420	.920					
	Huynh-Feldt	247.051	294.705	.838					
	Lower-bound	247.051	69.000	3.580					

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	10187.490	1	10187.490	4330.824	.000	.984	4330.824	1.000
agegroup	12.243	2	6.122	2.602	.081	.070	5.205	.502
Error	162.310	69	2.352					

a. Computed using alpha = .05

1. agegroup

Measure: MEASURE_1

			95% Confidence Interval	
agegroup	Mean	Std. Error	Lower Bound	Upper Bound
young	4.912	.104	4.704	5.120
older	5.315	.148	5.020	5.609
veryold	5.130	.148	4.835	5.424

2. emotion

Measure: MEASURE_1

			95% Confidence Interval	
emotion	Mean	Std. Error	Lower Bound	Upper Bound
1	5.583	.075	5.434	5.733
2	5.194	.108	4.978	5.410
3	5.074	.121	4.832	5.316
4	5.352	.099	5.155	5.548
5	4.611	.158	4.297	4.925
6	4.898	.158	4.583	5.213

3. agegroup * emotion

Measure: MEASURE_1

				95% Confidence Interval	
agegroup	emotion	Mean	Std. Error	Lower Bound	Upper Bound
young	1	5.528	.100	5.327	5.728
	2	4.806	.145	4.516	5.095
	3	4.889	.163	4.564	5.214
	4	5.500	.132	5.236	5.764
	5	4.167	.211	3.745	4.588
	6	4.583	.212	4.160	5.006
older	1	5.722	.142	5.439	6.006
	2	5.611	.205	5.201	6.021
	3	5.444	.230	4.985	5.904
	4	5.556	.187	5.182	5.929
	5	4.667	.299	4.070	5.263
	6	4.889	.300	4.291	5.487
veryold	1	5.500	.142	5.216	5.784
	2	5.167	.205	4.757	5.576
	3	4.889	.230	4.430	5.348
	4	5.000	.187	4.627	5.373
	5	5.000	.299	4.404	5.596
	6	5.222	.300	4.624	5.820

*Post hoc Tests Investigating the Age Group*Emotion Type Interaction*

Comparing between YAs and younger-older adults

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
happywordcorrect	young	36	5.5278	.69636	.11606
	older	18	5.7222	.46089	.10863
sadwordcorrect	young	36	4.8056	.85589	.14265
	older	18	5.6111	.50163	.11824
fearwordcorrect	young	36	4.8889	1.03586	.17264
	older	18	5.4444	.85559	.20166
angerwordcorrect	young	36	5.5000	.81064	.13511
	older	18	5.5556	.61570	.14512
disgustwordcorrect	young	36	4.1667	1.15882	.19314
	older	18	4.6667	1.57181	.37048
neutralwordcorrect	young	36	4.5833	1.25071	.20845
	older	18	4.8889	1.36722	.32226

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
happywordcorrect	Equal variances assumed	3.392	.071	-1.071	52	.289	-.19444	.18162	-.55889	.17000
	Equal variances not assumed			-1.223	47.744	.227	-.19444	.15897	-.51412	.12523
sadwordcorrect	Equal variances assumed	3.449	.069	-3.679	52	.001	-.80556	.21896	-1.24493	-.36618
	Equal variances not assumed			-4.348	50.519	.000	-.80556	.18528	-1.17760	-.43351
fearwordcorrect	Equal variances assumed	.264	.610	-1.963	52	.055	-.55556	.28307	-1.12358	.01246
	Equal variances not assumed			-2.093	40.487	.043	-.55556	.26547	-1.09189	-.01922
angerwordcorrect	Equal variances assumed	1.169	.285	-.256	52	.799	-.05556	.21722	-.49145	.38034
	Equal variances not assumed			-.280	43.403	.781	-.05556	.19828	-.45531	.34420
disgustwordcorrect	Equal variances assumed	.955	.333	-1.324	52	.191	-.50000	.37766	-1.25783	.25783
	Equal variances not assumed			-1.197	26.544	.242	-.50000	.41780	-1.35794	.35794
neutralwordcorrect	Equal variances assumed	.161	.690	-.821	52	.416	-.30556	.37238	-1.05279	.44168
	Equal variances not assumed			-.796	31.522	.432	-.30556	.38380	-1.08779	.47668

Comparing between YAs and older-older adults

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
happywordcorrect	young	36	5.5278	.69636	.11606
	veryold	18	5.5000	.51450	.12127
sadwordcorrect	young	36	4.8056	.85589	.14265
	veryold	18	5.1667	1.15045	.27116
fearwordcorrect	young	36	4.8889	1.03586	.17264
	veryold	18	4.8889	.96338	.22707
angerwordcorrect	young	36	5.5000	.81064	.13511
	veryold	18	5.0000	.90749	.21390
disgustwordcorrect	young	36	4.1667	1.15882	.19314
	veryold	18	5.0000	1.13759	.26813
neutralwordcorrect	young	36	4.5833	1.25071	.20845
	veryold	18	5.2222	1.21537	.28647

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
happywordcorrect	Equal variances assumed	.746	.392	.150	52	.882	.02778	.18550	-.34446	.40001
	Equal variances not assumed			.165	44.338	.869	.02778	.16786	-.31044	.36600
sadwordcorrect	Equal variances assumed	2.197	.144	-1.300	52	.199	-.36111	.27775	-.91846	.19624
	Equal variances not assumed			-1.179	26.717	.249	-.36111	.30639	-.99009	.26787
fearwordcorrect	Equal variances assumed	.029	.865	.000	52	1.000	.00000	.29235	-.58665	.58665
	Equal variances not assumed			.000	36.423	1.000	.00000	.28525	-.57828	.57828
angerwordcorrect	Equal variances assumed	.000	1.000	2.053	52	.045	.50000	.24351	.01137	.98863
	Equal variances not assumed			1.976	30.884	.057	.50000	.25299	-.01606	1.01606
disgustwordcorrect	Equal variances assumed	.020	.889	-2.506	52	.015	-.83333	.33253	-1.50061	-.16606
	Equal variances not assumed			-2.522	34.682	.016	-.83333	.33045	-1.50440	-.16226
neutralwordcorrect	Equal variances assumed	.431	.514	-1.786	52	.080	-.63889	.35775	-1.35676	.07898
	Equal variances not assumed			-1.803	35.003	.080	-.63889	.35428	-1.35811	.08034

Comparing between younger-older and older-older adults

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
happywordcorrect	older	18	5.7222	.46089	.10863
	veryold	18	5.5000	.51450	.12127
sadwordcorrect	older	18	5.6111	.50163	.11824
	veryold	18	5.1667	1.15045	.27116
fearwordcorrect	older	18	5.4444	.85559	.20166
	veryold	18	4.8889	.96338	.22707
angerwordcorrect	older	18	5.5556	.61570	.14512
	veryold	18	5.0000	.90749	.21390
disgustwordcorrect	older	18	4.6667	1.57181	.37048
	veryold	18	5.0000	1.13759	.26813
neutralwordcorrect	older	18	4.8889	1.36722	.32226
	veryold	18	5.2222	1.21537	.28647

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
happywordcorrect	Equal variances assumed	4.185	.049	1.365	34	.181	.22222	.16281	-.10865	.55309
	Equal variances not assumed			1.365	33.597	.181	.22222	.16281	-.10879	.55324
sadwordcorrect	Equal variances assumed	8.536	.006	1.502	34	.142	.44444	.29582	-.15673	1.04562
	Equal variances not assumed			1.502	23.239	.146	.44444	.29582	-.16716	1.05605
fearwordcorrect	Equal variances assumed	.560	.460	1.829	34	.076	.55556	.30369	-.06162	1.17273
	Equal variances not assumed			1.829	33.532	.076	.55556	.30369	-.06194	1.17305
angerwordcorrect	Equal variances assumed	.654	.424	2.149	34	.039	.55556	.25848	.03026	1.08085
	Equal variances not assumed			2.149	29.914	.040	.55556	.25848	.02761	1.08351
disgustwordcorrect	Equal variances assumed	.790	.380	-.729	34	.471	-.33333	.45733	-1.26274	.59607
	Equal variances not assumed			-.729	30.975	.472	-.33333	.45733	-1.26609	.59943
neutralwordcorrect	Equal variances assumed	.707	.406	-.773	34	.445	-.33333	.43117	-1.20959	.54292
	Equal variances not assumed			-.773	33.539	.445	-.33333	.43117	-1.21003	.54336

The pattern of recognition ability across emotion types in YAs

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	happywordcorrect	5.5278	36	.69636	.11606
	sadwordcorrect	4.8056	36	.85589	.14265
Pair 2	happywordcorrect	5.5278	36	.69636	.11606
	fearwordcorrect	4.8889	36	1.03586	.17264
Pair 3	happywordcorrect	5.5278	36	.69636	.11606
	angerwordcorrect	5.5000	36	.81064	.13511
Pair 4	happywordcorrect	5.5278	36	.69636	.11606
	disgustwordcorrect	4.1667	36	1.15882	.19314
Pair 5	happywordcorrect	5.5278	36	.69636	.11606
	neutralwordcorrect	4.5833	36	1.25071	.20845
Pair 6	sadwordcorrect	4.8056	36	.85589	.14265
	fearwordcorrect	4.8889	36	1.03586	.17264
Pair 7	sadwordcorrect	4.8056	36	.85589	.14265
	angerwordcorrect	5.5000	36	.81064	.13511
Pair 8	sadwordcorrect	4.8056	36	.85589	.14265
	disgustwordcorrect	4.1667	36	1.15882	.19314
Pair 9	sadwordcorrect	4.8056	36	.85589	.14265
	neutralwordcorrect	4.5833	36	1.25071	.20845
Pair 10	fearwordcorrect	4.8889	36	1.03586	.17264
	angerwordcorrect	5.5000	36	.81064	.13511
Pair 11	fearwordcorrect	4.8889	36	1.03586	.17264
	disgustwordcorrect	4.1667	36	1.15882	.19314
Pair 12	angerwordcorrect	5.5000	36	.81064	.13511
	disgustwordcorrect	4.1667	36	1.15882	.19314
Pair 13	angerwordcorrect	5.5000	36	.81064	.13511
	neutralwordcorrect	4.5833	36	1.25071	.20845
Pair 14	disgustwordcorrect	4.1667	36	1.15882	.19314
	neutralwordcorrect	4.5833	36	1.25071	.20845
Pair 15	fearwordcorrect	4.8889	36	1.03586	.17264
	neutralwordcorrect	4.5833	36	1.25071	.20845

a. agegroup = young

Paired Samples Test[a]

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	happywordcorrect - sadwordcorrect	.72222	.77868	.12978	.45875	.98569	5.565	35	.000
Pair 2	happywordcorrect - fearwordcorrect	.63889	1.09942	.18324	.26690	1.01088	3.487	35	.001
Pair 3	happywordcorrect - angerwordcorrect	.02778	.87786	.14631	-.26925	.32480	.190	35	.851
Pair 4	happywordcorrect - disgustwordcorrect	1.36111	.93052	.15509	1.04627	1.67595	8.776	35	.000
Pair 5	happywordcorrect - neutralwordcorrect	.94444	1.24084	.20681	.52460	1.36428	4.567	35	.000
Pair 6	sadwordcorrect - fearwordcorrect	-.08333	1.15573	.19262	-.47438	.30771	-.433	35	.668
Pair 7	sadwordcorrect - angerwordcorrect	-.69444	.82183	.13697	-.97251	-.41638	-5.070	35	.000
Pair 8	sadwordcorrect - disgustwordcorrect	.63889	1.04616	.17436	.28492	.99286	3.664	35	.001
Pair 9	sadwordcorrect - neutralwordcorrect	.22222	1.07201	.17867	-.14049	.58494	1.244	35	.222
Pair 10	fearwordcorrect - angerwordcorrect	-.61111	1.15333	.19222	-1.00134	-.22088	-3.179	35	.003
Pair 11	fearwordcorrect - disgustwordcorrect	.72222	1.38587	.23098	.25331	1.19113	3.127	35	.004
Pair 12	angerwordcorrect - disgustwordcorrect	1.33333	.98561	.16427	.99985	1.66682	8.117	35	.000
Pair 13	angerwordcorrect - neutralwordcorrect	.91667	1.15573	.19262	.52562	1.30771	4.759	35	.000
Pair 14	disgustwordcorrect - neutralwordcorrect	-.41667	1.50000	.25000	-.92419	.09086	-1.667	35	.105
Pair 15	fearwordcorrect - neutralwordcorrect	.30556	1.47007	.24501	-.19185	.80296	1.247	35	.221

a. agegroup = young

The pattern of recognition ability across emotion types in younger-older adults

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	happywordcorrect	5.7222	18	.46089	.10863
	sadwordcorrect	5.6111	18	.50163	.11824
Pair 2	happywordcorrect	5.7222	18	.46089	.10863
	fearwordcorrect	5.4444	18	.85559	.20166
Pair 3	happywordcorrect	5.7222	18	.46089	.10863
	angerwordcorrect	5.5556	18	.61570	.14512
Pair 4	happywordcorrect	5.7222	18	.46089	.10863
	disgustwordcorrect	4.6667	18	1.57181	.37048
Pair 5	happywordcorrect	5.7222	18	.46089	.10863
	neutralwordcorrect	4.8889	18	1.36722	.32226
Pair 6	sadwordcorrect	5.6111	18	.50163	.11824
	fearwordcorrect	5.4444	18	.85559	.20166
Pair 7	sadwordcorrect	5.6111	18	.50163	.11824
	angerwordcorrect	5.5556	18	.61570	.14512
Pair 8	sadwordcorrect	5.6111	18	.50163	.11824
	disgustwordcorrect	4.6667	18	1.57181	.37048
Pair 9	sadwordcorrect	5.6111	18	.50163	.11824
	neutralwordcorrect	4.8889	18	1.36722	.32226
Pair 10	fearwordcorrect	5.4444	18	.85559	.20166
	angerwordcorrect	5.5556	18	.61570	.14512
Pair 11	fearwordcorrect	5.4444	18	.85559	.20166
	disgustwordcorrect	4.6667	18	1.57181	.37048
Pair 12	angerwordcorrect	5.5556	18	.61570	.14512
	disgustwordcorrect	4.6667	18	1.57181	.37048
Pair 13	angerwordcorrect	5.5556	18	.61570	.14512
	neutralwordcorrect	4.8889	18	1.36722	.32226
Pair 14	disgustwordcorrect	4.6667	18	1.57181	.37048
	neutralwordcorrect	4.8889	18	1.36722	.32226
Pair 15	fearwordcorrect	5.4444	18	.85559	.20166
	neutralwordcorrect	4.8889	18	1.36722	.32226

a. agegroup = older

Paired Samples Test[a]

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	happywordcorrect - sadwordcorrect	.11111	.58298	.13741	-.17880	.40102	.809	17	.430
Pair 2	happywordcorrect - fearwordcorrect	.27778	.82644	.19479	-.13320	.68876	1.426	17	.172
Pair 3	happywordcorrect - angerwordcorrect	.16667	.70711	.16667	-.18497	.51830	1.000	17	.331
Pair 4	happywordcorrect - disgustwordcorrect	1.05556	1.39209	.32812	.36329	1.74782	3.217	17	.005
Pair 5	happywordcorrect - neutralwordcorrect	.83333	1.50489	.35471	.08497	1.58170	2.349	17	.031
Pair 6	sadwordcorrect - fearwordcorrect	.16667	.85749	.20211	-.25975	.59309	.825	17	.421
Pair 7	sadwordcorrect - angerwordcorrect	.05556	.63914	.15065	-.26228	.37339	.369	17	.717
Pair 8	sadwordcorrect - disgustwordcorrect	.94444	1.39209	.32812	.25218	1.63671	2.878	17	.010
Pair 9	sadwordcorrect - neutralwordcorrect	.72222	1.22741	.28930	.11185	1.33260	2.496	17	.023
Pair 10	fearwordcorrect - angerwordcorrect	-.11111	1.07861	.25423	-.64749	.42527	-.437	17	.668
Pair 11	fearwordcorrect - disgustwordcorrect	.77778	1.66470	.39237	-.05006	1.60562	1.982	17	.064
Pair 12	angerwordcorrect - disgustwordcorrect	.88889	1.40958	.33224	.18792	1.58986	2.675	17	.016
Pair 13	angerwordcorrect - neutralwordcorrect	.66667	1.23669	.29149	.05167	1.28166	2.287	17	.035
Pair 14	disgustwordcorrect - neutralwordcorrect	-.22222	1.86470	.43952	-1.14952	.70507	-.506	17	.620
Pair 15	fearwordcorrect - neutralwordcorrect	.55556	1.58011	.37243	-.23021	1.34132	1.492	17	.154

a. agegroup = older

The pattern of recognition ability across emotion types in older-older adults

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	happywordcorrect	5.5000	18	.51450	.12127
	sadwordcorrect	5.1667	18	1.15045	.27116
Pair 2	happywordcorrect	5.5000	18	.51450	.12127
	fearwordcorrect	4.8889	18	.96338	.22707
Pair 3	happywordcorrect	5.5000	18	.51450	.12127
	angerwordcorrect	5.0000	18	.90749	.21390
Pair 4	happywordcorrect	5.5000	18	.51450	.12127
	disgustwordcorrect	5.0000	18	1.13759	.26813
Pair 5	happywordcorrect	5.5000	18	.51450	.12127
	neutralwordcorrect	5.2222	18	1.21537	.28647
Pair 6	sadwordcorrect	5.1667	18	1.15045	.27116
	fearwordcorrect	4.8889	18	.96338	.22707
Pair 7	sadwordcorrect	5.1667	18	1.15045	.27116
	angerwordcorrect	5.0000	18	.90749	.21390
Pair 8	sadwordcorrect	5.1667	18	1.15045	.27116
	disgustwordcorrect	5.0000	18	1.13759	.26813
Pair 9	sadwordcorrect	5.1667	18	1.15045	.27116
	neutralwordcorrect	5.2222	18	1.21537	.28647
Pair 10	fearwordcorrect	4.8889	18	.96338	.22707
	angerwordcorrect	5.0000	18	.90749	.21390
Pair 11	fearwordcorrect	4.8889	18	.96338	.22707
	disgustwordcorrect	5.0000	18	1.13759	.26813
Pair 12	angerwordcorrect	5.0000	18	.90749	.21390
	disgustwordcorrect	5.0000	18	1.13759	.26813
Pair 13	angerwordcorrect	5.0000	18	.90749	.21390
	neutralwordcorrect	5.2222	18	1.21537	.28647
Pair 14	disgustwordcorrect	5.0000	18	1.13759	.26813
	neutralwordcorrect	5.2222	18	1.21537	.28647
Pair 15	fearwordcorrect	4.8889	18	.96338	.22707
	neutralwordcorrect	5.2222	18	1.21537	.28647

a. agegroup = veryold

Paired Samples Test[a]

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	happywordcorrect - sadwordcorrect	.33333	1.08465	.25565	-.20605	.87272	1.304	17	.210
Pair 2	happywordcorrect - fearwordcorrect	.61111	1.09216	.25742	.06799	1.15423	2.374	17	.030
Pair 3	happywordcorrect - angerwordcorrect	.50000	.92355	.21768	.04073	.95927	2.297	17	.035
Pair 4	happywordcorrect - disgustwordcorrect	.50000	1.15045	.27116	-.07210	1.07210	1.844	17	.083
Pair 5	happywordcorrect - neutralwordcorrect	.27778	1.22741	.28930	-.33260	.88815	.960	17	.350
Pair 6	sadwordcorrect - fearwordcorrect	.27778	1.22741	.28930	-.33260	.88815	.960	17	.350
Pair 7	sadwordcorrect - angerwordcorrect	.16667	1.42457	.33578	-.54176	.87509	.496	17	.626
Pair 8	sadwordcorrect - disgustwordcorrect	.16667	1.42457	.33578	-.54176	.87509	.496	17	.626
Pair 9	sadwordcorrect - neutralwordcorrect	-.05556	1.39209	.32812	-.74782	.63671	-.169	17	.868
Pair 10	fearwordcorrect - angerwordcorrect	-.11111	.96338	.22707	-.59019	.36797	-.489	17	.631
Pair 11	fearwordcorrect - disgustwordcorrect	-.11111	1.56765	.36950	-.89068	.66846	-.301	17	.767
Pair 12	angerwordcorrect - disgustwordcorrect	.00000	1.41421	.33333	-.70327	.70327	.000	17	1.000
Pair 13	angerwordcorrect - neutralwordcorrect	-.22222	1.16597	.27482	-.80204	.35760	-.809	17	.430
Pair 14	disgustwordcorrect - neutralwordcorrect	-.22222	1.26284	.29765	-.85022	.40577	-.747	17	.466
Pair 15	fearwordcorrect - neutralwordcorrect	-.33333	1.41421	.33333	-1.03661	.36994	-1.000	17	.331

a. agegroup = veryold

Comparing across the Emotion and Non-emotion Tasks

Descriptive Statistics

	agegroup	Mean	Std. Deviation	N
totalemotionwordcorrect	young	29.8000	3.52136	35
	older	31.5714	3.23842	35
	Total	30.6857	3.47472	70
totalcontrolwordcorrect	young	31.8857	2.01131	35
	older	34.0857	1.68682	35
	Total	32.9857	2.15011	70

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Content_type	Sphericity Assumed	185.150	1	185.150	32.139	.000	.321
	Greenhouse-Geisser	185.150	1.000	185.150	32.139	.000	.321
	Huynh-Feldt	185.150	1.000	185.150	32.139	.000	.321
	Lower-bound	185.150	1.000	185.150	32.139	.000	.321
Content_type * agegroup	Sphericity Assumed	1.607	1	1.607	.279	.599	.004
	Greenhouse-Geisser	1.607	1.000	1.607	.279	.599	.004
	Huynh-Feldt	1.607	1.000	1.607	.279	.599	.004
	Lower-bound	1.607	1.000	1.607	.279	.599	.004
Error(Content_type)	Sphericity Assumed	391.743	68	5.761			
	Greenhouse-Geisser	391.743	68.000	5.761			
	Huynh-Feldt	391.743	68.000	5.761			
	Lower-bound	391.743	68.000	5.761			

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	141891.779	1	141891.779	15544.416	.000	.996
agegroup	138.007	1	138.007	15.119	.000	.182
Error	620.714	68	9.128			

1. agegroup

Measure: MEASURE_1

			95% Confidence Interval	
agegroup	Mean	Std. Error	Lower Bound	Upper Bound
young	30.843	.361	30.122	31.563
older	32.829	.361	32.108	33.549

2. Content_type

Measure: MEASURE_1

			95% Confidence Interval	
Content_type	Mean	Std. Error	Lower Bound	Upper Bound
1	30.686	.404	29.879	31.493
2	32.986	.222	32.543	33.428

Comparing Emotion and Non-emotion Tasks across Three Age Groups

Descriptive Statistics

	agegroup	Mean	Std. Deviation	N
totalemotionwordcorrect	young	29.8000	3.52136	35
	older	31.8889	3.42807	18
	veryold	30.7778	3.57369	18
	Total	30.5775	3.56836	71
totalcontrolwordcorrect	young	31.8857	2.01131	35
	older	34.8889	1.07861	18
	veryold	32.8333	2.45549	18
	Total	32.8873	2.29004	71

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
content	Sphericity Assumed	182.549	1	182.549	32.006	.000	.320	32.006	1.000
	Greenhouse-Geisser	182.549	1.000	182.549	32.006	.000	.320	32.006	1.000
	Huynh-Feldt	182.549	1.000	182.549	32.006	.000	.320	32.006	1.000
	Lower-bound	182.549	1.000	182.549	32.006	.000	.320	32.006	1.000
content * agegroup	Sphericity Assumed	5.748	2	2.874	.504	.606	.015	1.008	.130
	Greenhouse-Geisser	5.748	2.000	2.874	.504	.606	.015	1.008	.130
	Huynh-Feldt	5.748	2.000	2.874	.504	.606	.015	1.008	.130
	Lower-bound	5.748	2.000	2.874	.504	.606	.015	1.008	.130
Error(content)	Sphericity Assumed	387.844	68	5.704					
	Greenhouse-Geisser	387.844	68.000	5.704					
	Huynh-Feldt	387.844	68.000	5.704					
	Lower-bound	387.844	68.000	5.704					

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	132058.929	1	132058.929	12639.604	.000	.995	12639.604	1.000
agegroup	154.365	2	77.183	7.387	.001	.178	14.775	.930
Error	710.466	68	10.448					

a. Computed using alpha = .05

1. agegroup

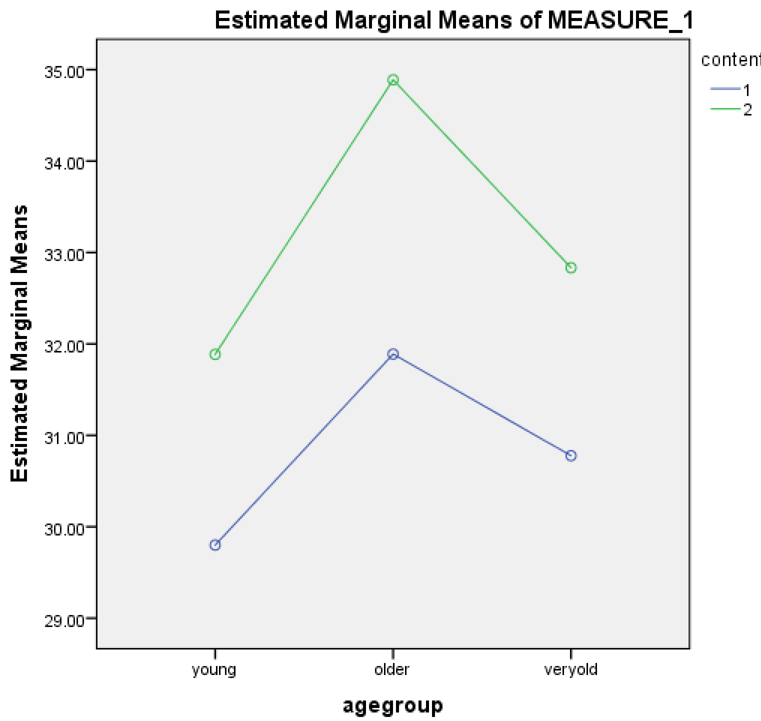
Measure: MEASURE_1

agegroup	Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
young	30.843	.386	30.072	31.614
older	33.389	.539	32.314	34.464
veryold	31.806	.539	30.731	32.881

2. content

Measure: MEASURE_1

content	Mean	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
1	30.822	.437	29.949	31.695
2	33.203	.244	32.717	33.689


Estimated Marginal Means of MEASURE_1
content
1
2
35.00
34.00
33.00
32.00
31.00
30.00
29.00
Estimated Marginal Means
young
older
veryold
agegroup

Post hoc Tests Investigating the Main effect of Age Group

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
wordtaskstotalaccuracy2	young	35	61.6857	4.61947	.78083
	older	18	66.7778	3.45655	.81472

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
wordtaskstotalaccuracy2	Equal variances assumed	.552	.461	-4.114	51	.000	-5.09206	1.23768	-7.57682	-2.60731
	Equal variances not assumed			-4.512	44.008	.000	-5.09206	1.12848	-7.36635	-2.81778

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
wordtaskstotalaccuracy2	young	35	61.6857	4.61947	.78083
	veryold	18	63.6111	5.38122	1.26837

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
wordtaskstotalaccuracy2	Equal variances assumed	.604	.441	-1.358	51	.180	-1.92540	1.41734	-4.77083	.92003
	Equal variances not assumed			-1.293	30.161	.206	-1.92540	1.48945	-4.96657	1.11578

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
wordtaskstotalaccuracy2	older	18	66.7778	3.45655	.81472
	veryold	18	63.6111	5.38122	1.26837

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
wordtaskstotalaccuracy2	Equal variances assumed	2.038	.162	2.101	34	.043	3.16667	1.50749	.10309	6.23025
	Equal variances not assumed			2.101	28.988	.044	3.16667	1.50749	.08345	6.24988

Appendix 6.1

MANOVA and DFA

Descriptive Statistics

	agegroup	Mean	Std. Deviation	N
totalemotionfacecorrect	young	27.0278	3.76818	36
	older	25.7429	4.38140	35
	Total	26.3944	4.10393	71
totalemotionsoundcorrect	young	29.1111	2.63794	36
	older	27.0000	2.75468	35
	Total	28.0704	2.88010	71
totalemotionwordcorrect	young	29.4722	3.98917	36
	older	31.5714	3.23842	35
	Total	30.5070	3.76401	71

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Intercept	Pillai's Trace	.993	3219.035[b]	3.000	67.000	.000	.993	9657.104	1.000
	Wilks' Lambda	.007	3219.035[b]	3.000	67.000	.000	.993	9657.104	1.000
	Hotelling's Trace	144.136	3219.035[b]	3.000	67.000	.000	.993	9657.104	1.000
	Roy's Largest Root	144.136	3219.035[b]	3.000	67.000	.000	.993	9657.104	1.000
agegroup	Pillai's Trace	.279	8.643[b]	3.000	67.000	.000	.279	25.930	.992
	Wilks' Lambda	.721	8.643[b]	3.000	67.000	.000	.279	25.930	.992
	Hotelling's Trace	.387	8.643[b]	3.000	67.000	.000	.279	25.930	.992
	Roy's Largest Root	.387	8.643[b]	3.000	67.000	.000	.279	25.930	.992

a. Design: Intercept + agegroup

b. Exact statistic

c. Computed using alpha = .05

Levene's Test of Equality of Error Variances[a]

	F	df1	df2	Sig.
totalemotionfacecorrect	.115	1	69	.736
totalemotionsoundcorrect	.264	1	69	.609
totalemotionwordcorrect	.356	1	69	.553

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + agegroup

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[d]
Corrected Model	totalemotionfacecorrect	29.300[a]	1	29.300	1.759	.189	.025	1.759	.258
	totalemotionsoundcorrect	79.092[b]	1	79.092	10.881	.002	.136	10.881	.902
	totalemotionwordcorrect	78.203[c]	1	78.203	5.907	.018	.079	5.907	.669
Intercept	totalemotionfacecorrect	49419.328	1	49419.328	2966.042	.000	.977	2966.042	1.000
	totalemotionsoundcorrect	55874.022	1	55874.022	7686.701	.000	.991	7686.701	1.000
	totalemotionwordcorrect	66129.189	1	66129.189	4994.741	.000	.986	4994.741	1.000
agegroup	totalemotionfacecorrect	29.300	1	29.300	1.759	.189	.025	1.759	.258
	totalemotionsoundcorrect	79.092	1	79.092	10.881	.002	.136	10.881	.902
	totalemotionwordcorrect	78.203	1	78.203	5.907	.018	.079	5.907	.669
Error	totalemotionfacecorrect	1149.658	69	16.662					
	totalemotionsoundcorrect	501.556	69	7.269					
	totalemotionwordcorrect	913.544	69	13.240					
Total	totalemotionfacecorrect	50642.000	71						
	totalemotionsoundcorrect	56525.000	71						
	totalemotionwordcorrect	67070.000	71						
Corrected Total	totalemotionfacecorrect	1178.958	70						
	totalemotionsoundcorrect	580.648	70						
	totalemotionwordcorrect	991.746	70						

a. R Squared = .025 (Adjusted R Squared = .011)

b. R Squared = .136 (Adjusted R Squared = .124)

c. R Squared = .079 (Adjusted R Squared = .066)

d. Computed using alpha = .05

Between-Subjects SSCP Matrix

			totalemotionfacecorrect	totalemotionsoundcorrect	totalemotionwordcorrect
Hypothesis	Intercept	totalemotionfacecorrect	49419.328	52547.660	57166.949
		totalemotionsoundcorrect	52547.660	55874.022	60785.720
		totalemotionwordcorrect	57166.949	60785.720	66129.189
	agegroup	totalemotionfacecorrect	29.300	48.139	-47.868
		totalemotionsoundcorrect	48.139	79.092	-78.646
		totalemotionwordcorrect	-47.868	-78.646	78.203
Error		totalemotionfacecorrect	1149.658	233.889	341.671
		totalemotionsoundcorrect	233.889	501.556	226.111
		totalemotionwordcorrect	341.671	226.111	913.544

Based on Type III Sum of Squares

Correlations

		totalemotionfacecorrect	totalemotionsoundcorrect	totalemotionwordcorrect
totalemotionfacecorrect	Pearson Correlation	1	.341**	.272*
	Sig. (2-tailed)		.004	.022
	N	71	71	71
totalemotionsoundcorrect	Pearson Correlation	.341**	1	.194
	Sig. (2-tailed)	.004		.104
	N	71	71	71
totalemotionwordcorrect	Pearson Correlation	.272*	.194	1
	Sig. (2-tailed)	.022	.104	
	N	71	71	71

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Between-Subjects Factors

		Value Label	N
agegroup	1.00	young	36
	2.00	older	35

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.993	3219.035[b]	3.000	67.000	.000
	Wilks' Lambda	.007	3219.035[b]	3.000	67.000	.000
	Hotelling's Trace	144.136	3219.035[b]	3.000	67.000	.000
	Roy's Largest Root	144.136	3219.035[b]	3.000	67.000	.000
agegroup	Pillai's Trace	.279	8.643[b]	3.000	67.000	.000
	Wilks' Lambda	.721	8.643[b]	3.000	67.000	.000
	Hotelling's Trace	.387	8.643[b]	3.000	67.000	.000
	Roy's Largest Root	.387	8.643[b]	3.000	67.000	.000

a. Design: Intercept + agegroup

b. Exact statistic

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	totalemotionfacecorrect	29.300[a]	1	29.300	1.759	.189
	totalemotionsoundcorrect	79.092[b]	1	79.092	10.881	.002
	totalemotionwordcorrect	78.203[c]	1	78.203	5.907	.018
Intercept	totalemotionfacecorrect	49419.328	1	49419.328	2966.042	.000
	totalemotionsoundcorrect	55874.022	1	55874.022	7686.701	.000
	totalemotionwordcorrect	66129.189	1	66129.189	4994.741	.000
agegroup	totalemotionfacecorrect	29.300	1	29.300	1.759	.189
	totalemotionsoundcorrect	79.092	1	79.092	10.881	.002
	totalemotionwordcorrect	78.203	1	78.203	5.907	.018
Error	totalemotionfacecorrect	1149.658	69	16.662		
	totalemotionsoundcorrect	501.556	69	7.269		
	totalemotionwordcorrect	913.544	69	13.240		
Total	totalemotionfacecorrect	50642.000	71			
	totalemotionsoundcorrect	56525.000	71			
	totalemotionwordcorrect	67070.000	71			
Corrected Total	totalemotionfacecorrect	1178.958	70			
	totalemotionsoundcorrect	580.648	70			
	totalemotionwordcorrect	991.746	70			

a. R Squared = .025 (Adjusted R Squared = .011)

b. R Squared = .136 (Adjusted R Squared = .124)

c. R Squared = .079 (Adjusted R Squared = .066)

Transformation Coefficients (M Matrix)

	Transformed Variable		
Dependent Variable	totalemotionfacecorrect	totalemotionsoundcorrect	totalemotionwordcorrect
totalemotionfacecorrect	1	0	0
totalemotionsoundcorrect	0	1	0
totalemotionwordcorrect	0	0	1

Discriminate Functions Analysis

Group Statistics

agegroup		Valid N (listwise) Unweighted	Weighted
young	totalemotionfacecorrect	36	36.000
	totalemotionsoundcorrect	36	36.000
	totalemotionwordcorrect	36	36.000
older	totalemotionfacecorrect	35	35.000
	totalemotionsoundcorrect	35	35.000
	totalemotionwordcorrect	35	35.000
Total	totalemotionfacecorrect	71	71.000
	totalemotionsoundcorrect	71	71.000
	totalemotionwordcorrect	71	71.000

Covariance Matrices

agegroup		totalemotionfacecorrect	totalemotionsoundcorrect	totalemotionwordcorrect
young	totalemotionfacecorrect	14.199	2.083	3.072
	totalemotionsoundcorrect	2.083	6.959	4.175
	totalemotionwordcorrect	3.072	4.175	15.913
older	totalemotionfacecorrect	19.197	4.735	6.887
	totalemotionsoundcorrect	4.735	7.588	2.353
	totalemotionwordcorrect	6.887	2.353	10.487

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	.387[a]	100.0	100.0	.528

a. First 1 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.721	22.083	3	.000

Standardized Canonical Discriminant Function Coefficients

	Function 1
totalemotionfacecorrect	.281
totalemotionsoundcorrect	.833
totalemotionwordcorrect	-.842

Structure Matrix

	Function 1
totalemotionsoundcorrect	.638
totalemotionwordcorrect	-.470
totalemotionfacecorrect	.257

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions
Variables ordered by absolute size of correlation within function.

Group Statistics

agegroup		Valid N (listwise) Unweighted	Weighted
young	totalemotionfacecorrect	36	36.000
	totalemotionsoundcorrect	36	36.000
	totalemotionwordcorrect	36	36.000
older	totalemotionfacecorrect	35	35.000
	totalemotionsoundcorrect	35	35.000
	totalemotionwordcorrect	35	35.000
Total	totalemotionfacecorrect	71	71.000
	totalemotionsoundcorrect	71	71.000
	totalemotionwordcorrect	71	71.000

Covariance Matrices

agegroup		totalemotionfacecorrect	totalemotionsoundcorrect	totalemotionwordcorrect
young	totalemotionfacecorrect	14.199	2.083	3.072
	totalemotionsoundcorrect	2.083	6.959	4.175
	totalemotionwordcorrect	3.072	4.175	15.913
older	totalemotionfacecorrect	19.197	4.735	6.887
	totalemotionsoundcorrect	4.735	7.588	2.353
	totalemotionwordcorrect	6.887	2.353	10.487

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	.387[a]	100.0	100.0	.528

a. First 1 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.721	22.083	3	.000

Standardized Canonical Discriminant Function Coefficients

	Function 1
totalemotionfacecorrect	.281
totalemotionsoundcorrect	.833
totalemotionwordcorrect	-.842

Structure Matrix

	Function 1
totalemotionsoundcorrect	.638
totalemotionwordcorrect	-.470
totalemotionfacecorrect	.257

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions
Variables ordered by absolute size of correlation within function.

Canonical Discriminant Function Coefficients

	Function 1
totalemotionfacecorrect	.069
totalemotionsoundcorrect	.309
totalemotionwordcorrect	-.231
(Constant)	-3.429

Unstandardized coefficients

Functions at Group Centroids

agegroup	Function 1
young	.605
older	-.622

Unstandardized canonical discriminant functions evaluated at group means

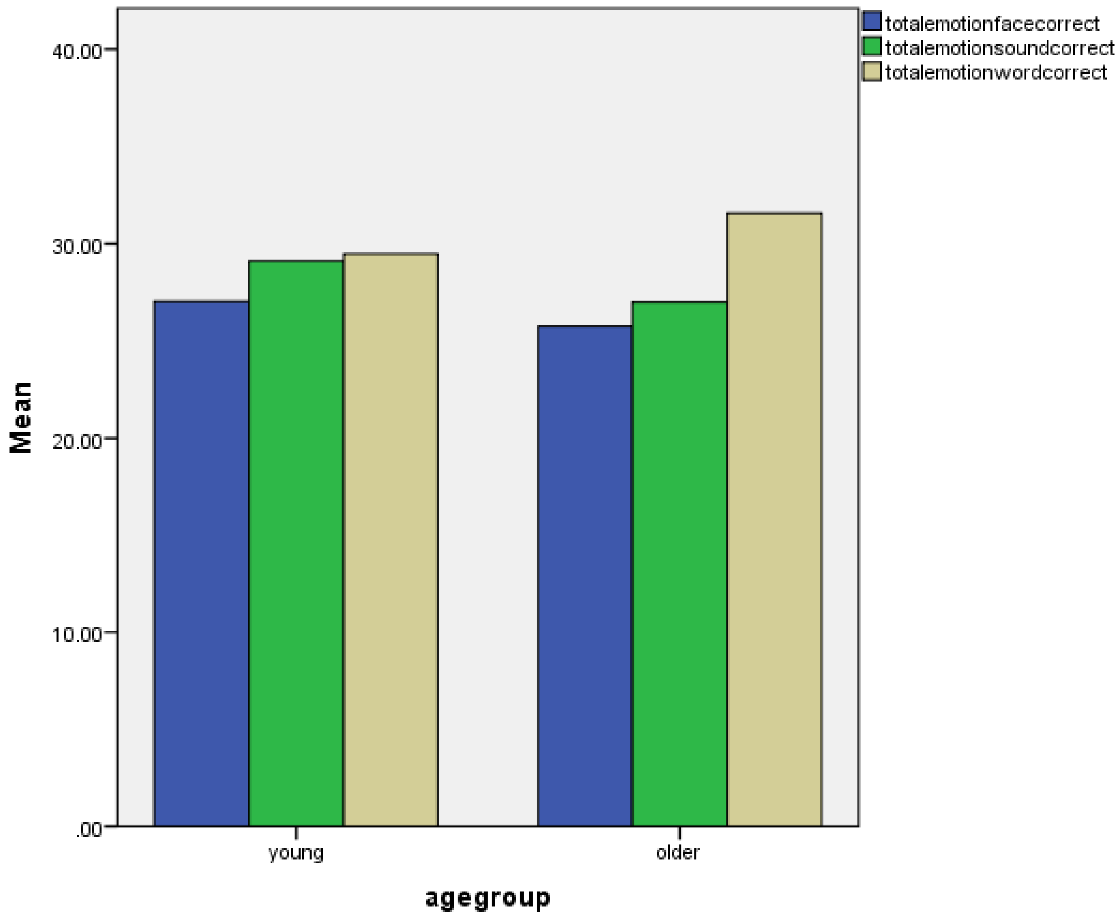
Classification Processing Summary

Processed		71
Excluded	Missing or out-of-range group codes	0
	At least one missing discriminating variable	0
Used in Output		71

Classification Results[a]

		agegroup	Predicted Group Membership young	older	Total
Original	Count	young	27	9	36
		older	10	25	35
	%	young	75.0	25.0	100.0
		older	28.6	71.4	100.0

a. 73.2% of original grouped cases correctly classified.



Correlations

agegroup			totalemotionfacecorrect	totalemotionsoundcorrect	totalemotionwordcorrect
young	totalemotionfacecorrect	Pearson Correlation	1	.210	.204
		Sig. (2-tailed)		.220	.232
		N	36	36	36
	totalemotionsoundcorrect	Pearson Correlation	.210	1	.397*
		Sig. (2-tailed)	.220		.017
		N	36	36	36
	totalemotionwordcorrect	Pearson Correlation	.204	.397*	1
		Sig. (2-tailed)	.232	.017	
		N	36	36	36
older	totalemotionfacecorrect	Pearson Correlation	1	.392*	.485**
		Sig. (2-tailed)		.020	.003
		N	35	35	35
	totalemotionsoundcorrect	Pearson Correlation	.392*	1	.264
		Sig. (2-tailed)	.020		.126
		N	35	35	35
	totalemotionwordcorrect	Pearson Correlation	.485**	.264	1
		Sig. (2-tailed)	.003	.126	
		N	35	35	35

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Appendix 6.2

Results for Chapter 6 Comparing across the Presentation Types

2*3*6 ANOVA Comparing between YAs and OAs

Descriptive Statistics

	agegroup	Mean	Std. Deviation	N
happyfacecorrect	young	5.8611	.42445	36
	older	5.8000	.47279	35
	Total	5.8310	.44676	71
sadfacecorrect	young	3.8889	1.44969	36
	older	3.4286	1.91412	35
	Total	3.6620	1.69827	71
fearfacecorrect	young	4.0833	1.66261	36
	older	3.5429	1.88403	35
	Total	3.8169	1.78333	71
angerfacecorrect	young	3.9444	1.24084	36
	older	2.9714	1.88626	35
	Total	3.4648	1.65470	71
disgustfacecorrect	young	4.3056	1.32707	36
	older	4.9143	1.22165	35
	Total	4.6056	1.30361	71
neutralfacecorrect	young	4.9444	1.43317	36
	older	5.0857	.91944	35
	Total	5.0141	1.20111	71
happysoundcorrect	young	5.9722	.16667	36
	older	5.8571	.35504	35
	Total	5.9155	.28013	71
sadsoundcorrect	young	5.6389	.54263	36
	older	5.3429	.80231	35
	Total	5.4930	.69433	71
fearsoundcorrect	young	4.5833	1.67971	36
	older	4.0286	1.20014	35
	Total	4.3099	1.47930	71
angersoundcorrect	young	2.6389	1.19888	36
	older	2.1714	1.24819	35
	Total	2.4085	1.23725	71
disgustsoundcorrect	young	4.4444	.96937	36
	older	4.4857	.74247	35
	Total	4.4648	.85909	71
neutralsoundcorrect	young	5.8333	.44721	36
	older	5.1714	1.29446	35
	Total	5.5070	1.01240	71
happywordcorrect	young	5.5278	.69636	36
	older	5.6286	.49024	35
	Total	5.5775	.60147	71
sadwordcorrect	young	4.8056	.85589	36
	older	5.4286	.88403	35
	Total	5.1127	.91884	71
fearwordcorrect	young	4.8889	1.03586	36
	older	5.1714	.95442	35
	Total	5.0282	.99960	71
angerwordcorrect	young	5.5000	.81064	36
	older	5.3143	.79600	35
	Total	5.4085	.80316	71
disgustwordcorrect	young	4.1667	1.15882	36
	older	4.8857	1.34539	35
	Total	4.5211	1.29680	71
neutralwordcorrect	young	4.5833	1.25071	36
	older	5.1429	1.19171	35
	Total	4.8592	1.24552	71

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
presenationtype	.955	3.160	2	.206	.957	.997	.500
emotiontype	.484	48.634	14	.000	.806	.875	.200
presenationtype * emotiontype	.068	175.586	54	.000	.711	.813	.100

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + agegroup
Within Subjects Design: presenationtype + emotiontype + presenationtype * emotiontype

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
presenationtype	Sphericity Assumed	102.295	2	51.147	36.267	.000	.345	72.534	1.000
	Greenhouse-Geisser	102.295	1.913	53.470	36.267	.000	.345	69.384	1.000
	Huynh-Feldt	102.295	1.995	51.278	36.267	.000	.345	72.350	1.000
	Lower-bound	102.295	1.000	102.295	36.267	.000	.345	36.267	1.000
presenationtype * agegroup	Sphericity Assumed	28.880	2	14.440	10.239	.000	.129	20.478	.985
	Greenhouse-Geisser	28.880	1.913	15.096	10.239	.000	.129	19.588	.982
	Huynh-Feldt	28.880	1.995	14.477	10.239	.000	.129	20.426	.985
	Lower-bound	28.880	1.000	28.880	10.239	.002	.129	10.239	.884
Error(presenationtype)	Sphericity Assumed	194.622	138	1.410					
	Greenhouse-Geisser	194.622	132.007	1.474					
	Huynh-Feldt	194.622	137.650	1.414					
	Lower-bound	194.622	69.000	2.821					
emotiontype	Sphericity Assumed	501.465	5	100.293	76.091	.000	.524	380.454	1.000
	Greenhouse-Geisser	501.465	4.030	124.421	76.091	.000	.524	306.674	1.000
	Huynh-Feldt	501.465	4.374	114.655	76.091	.000	.524	332.797	1.000
	Lower-bound	501.465	1.000	501.465	76.091	.000	.524	76.091	1.000
emotiontype * agegroup	Sphericity Assumed	29.270	5	5.854	4.441	.001	.060	22.207	.968
	Greenhouse-Geisser	29.270	4.030	7.262	4.441	.002	.060	17.901	.937
	Huynh-Feldt	29.270	4.374	6.692	4.441	.001	.060	19.425	.951
	Lower-bound	29.270	1.000	29.270	4.441	.039	.060	4.441	.547
Error(emotiontype)	Sphericity Assumed	454.734	345	1.318					
	Greenhouse-Geisser	454.734	278.096	1.635					
	Huynh-Feldt	454.734	301.784	1.507					
	Lower-bound	454.734	69.000	6.590					
presenationtype * emotiontype	Sphericity Assumed	434.276	10	43.428	40.138	.000	.368	401.378	1.000
	Greenhouse-Geisser	434.276	7.114	61.043	40.138	.000	.368	285.549	1.000
	Huynh-Feldt	434.276	8.130	53.419	40.138	.000	.368	326.306	1.000
	Lower-bound	434.276	1.000	434.276	40.138	.000	.368	40.138	1.000
presenationtype * emotiontype * agegroup	Sphericity Assumed	15.840	10	1.584	1.464	.148	.021	14.641	.740
	Greenhouse-Geisser	15.840	7.114	2.227	1.464	.177	.021	10.416	.625
	Huynh-Feldt	15.840	8.130	1.948	1.464	.166	.021	11.902	.670
	Lower-bound	15.840	1.000	15.840	1.464	.230	.021	1.464	.222
Error (presenationtype*emotiontype)	Sphericity Assumed	746.554	690	1.082					
	Greenhouse-Geisser	746.554	490.881	1.521					
	Huynh-Feldt	746.554	560.946	1.331					
	Lower-bound	746.554	69.000	10.820					

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	28487.105	1	28487.105	8640.621	.000	.992	8640.621	1.000
agegroup	1.515	1	1.515	.460	.500	.007	.460	.103
Error	227.485	69	3.297					

a. Computed using alpha = .05

Post hoc Tests for Main Effect of Presentation Type

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	totalemotionfacecorrect	26.3944	71	4.10393	.48705
	totalemotionsoundcorrect	28.0704	71	2.88010	.34180
Pair 2	totalemotionfacecorrect	26.2083	72	4.36999	.51501
	totalemotionwordcorrect	30.4028	72	3.84070	.45263
Pair 3	totalemotionsoundcorrect	28.0704	71	2.88010	.34180
	totalemotionwordcorrect	30.5070	71	3.76401	.44671

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	totalemotionfacecorrect - totalemotionsoundcorrect	-1.67606	4.13271	.49046	-2.65425	-.69786	-3.417	70	.001
Pair 2	totalemotionfacecorrect - totalemotionwordcorrect	-4.19444	4.77269	.56247	-5.31597	-3.07292	-7.457	71	.000
Pair 3	totalemotionsoundcorrect - totalemotionwordcorrect	-2.43662	4.27194	.50699	-3.44777	-1.42547	-4.806	70	.000

*Post hoc Tests for Presentation Type*Age Group Interaction*

Comparing Between YAs and OAs

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
totalemotionfacecorrect	young	36	27.0278	3.76818	.62803
	older	35	25.7429	4.38140	.74059
totalemotionsoundcorrect	young	36	29.1111	2.63794	.43966
	older	35	27.0000	2.75468	.46563
totalemotionwordcorrect	young	36	29.4722	3.98917	.66486
	older	35	31.5714	3.23842	.54739

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
totalemotionfacecorrect	Equal variances assumed	.115	.736	1.326	69	.189	1.28492	.96896	-.64809	3.21793
	Equal variances not assumed			1.323	66.883	.190	1.28492	.97103	-.65332	3.22317
totalemotionsoundcorrect	Equal variances assumed	.264	.609	3.299	69	.002	2.11111	.64000	.83435	3.38787
	Equal variances not assumed			3.297	68.646	.002	2.11111	.64039	.83344	3.38878
totalemotionwordcorrect	Equal variances assumed	.356	.553	-2.430	69	.018	-2.09921	.86374	-3.82232	-.37609
	Equal variances not assumed			-2.438	66.892	.017	-2.09921	.86121	-3.81824	-.38017

The Pattern of Recognition across Presentation Types for YAs

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	totalemotionfacecorrect	27.0278	36	3.76818	.62803
	totalemotionsoundcorrect	29.1111	36	2.63794	.43966
Pair 2	totalemotionfacecorrect	27.0278	36	3.76818	.62803
	totalemotionwordcorrect	29.4722	36	3.98917	.66486
Pair 3	totalemotionsoundcorrect	29.1111	36	2.63794	.43966
	totalemotionwordcorrect	29.4722	36	3.98917	.66486

a. agegroup = young

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	totalemotionfacecorrect - totalemotionsoundcorrect	-2.08333	4.12224	.68704	-3.47810	-.68857	-3.032	35	.005
Pair 2	totalemotionfacecorrect - totalemotionwordcorrect	-2.44444	4.89574	.81596	-4.10092	-.78796	-2.996	35	.005
Pair 3	totalemotionsoundcorrect - totalemotionwordcorrect	-.36111	3.81091	.63515	-1.65054	.92831	-.569	35	.573

a. agegroup = young

The Pattern of Recognition across Presentation Types for OAs

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	totalemotionfacecorrect	25.7429	35	4.38140	.74059
	totalemotionsoundcorrect	27.0000	35	2.75468	.46563
Pair 2	totalemotionfacecorrect	25.7429	35	4.38140	.74059
	totalemotionwordcorrect	31.5714	35	3.23842	.54739
Pair 3	totalemotionsoundcorrect	27.0000	35	2.75468	.46563
	totalemotionwordcorrect	31.5714	35	3.23842	.54739

a. agegroup = older

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	totalemotionfacecorrect - totalemotionsoundcorrect	-1.25714	4.16104	.70334	-2.68651	.17223	-1.787	34	.083
Pair 2	totalemotionfacecorrect - totalemotionwordcorrect	-5.82857	3.98885	.67424	-7.19879	-4.45835	-8.645	34	.000
Pair 3	totalemotionsoundcorrect - totalemotionwordcorrect	-4.57143	3.65647	.61806	-5.82747	-3.31539	-7.396	34	.000

a. agegroup = older

Post Hoc Tests for Main Effect of Emotion Type

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	totalhappy	17.3239	71	.78875	.09361
	Totalsad	14.2676	71	2.24218	.26610
Pair 2	totalhappy	17.3239	71	.78875	.09361
	totalfear	13.1549	71	3.04560	.36145
Pair 3	totalhappy	17.3239	71	.78875	.09361
	Totalanger	11.2817	71	2.71600	.32233
Pair 4	totalhappy	17.3239	71	.78875	.09361
	Totaldisgust	13.5915	71	2.26512	.26882
Pair 5	totalhappy	17.3239	71	.78875	.09361
	totalneutral	15.3803	71	1.76770	.20979
Pair 6	Totalsad	14.2676	71	2.24218	.26610
	totalfear	13.1549	71	3.04560	.36145
Pair 7	Totalsad	14.2676	71	2.24218	.26610
	Totalanger	11.2817	71	2.71600	.32233
Pair 8	Totalsad	14.2676	71	2.24218	.26610
	Totaldisgust	13.5915	71	2.26512	.26882
Pair 9	Totalsad	14.2676	71	2.24218	.26610
	totalneutral	15.3803	71	1.76770	.20979
Pair 10	totalfear	13.1549	71	3.04560	.36145
	Totalanger	11.2817	71	2.71600	.32233
Pair 11	totalfear	13.1549	71	3.04560	.36145
	Totaldisgust	13.5915	71	2.26512	.26882
Pair 12	totalfear	13.1549	71	3.04560	.36145
	totalneutral	15.3803	71	1.76770	.20979
Pair 13	Totalanger	11.2817	71	2.71600	.32233
	Totaldisgust	13.5915	71	2.26512	.26882
Pair 14	Totalanger	11.2817	71	2.71600	.32233
	totalneutral	15.3803	71	1.76770	.20979
Pair 15	Totaldisgust	13.5915	71	2.26512	.26882
	totalneutral	15.3803	71	1.76770	.20979

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	totalhappy - Totalsad	3.05634	2.26708	.26905	2.51973	3.59295	11.360	70	.000
Pair 2	totalhappy - totalfear	4.16901	2.93251	.34802	3.47490	4.86313	11.979	70	.000
Pair 3	totalhappy - Totalanger	6.04225	2.74870	.32621	5.39165	6.69286	18.523	70	.000
Pair 4	totalhappy - Totaldisgust	3.73239	2.14448	.25450	3.22480	4.23998	14.665	70	.000
Pair 5	totalhappy - totalneutral	1.94366	1.92641	.22862	1.48769	2.39964	8.502	70	.000
Pair 6	Totalsad - totalfear	1.11268	3.08244	.36582	.38308	1.84228	3.042	70	.003
Pair 7	Totalsad - Totalanger	2.98592	2.93010	.34774	2.29237	3.67946	8.587	70	.000
Pair 8	Totalsad - Totaldisgust	.67606	2.61192	.30998	.05782	1.29429	2.181	70	.033
Pair 9	Totalsad - totalneutral	-1.11268	2.90590	.34487	-1.80049	-.42486	-3.226	70	.002
Pair 10	totalfear - Totalanger	1.87324	3.37609	.40067	1.07413	2.67235	4.675	70	.000
Pair 11	totalfear - Totaldisgust	-.43662	3.13839	.37246	-1.17946	.30623	-1.172	70	.245
Pair 12	totalfear - totalneutral	-2.22535	3.53431	.41945	-3.06191	-1.38879	-5.305	70	.000
Pair 13	Totalanger - Totaldisgust	-2.30986	3.46654	.41140	-3.13038	-1.48934	-5.615	70	.000
Pair 14	Totalanger - totalneutral	-4.09859	3.02917	.35950	-4.81558	-3.38160	-11.401	70	.000
Pair 15	Totaldisgust - totalneutral	-1.78873	2.56301	.30417	-2.39539	-1.18208	-5.881	70	.000

*Post hoc Tests for Emotion*Age Group Interaction*

Comparing Between YAs and OAs

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
totalhappy	young	36	17.3611	.79831	.13305
	older	35	17.2857	.78857	.13329
totalsad	young	36	14.3333	1.95667	.32611
	older	35	14.2000	2.52982	.42762
totalfear	young	36	13.5556	3.00898	.50150
	older	35	12.7429	3.07115	.51912
totalanger	young	36	12.0833	2.25990	.37665
	older	35	10.4571	2.92397	.49424
totaldisgust	young	36	12.9167	2.32225	.38704
	older	35	14.2857	2.00839	.33948
totalneutral	young	36	15.3611	1.83852	.30642
	older	35	15.4000	1.71841	.29046

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
totalhappy	Equal variances assumed	.046	.832	.400	69	.690	.07540	.18837	-.30039	.45118
	Equal variances not assumed			.400	68.982	.690	.07540	.18833	-.30032	.45112
totalsad	Equal variances assumed	5.303	.024	.249	69	.804	.13333	.53585	-.93566	1.20233
	Equal variances not assumed			.248	64.015	.805	.13333	.53778	-.94100	1.20767
totalfear	Equal variances assumed	.229	.634	1.126	69	.264	.81270	.72158	-.62682	2.25221
	Equal variances not assumed			1.126	68.835	.264	.81270	.72179	-.62730	2.25269
totalanger	Equal variances assumed	7.792	.007	2.626	69	.011	1.62619	.61917	.39099	2.86139
	Equal variances not assumed			2.617	63.993	.011	1.62619	.62140	.38480	2.86758
totaldisgust	Equal variances assumed	1.107	.296	-2.654	69	.010	-1.36905	.51589	-2.39822	-.33988
	Equal variances not assumed			-2.659	68.086	.010	-1.36905	.51483	-2.39635	-.34175
totalneutral	Equal variances assumed	.013	.909	-.092	69	.927	-.03889	.42262	-.88199	.80421
	Equal variances not assumed			-.092	68.896	.927	-.03889	.42221	-.88120	.80342

The Pattern of Recognition across Emotion Types for YAs

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	totalhappy	17.3611	36	.79831	.13305
	totalsad	14.3333	36	1.95667	.32611
Pair 2	totalhappy	17.3611	36	.79831	.13305
	totalfear	13.5556	36	3.00898	.50150
Pair 3	totalhappy	17.3611	36	.79831	.13305
	totalanger	12.0833	36	2.25990	.37665
Pair 4	totalhappy	17.3611	36	.79831	.13305
	totaldisgust	12.9167	36	2.32225	.38704
Pair 5	totalhappy	17.3611	36	.79831	.13305
	totalneutral	15.3611	36	1.83852	.30642
Pair 6	totalsad	14.3333	36	1.95667	.32611
	totalfear	13.5556	36	3.00898	.50150
Pair 7	totalsad	14.3333	36	1.95667	.32611
	totalanger	12.0833	36	2.25990	.37665
Pair 8	totalsad	14.3333	36	1.95667	.32611
	totaldisgust	12.9167	36	2.32225	.38704
Pair 9	totalsad	14.3333	36	1.95667	.32611
	totalneutral	15.3611	36	1.83852	.30642
Pair 10	totalfear	13.5556	36	3.00898	.50150
	totalanger	12.0833	36	2.25990	.37665
Pair 11	totalfear	13.5556	36	3.00898	.50150
	totaldisgust	12.9167	36	2.32225	.38704
Pair 12	totalfear	13.5556	36	3.00898	.50150
	totalneutral	15.3611	36	1.83852	.30642
Pair 13	totalanger	12.0833	36	2.25990	.37665
	totaldisgust	12.9167	36	2.32225	.38704
Pair 14	totalanger	12.0833	36	2.25990	.37665
	totalneutral	15.3611	36	1.83852	.30642
Pair 15	totaldisgust	12.9167	36	2.32225	.38704
	totalneutral	15.3611	36	1.83852	.30642

a. agegroup = young

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	totalhappy - totalsad	3.02778	1.87443	.31241	2.39356	3.66199	9.692	35	.000
Pair 2	totalhappy - totalfear	3.80556	2.94540	.49090	2.80897	4.80214	7.752	35	.000
Pair 3	totalhappy - totalanger	5.27778	2.40964	.40161	4.46247	6.09308	13.142	35	.000
Pair 4	totalhappy - totaldisgust	4.44444	2.04862	.34144	3.75129	5.13760	13.017	35	.000
Pair 5	totalhappy - totalneutral	2.00000	1.83615	.30602	1.37874	2.62126	6.535	35	.000
Pair 6	totalsad - totalfear	.77778	2.80928	.46821	-.17275	1.72830	1.661	35	.106
Pair 7	totalsad - totalanger	2.25000	2.87228	.47871	1.27816	3.22184	4.700	35	.000
Pair 8	totalsad - totaldisgust	1.41667	2.20875	.36812	.66933	2.16400	3.848	35	.000
Pair 9	totalsad - totalneutral	-1.02778	2.91289	.48548	-2.01336	-.04220	-2.117	35	.041
Pair 10	totalfear - totalanger	1.47222	3.26441	.54407	.36771	2.57674	2.706	35	.010
Pair 11	totalfear - totaldisgust	.63889	2.69553	.44925	-.27315	1.55092	1.422	35	.164
Pair 12	totalfear - totalneutral	-1.80556	3.45435	.57573	-2.97434	-.63677	-3.136	35	.003
Pair 13	totalanger - totaldisgust	-.83333	3.09377	.51563	-1.88012	.21345	-1.616	35	.115
Pair 14	totalanger - totalneutral	-3.27778	2.83459	.47243	-4.23687	-2.31869	-6.938	35	.000
Pair 15	totaldisgust - totalneutral	-2.44444	2.47784	.41297	-3.28282	-1.60606	-5.919	35	.000

a. agegroup = young

The Pattern of Recognition across Emotion Types for OAs

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	totalhappy	17.2857	35	.78857	.13329
	totalsad	14.2000	35	2.52982	.42762
Pair 2	totalhappy	17.2857	35	.78857	.13329
	totalfear	12.7429	35	3.07115	.51912
Pair 3	totalhappy	17.2857	35	.78857	.13329
	totalanger	10.4571	35	2.92397	.49424
Pair 4	totalhappy	17.2857	35	.78857	.13329
	totaldisgust	14.2857	35	2.00839	.33948
Pair 5	totalhappy	17.2857	35	.78857	.13329
	totalneutral	15.4000	35	1.71841	.29046
Pair 6	totalsad	14.2000	35	2.52982	.42762
	totalfear	12.7429	35	3.07115	.51912
Pair 7	totalsad	14.2000	35	2.52982	.42762
	totalanger	10.4571	35	2.92397	.49424
Pair 8	totalsad	14.2000	35	2.52982	.42762
	totaldisgust	14.2857	35	2.00839	.33948
Pair 9	totalsad	14.2000	35	2.52982	.42762
	totalneutral	15.4000	35	1.71841	.29046
Pair 10	totalfear	12.7429	35	3.07115	.51912
	totalanger	10.4571	35	2.92397	.49424
Pair 11	totalfear	12.7429	35	3.07115	.51912
	totaldisgust	14.2857	35	2.00839	.33948
Pair 12	totalfear	12.7429	35	3.07115	.51912
	totalneutral	15.4000	35	1.71841	.29046
Pair 13	totalanger	10.4571	35	2.92397	.49424
	totaldisgust	14.2857	35	2.00839	.33948
Pair 14	totalanger	10.4571	35	2.92397	.49424
	totalneutral	15.4000	35	1.71841	.29046
Pair 15	totaldisgust	14.2857	35	2.00839	.33948
	totalneutral	15.4000	35	1.71841	.29046

a. agegroup = older

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	totalhappy - totalsad	3.08571	2.63875	.44603	2.17927	3.99216	6.918	34	.000
Pair 2	totalhappy - totalfear	4.54286	2.91389	.49254	3.54190	5.54381	9.223	34	.000
Pair 3	totalhappy - totalanger	6.82857	2.88491	.48764	5.83757	7.81957	14.003	34	.000
Pair 4	totalhappy - totaldisgust	3.00000	2.01465	.34054	2.30794	3.69206	8.810	34	.000
Pair 5	totalhappy - totalneutral	1.88571	2.04035	.34488	1.18483	2.58660	5.468	34	.000
Pair 6	totalsad - totalfear	1.45714	3.34614	.56560	.30770	2.60658	2.576	34	.015
Pair 7	totalsad - totalanger	3.74286	2.83199	.47869	2.77003	4.71568	7.819	34	.000
Pair 8	totalsad - totaldisgust	-.08571	2.80096	.47345	-1.04788	.87645	-.181	34	.857
Pair 9	totalsad - totalneutral	-1.20000	2.93859	.49671	-2.20944	-.19056	-2.416	34	.021
Pair 10	totalfear - totalanger	2.28571	3.48587	.58922	1.08828	3.48315	3.879	34	.000
Pair 11	totalfear - totaldisgust	-1.54286	3.21159	.54286	-2.64608	-.43964	-2.842	34	.008
Pair 12	totalfear - totalneutral	-2.65714	3.61323	.61075	-3.89833	-1.41595	-4.351	34	.000
Pair 13	totalanger - totaldisgust	-3.82857	3.19453	.53997	-4.92593	-2.73121	-7.090	34	.000
Pair 14	totalanger - totalneutral	-4.94286	3.02871	.51195	-5.98326	-3.90246	-9.655	34	.000
Pair 15	totaldisgust - totalneutral	-1.11429	2.50613	.42361	-1.97517	-.25340	-2.630	34	.013

a. agegroup = older

The Signal Detection Analysis for Disgust for Older Adults

Input: Observer's discrimination data

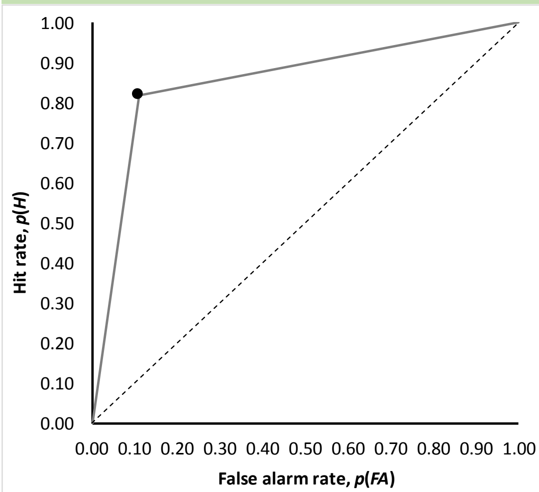
Response State		Stimulus State: Signal	Stimulus State: Noise	Σ
"Yes"		True Positive 'Hit' (*H*)	False Positive 'False alarm' (*FA*)	
		172	**116**	288
"No"		False Negative 'Miss' (*M*)	True Negative 'Correct rejection' (*CR*)	
		38	**934**	972
Σ		210	1050	1260

Variance ratio (σ_N / σ_S)	
Hit rate, *p* (*H*)	**0.8190**
False alarm rate, *p* (*FA*)	**0.1105**
Percentages: Signal trials	16.67%
Percentages: Noise trials	83.33%
Percentages: YES responses	22.86%
Percentages: NO responses	77.14%

Signals are distinguishable from noise

Output: Unbounded models

Distribution	Property	Index	Value
Gaussian	Sensitivity (distance)	*d'* or d_a	2.136
	Bias: Criterion location	*c* or c_a	0.156
	Bias: Criterion relative to sensitivity	*c'* or c_a'	0.073
	Bias: Likelihood ratio	β_G	1.396
	Bias: Log-likelihood ratio	log(β)	0.333
Logistic	Sensitivity (distance)	log(α)	0.781
	Bias: Criterion location	log(*b*)	0.125
	Bias: Criterion relative to sensitivity	*b'*	0.080
	Bias: Likelihood ratio	β_L	1.508
	Bias: Log-likelihood ratio	log(β_L)	0.178



*Post hoc Tests Investigating the Presentation Type*Emotion Type Interaction*

The difference in the pattern of accuracy for each emotion type within a particular presentation type has been reported in Chapters 3-5 inclusive. The interaction can also be explained by the pattern of accuracy across presentation types foe each emotion and these outputs are presented below.

Happy

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	happyfacecorrect	5.8310	71	.44676	.05302
	happysoundcorrect	5.9155	71	.28013	.03324
Pair 2	happyfacecorrect	5.8310	71	.44676	.05302
	happywordcorrect	5.5775	71	.60147	.07138
Pair 3	happysoundcorrect	5.9155	71	.28013	.03324
	happywordcorrect	5.5775	71	.60147	.07138

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	happyfacecorrect - happysoundcorrect	-.08451	.52770	.06263	-.20941	.04040	-1.349	70	.182
Pair 2	happyfacecorrect - happywordcorrect	.25352	.75059	.08908	.07586	.43118	2.846	70	.006
Pair 3	happysoundcorrect - happywordcorrect	.33803	.67493	.08010	.17827	.49778	4.220	70	.000

Sad

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	sadfacecorrect	3.6620	71	1.69827	.20155
	sadsoundcorrect	5.4930	71	.69433	.08240
Pair 2	sadfacecorrect	3.6620	71	1.69827	.20155
	sadwordcorrect	5.1127	71	.91884	.10905
Pair 3	sadsoundcorrect	5.4930	71	.69433	.08240
	sadwordcorrect	5.1127	71	.91884	.10905

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	sadfacecorrect - sadsoundcorrect	-1.83099	1.73193	.20554	-2.24093	-1.42104	-8.908	70	.000
Pair 2	sadfacecorrect - sadwordcorrect	-1.45070	1.83450	.21772	-1.88492	-1.01649	-6.663	70	.000
Pair 3	sadsoundcorrect - sadwordcorrect	.38028	1.11312	.13210	.11681	.64375	2.879	70	.005

Fear

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	fearfacecorrect	3.8169	71	1.78333	.21164
	fearsoundcorrect	4.3099	71	1.47930	.17556
Pair 2	fearfacecorrect	3.8169	71	1.78333	.21164
	fearwordcorrect	5.0282	71	.99960	.11863
Pair 3	fearsoundcorrect	4.3099	71	1.47930	.17556
	fearwordcorrect	5.0282	71	.99960	.11863

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	fearfacecorrect - fearsoundcorrect	-.49296	1.79581	.21312	-.91802	-.06790	-2.313	70	.024
Pair 2	fearfacecorrect - fearwordcorrect	-1.21127	1.97785	.23473	-1.67942	-.74312	-5.160	70	.000
Pair 3	fearsoundcorrect - fearwordcorrect	-.71831	1.64041	.19468	-1.10659	-.33003	-3.690	70	.000

Anger

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	angerfacecorrect	3.4648	71	1.65470	.19638
	angersoundcorrect	2.4085	71	1.23725	.14683
Pair 2	angerfacecorrect	3.4648	71	1.65470	.19638
	angerwordcorrect	5.4085	71	.80316	.09532
Pair 3	angersoundcorrect	2.4085	71	1.23725	.14683
	angerwordcorrect	5.4085	71	.80316	.09532

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	angerfacecorrect - angersoundcorrect	1.05634	1.71454	.20348	.65051	1.46216	5.191	70	.000
Pair 2	angerfacecorrect - angerwordcorrect	-1.94366	1.62909	.19334	-2.32926	-1.55806	-10.053	70	.000
Pair 3	angersoundcorrect - angerwordcorrect	-3.00000	1.33095	.15795	-3.31503	-2.68497	-18.993	70	.000

Disgust

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	disgustfacecorrect	4.6056	71	1.30361	.15471
	disgustsoundcorrect	4.4648	71	.85909	.10195
Pair 2	disgustfacecorrect	4.6056	71	1.30361	.15471
	disgustwordcorrect	4.5211	71	1.29680	.15390
Pair 3	disgustsoundcorrect	4.4648	71	.85909	.10195
	disgustwordcorrect	4.5211	71	1.29680	.15390

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	disgustfacecorrect - disgustsoundcorrect	.14085	1.61507	.19167	-.24144	.52313	.735	70	.465
Pair 2	disgustfacecorrect - disgustwordcorrect	.08451	1.69661	.20135	-.31707	.48609	.420	70	.676
Pair 3	disgustsoundcorrect - disgustwordcorrect	-.05634	1.31895	.15653	-.36853	.25585	-.360	70	.720

Neutral

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	neutralfacecorrect	5.0141	71	1.20111	.14255
	neutralsoundcorrect	5.5070	71	1.01240	.12015
Pair 2	neutralfacecorrect	5.0141	71	1.20111	.14255
	neutralwordcorrect	4.8592	71	1.24552	.14782
Pair 3	neutralsoundcorrect	5.5070	71	1.01240	.12015
	neutralwordcorrect	4.8592	71	1.24552	.14782

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	neutralfacecorrect - neutralsoundcorrect	-.49296	1.69767	.20148	-.89479	-.09113	-2.447	70	.017
Pair 2	neutralfacecorrect - neutralwordcorrect	.15493	1.82559	.21666	-.27718	.58704	.715	70	.477
Pair 3	neutralsoundcorrect - neutralwordcorrect	.64789	1.64836	.19562	.25773	1.03805	3.312	70	.001

3*3*6 ANOVA Comparing Between Three Age Groups

Descriptive Statistics

	agegroup	Mean	Std. Deviation	N
happyfacecorrect	young	5.8611	.42445	36
	older	5.8333	.38348	18
	veryold	5.7647	.56230	17
	Total	5.8310	.44676	71
sadfacecorrect	young	3.8889	1.44969	36
	older	4.2222	1.80051	18
	veryold	2.5882	1.69775	17
	Total	3.6620	1.69827	71
fearfacecorrect	young	4.0833	1.66261	36
	older	3.9444	1.92422	18
	veryold	3.1176	1.79869	17
	Total	3.8169	1.78333	71
angerfacecorrect	young	3.9444	1.24084	36
	older	3.2778	1.67352	18
	veryold	2.6471	2.08989	17
	Total	3.4648	1.65470	71
disgustfacecorrect	young	4.3056	1.32707	36
	older	4.9444	.93760	18
	veryold	4.8824	1.49509	17
	Total	4.6056	1.30361	71
neutralfacecorrect	young	4.9444	1.43317	36
	older	4.9444	1.05564	18
	veryold	5.2353	.75245	17
	Total	5.0141	1.20111	71
happysoundcorrect	young	5.9722	.16667	36
	older	5.8333	.38348	18
	veryold	5.8824	.33211	17
	Total	5.9155	.28013	71
sadsoundcorrect	young	5.6389	.54263	36
	older	5.3889	.69780	18
	veryold	5.2941	.91956	17
	Total	5.4930	.69433	71
fearsoundcorrect	young	4.5833	1.67971	36
	older	4.1111	.96338	18
	veryold	3.9412	1.43486	17
	Total	4.3099	1.47930	71
angersoundcorrect	young	2.6389	1.19888	36
	older	2.3333	1.28338	18
	veryold	2.0000	1.22474	17
	Total	2.4085	1.23725	71
disgustsoundcorrect	young	4.4444	.96937	36
	older	4.2222	.54832	18
	veryold	4.7647	.83137	17
	Total	4.4648	.85909	71
neutralsoundcorrect	young	5.8333	.44721	36
	older	5.2222	1.35280	18
	veryold	5.1176	1.26897	17
	Total	5.5070	1.01240	71
happywordcorrect	young	5.5278	.69636	36
	older	5.7222	.46089	18
	veryold	5.5294	.51450	17
	Total	5.5775	.60147	71
sadwordcorrect	young	4.8056	.85589	36
	older	5.6111	.50163	18
	veryold	5.2353	1.14725	17
	Total	5.1127	.91884	71
fearwordcorrect	young	4.8889	1.03586	36
	older	5.4444	.85559	18
	veryold	4.8824	.99262	17
	Total	5.0282	.99960	71
angerwordcorrect	young	5.5000	.81064	36
	older	5.5556	.61570	18
	veryold	5.0588	.89935	17
	Total	5.4085	.80316	71
disgustwordcorrect	young	4.1667	1.15882	36
	older	4.6667	1.57181	18
	veryold	5.1176	1.05370	17
	Total	4.5211	1.29680	71
neutralwordcorrect	young	4.5833	1.25071	36
	older	4.8889	1.36722	18
	veryold	5.4118	.93934	17
	Total	4.8592	1.24552	71

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
presentationtype	.960	2.725	2	.256	.962	1.000	.500
emotiontype	.490	47.194	14	.000	.802	.883	.200
presentationtype * emotiontype	.068	173.443	54	.000	.709	.824	.100

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + agegroup
Within Subjects Design: presentationtype + emotiontype + presentationtype * emotiontype

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
presentationtype	Sphericity Assumed	121.750	2	60.875	44.015	.000	.393	88.030	1.000
	Greenhouse-Geisser	121.750	1.923	63.301	44.015	.000	.393	84.656	1.000
	Huynh-Feldt	121.750	2.000	60.875	44.015	.000	.393	88.030	1.000
	Lower-bound	121.750	1.000	121.750	44.015	.000	.393	44.015	1.000
presentationtype * agegroup	Sphericity Assumed	35.406	4	8.852	6.400	.000	.158	25.600	.989
	Greenhouse-Geisser	35.406	3.847	9.204	6.400	.000	.158	24.619	.986
	Huynh-Feldt	35.406	4.000	8.852	6.400	.000	.158	25.600	.989
	Lower-bound	35.406	2.000	17.703	6.400	.003	.158	12.800	.890
Error(presentationtype)	Sphericity Assumed	188.096	136	1.383					
	Greenhouse-Geisser	188.096	130.788	1.438					
	Huynh-Feldt	188.096	136.000	1.383					
	Lower-bound	188.096	68.000	2.766					
emotiontype	Sphericity Assumed	484.630	5	96.926	76.455	.000	.529	382.275	1.000
	Greenhouse-Geisser	484.630	4.009	120.876	76.455	.000	.529	306.531	1.000
	Huynh-Feldt	484.630	4.417	109.714	76.455	.000	.529	337.718	1.000
	Lower-bound	484.630	1.000	484.630	76.455	.000	.529	76.455	1.000
emotiontype * agegroup	Sphericity Assumed	52.969	10	5.297	4.178	.000	.109	41.781	.998
	Greenhouse-Geisser	52.969	8.019	6.606	4.178	.000	.109	33.503	.994
	Huynh-Feldt	52.969	8.834	5.996	4.178	.000	.109	36.911	.997
	Lower-bound	52.969	2.000	26.484	4.178	.019	.109	8.356	.717
Error(emotiontype)	Sphericity Assumed	431.036	340	1.268					
	Greenhouse-Geisser	431.036	272.632	1.581					
	Huynh-Feldt	431.036	300.370	1.435					
	Lower-bound	431.036	68.000	6.339					
presentationtype * emotiontype	Sphericity Assumed	389.333	10	38.933	36.012	.000	.346	360.120	1.000
	Greenhouse-Geisser	389.333	7.093	54.886	36.012	.000	.346	255.449	1.000
	Huynh-Feldt	389.333	8.236	47.271	36.012	.000	.346	296.599	1.000
	Lower-bound	389.333	1.000	389.333	36.012	.000	.346	36.012	1.000
presentationtype * emotiontype * agegroup	Sphericity Assumed	27.232	20	1.362	1.259	.199	.036	25.189	.876
	Greenhouse-Geisser	27.232	14.187	1.920	1.259	.228	.036	17.868	.771
	Huynh-Feldt	27.232	16.472	1.653	1.259	.216	.036	20.746	.820
	Lower-bound	27.232	2.000	13.616	1.259	.290	.036	2.519	.265
Error (presentationtype*emotiontype)	Sphericity Assumed	735.162	680	1.081					
	Greenhouse-Geisser	735.162	482.353	1.524					
	Huynh-Feldt	735.162	560.056	1.313					
	Lower-bound	735.162	68.000	10.811					

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	25262.481	1	25262.481	7778.369	.000	.991	7778.369	1.000
agegroup	8.151	2	4.075	1.255	.292	.036	2.510	.264
Error	220.849	68	3.248					

a. Computed using alpha = .05

*Post hoc Tests Investigating the Presentation Type*Age Group Interaction*

Comparing accuracy between YAs and younger-older adults

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
totalemotionfacecorrect	young	36	27.0278	3.76818	.62803
	older	18	27.1667	3.89947	.91911
totalemotionsoundcorrect	young	36	29.1111	2.63794	.43966
	older	18	27.1111	2.29805	.54166
totalemotionwordcorrect	young	36	29.4722	3.98917	.66486
	older	18	31.8889	3.42807	.80800

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
totalemotionfacecorrect	Equal variances assumed	.629	.431	-.126	52	.900	-.13889	1.10031	-2.34683	2.06905
	Equal variances not assumed			-.125	33.078	.901	-.13889	1.11319	-2.40349	2.12571
totalemotionsoundcorrect	Equal variances assumed	.124	.727	2.736	52	.008	2.00000	.73088	.53338	3.46662
	Equal variances not assumed			2.867	38.634	.007	2.00000	.69763	.58848	3.41152
totalemotionwordcorrect	Equal variances assumed	.294	.590	-2.194	52	.033	-2.41667	1.10124	-4.62648	-.20686
	Equal variances not assumed			-2.310	39.106	.026	-2.41667	1.04638	-4.53299	-.30035

Comparing accuracy between YAs and older-older adults

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
totalemotionfacecorrect	young	36	27.0278	3.76818	.62803
	veryold	18	23.6111	5.07750	1.19678
totalemotionsoundcorrect	young	36	29.1111	2.63794	.43966
	veryold	17	26.8824	3.23810	.78535
totalemotionwordcorrect	young	36	29.4722	3.98917	.66486
	veryold	18	30.7778	3.57369	.84233

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
totalemotionfacecorrect	Equal variances assumed	.979	.327	2.791	52	.007	3.41667	1.22425	.96002	5.87331
	Equal variances not assumed			2.528	26.670	.018	3.41667	1.35156	.64190	6.19144
totalemotionsoundcorrect	Equal variances assumed	.310	.580	2.667	51	.010	2.22876	.83573	.55096	3.90656
	Equal variances not assumed			2.476	26.414	.020	2.22876	.90004	.38010	4.07742
totalemotionwordcorrect	Equal variances assumed	.009	.926	-1.172	52	.246	-1.30556	1.11379	-3.54053	.92942
	Equal variances not assumed			-1.217	37.678	.231	-1.30556	1.07311	-3.47855	.86744

Comparing accuracy between younger-older and older-older adults

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
totalemotionfacecorrect	older	18	27.1667	3.89947	.91911
	veryold	18	23.6111	5.07750	1.19678
totalemotionsoundcorrect	older	18	27.1111	2.29805	.54166
	veryold	17	26.8824	3.23810	.78535
totalemotionwordcorrect	older	18	31.8889	3.42807	.80800
	veryold	18	30.7778	3.57369	.84233

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
totalemotionfacecorrect	Equal variances assumed	1.388	.247	2.356	34	.024	3.55556	1.50899	.48892	6.62219
	Equal variances not assumed			2.356	31.878	.025	3.55556	1.50899	.48138	6.62973
totalemotionsoundcorrect	Equal variances assumed	.075	.786	.242	33	.810	.22876	.94480	-1.69346	2.15097
	Equal variances not assumed			.240	28.725	.812	.22876	.95403	-1.72326	2.18078
totalemotionwordcorrect	Equal variances assumed	.220	.642	.952	34	.348	1.11111	1.16721	-1.26095	3.48317
	Equal variances not assumed			.952	33.941	.348	1.11111	1.16721	-1.26110	3.48332

*Post hoc Tests Investigating the Emotion Type*Age Group Interaction*

Comparing accuracy between YAs and younger-older adults

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
Totalanger	young	36	12.0833	2.25990	.37665
	older	18	11.1667	2.74933	.64802
Totalsad	young	36	14.3333	1.95667	.32611
	older	18	15.2222	2.23753	.52739
Totaldisgust	young	36	12.9167	2.32225	.38704
	older	18	13.8333	1.97782	.46618
totalhappy	young	36	17.3611	.79831	.13305
	older	18	17.3889	.77754	.18327
totalfear	young	36	13.5556	3.00898	.50150
	older	18	13.5000	2.83362	.66789
totalneutral	young	36	15.3611	1.83852	.30642
	older	18	15.0556	1.62597	.38325

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Totalanger	Equal variances assumed	2.818	.099	1.306	52	.197	.91667	.70170	-.49140	2.32474
	Equal variances not assumed			1.223	28.828	.231	.91667	.74953	-.61670	2.45003
Totalsad	Equal variances assumed	.268	.607	-1.500	52	.140	-.88889	.59257	-2.07797	.30019
	Equal variances not assumed			-1.434	30.332	.162	-.88889	.62007	-2.15467	.37689
Totaldisgust	Equal variances assumed	1.117	.295	-1.433	52	.158	-.91667	.63957	-2.20007	.36673
	Equal variances not assumed			-1.513	39.417	.138	-.91667	.60591	-2.14181	.30848
totalhappy	Equal variances assumed	.002	.967	-.122	52	.904	-.02778	.22851	-.48632	.43076
	Equal variances not assumed			-.123	34.930	.903	-.02778	.22647	-.48758	.43202
totalfear	Equal variances assumed	.001	.971	.065	52	.948	.05556	.85240	-1.65491	1.76602
	Equal variances not assumed			.067	36.013	.947	.05556	.83521	-1.63831	1.74942
totalneutral	Equal variances assumed	.000	.984	.597	52	.553	.30556	.51149	-.72082	1.33193
	Equal variances not assumed			.623	38.116	.537	.30556	.49068	-.68768	1.29879

Comparing accuracy between YAs and older-older adults

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
Totalanger	young	36	12.0833	2.25990	.37665
	veryold	17	9.7059	2.99509	.72642
Totalsad	young	36	14.3333	1.95667	.32611
	veryold	17	13.1176	2.42080	.58713
Totaldisgust	young	36	12.9167	2.32225	.38704
	veryold	17	14.7647	1.98524	.48149
totalhappy	young	36	17.3611	.79831	.13305
	veryold	17	17.1765	.80896	.19620
totalfear	young	36	13.5556	3.00898	.50150
	veryold	17	11.9412	3.19121	.77398
totalneutral	young	36	15.3611	1.83852	.30642
	veryold	17	15.7647	1.78639	.43326

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Totalanger	Equal variances assumed	6.051	.017	3.214	51	.002	2.37745	.73976	.89231	3.86259
	Equal variances not assumed			2.906	24.936	.008	2.37745	.81826	.69200	4.06291
Totalsad	Equal variances assumed	.407	.526	1.955	51	.056	1.21569	.62190	-.03283	2.46420
	Equal variances not assumed			1.810	26.253	.082	1.21569	.67162	-.16420	2.59557
Totaldisgust	Equal variances assumed	.282	.598	-2.826	51	.007	-1.84804	.65390	-3.16080	-.53528
	Equal variances not assumed			-2.991	36.408	.005	-1.84804	.61777	-3.10044	-.59564
totalhappy	Equal variances assumed	.001	.975	.783	51	.437	.18464	.23592	-.28898	.65826
	Equal variances not assumed			.779	31.094	.442	.18464	.23706	-.29879	.66807
totalfear	Equal variances assumed	.112	.739	1.788	51	.080	1.61438	.90265	-.19777	3.42653
	Equal variances not assumed			1.750	29.850	.090	1.61438	.92225	-.26951	3.49827
totalneutral	Equal variances assumed	.467	.497	-.753	51	.455	-.40359	.53628	-1.48021	.67302
	Equal variances not assumed			-.761	32.313	.452	-.40359	.53067	-1.48412	.67693

Comparing accuracy between younger-older and older-older adults

Group Statistics

	agegroup	N	Mean	Std. Deviation	Std. Error Mean
Totalanger	older	18	11.1667	2.74933	.64802
	veryold	17	9.7059	2.99509	.72642
Totalsad	older	18	15.2222	2.23753	.52739
	veryold	17	13.1176	2.42080	.58713
Totaldisgust	older	18	13.8333	1.97782	.46618
	veryold	17	14.7647	1.98524	.48149
totalhappy	older	18	17.3889	.77754	.18327
	veryold	17	17.1765	.80896	.19620
totalfear	older	18	13.5000	2.83362	.66789
	veryold	17	11.9412	3.19121	.77398
totalneutral	older	18	15.0556	1.62597	.38325
	veryold	17	15.7647	1.78639	.43326

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Totalanger	Equal variances assumed	.585	.450	1.504	33	.142	1.46078	.97101	-.51475	3.43632
	Equal variances not assumed			1.501	32.329	.143	1.46078	.97346	-.52129	3.44286
Totalsad	Equal variances assumed	.015	.902	2.673	33	.012	2.10458	.78739	.50261	3.70654
	Equal variances not assumed			2.667	32.390	.012	2.10458	.78922	.49775	3.71140
Totaldisgust	Equal variances assumed	.298	.589	-1.390	33	.174	-.93137	.67012	-2.29473	.43199
	Equal variances not assumed			-1.390	32.871	.174	-.93137	.67019	-2.29509	.43234
totalhappy	Equal variances assumed	.000	.995	.792	33	.434	.21242	.26817	-.33318	.75801
	Equal variances not assumed			.791	32.683	.435	.21242	.26848	-.33401	.75885
totalfear	Equal variances assumed	.124	.727	1.530	33	.136	1.55882	1.01876	-.51386	3.63151
	Equal variances not assumed			1.525	32.000	.137	1.55882	1.02231	-.52356	3.64121
totalneutral	Equal variances assumed	.432	.516	-1.229	33	.228	-.70915	.57685	-1.88275	.46445
	Equal variances not assumed			-1.226	32.251	.229	-.70915	.57844	-1.88704	.46874

Post hoc Tests for Pattern of Recognition Accuracy across Emotions in YAs

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	totalhappy	17.3611	36	.79831	.13305
	Totalsad	14.3333	36	1.95667	.32611
Pair 2	totalhappy	17.3611	36	.79831	.13305
	totalfear	13.5556	36	3.00898	.50150
Pair 3	totalhappy	17.3611	36	.79831	.13305
	Totalanger	12.0833	36	2.25990	.37665
Pair 4	totalhappy	17.3611	36	.79831	.13305
	Totaldisgust	12.9167	36	2.32225	.38704
Pair 5	totalhappy	17.3611	36	.79831	.13305
	totalneutral	15.3611	36	1.83852	.30642
Pair 6	Totalsad	14.3333	36	1.95667	.32611
	totalfear	13.5556	36	3.00898	.50150
Pair 7	Totalsad	14.3333	36	1.95667	.32611
	Totalanger	12.0833	36	2.25990	.37665
Pair 8	Totalsad	14.3333	36	1.95667	.32611
	Totaldisgust	12.9167	36	2.32225	.38704
Pair 9	Totalsad	14.3333	36	1.95667	.32611
	totalneutral	15.3611	36	1.83852	.30642
Pair 10	totalfear	13.5556	36	3.00898	.50150
	Totalanger	12.0833	36	2.25990	.37665
Pair 11	totalfear	13.5556	36	3.00898	.50150
	Totaldisgust	12.9167	36	2.32225	.38704
Pair 12	totalfear	13.5556	36	3.00898	.50150
	totalneutral	15.3611	36	1.83852	.30642
Pair 13	Totalanger	12.0833	36	2.25990	.37665
	Totaldisgust	12.9167	36	2.32225	.38704
Pair 14	Totalanger	12.0833	36	2.25990	.37665
	totalneutral	15.3611	36	1.83852	.30642
Pair 15	Totaldisgust	12.9167	36	2.32225	.38704
	totalneutral	15.3611	36	1.83852	.30642

a. agegroup = young

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper			
Pair 1	totalhappy - Totalsad	3.02778	1.87443	.31241	2.39356	3.66199	9.692	35	.000
Pair 2	totalhappy - totalfear	3.80556	2.94540	.49090	2.80897	4.80214	7.752	35	.000
Pair 3	totalhappy - Totalanger	5.27778	2.40964	.40161	4.46247	6.09308	13.142	35	.000
Pair 4	totalhappy - Totaldisgust	4.44444	2.04862	.34144	3.75129	5.13760	13.017	35	.000
Pair 5	totalhappy - totalneutral	2.00000	1.83615	.30602	1.37874	2.62126	6.535	35	.000
Pair 6	Totalsad - totalfear	.77778	2.80928	.46821	-.17275	1.72830	1.661	35	.106
Pair 7	Totalsad - Totalanger	2.25000	2.87228	.47871	1.27816	3.22184	4.700	35	.000
Pair 8	Totalsad - Totaldisgust	1.41667	2.20875	.36812	.66933	2.16400	3.848	35	.000
Pair 9	Totalsad - totalneutral	-1.02778	2.91289	.48548	-2.01336	-.04220	-2.117	35	.041
Pair 10	totalfear - Totalanger	1.47222	3.26441	.54407	.36771	2.57674	2.706	35	.010
Pair 11	totalfear - Totaldisgust	.63889	2.69553	.44925	-.27315	1.55092	1.422	35	.164
Pair 12	totalfear - totalneutral	-1.80556	3.45435	.57573	-2.97434	-.63677	-3.136	35	.003
Pair 13	Totalanger - Totaldisgust	-.83333	3.09377	.51563	-1.88012	.21345	-1.616	35	.115
Pair 14	Totalanger - totalneutral	-3.27778	2.83459	.47243	-4.23687	-2.31869	-6.938	35	.000
Pair 15	Totaldisgust - totalneutral	-2.44444	2.47784	.41297	-3.28282	-1.60606	-5.919	35	.000

a. agegroup = young

Post hoc Tests for Pattern of Recognition Accuracy across Emotions in Younger-older adults

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	totalhappy	17.3889	18	.77754	.18327
	Totalsad	15.2222	18	2.23753	.52739
Pair 2	totalhappy	17.3889	18	.77754	.18327
	totalfear	13.5000	18	2.83362	.66789
Pair 3	totalhappy	17.3889	18	.77754	.18327
	Totalanger	11.1667	18	2.74933	.64802
Pair 4	totalhappy	17.3889	18	.77754	.18327
	Totaldisgust	13.8333	18	1.97782	.46618
Pair 5	totalhappy	17.3889	18	.77754	.18327
	totalneutral	15.0556	18	1.62597	.38325
Pair 6	Totalsad	15.2222	18	2.23753	.52739
	totalfear	13.5000	18	2.83362	.66789
Pair 7	Totalsad	15.2222	18	2.23753	.52739
	Totalanger	11.1667	18	2.74933	.64802
Pair 8	Totalsad	15.2222	18	2.23753	.52739
	Totaldisgust	13.8333	18	1.97782	.46618
Pair 9	Totalsad	15.2222	18	2.23753	.52739
	totalneutral	15.0556	18	1.62597	.38325
Pair 10	totalfear	13.5000	18	2.83362	.66789
	Totalanger	11.1667	18	2.74933	.64802
Pair 11	totalfear	13.5000	18	2.83362	.66789
	Totaldisgust	13.8333	18	1.97782	.46618
Pair 12	totalfear	13.5000	18	2.83362	.66789
	totalneutral	15.0556	18	1.62597	.38325
Pair 13	Totalanger	11.1667	18	2.74933	.64802
	Totaldisgust	13.8333	18	1.97782	.46618
Pair 14	Totalanger	11.1667	18	2.74933	.64802
	totalneutral	15.0556	18	1.62597	.38325
Pair 15	Totaldisgust	13.8333	18	1.97782	.46618
	totalneutral	15.0556	18	1.62597	.38325

a. agegroup = older

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	totalhappy - Totalsad	2.16667	2.30728	.54383	1.01928	3.31405	3.984	17	.001
Pair 2	totalhappy - totalfear	3.88889	2.67645	.63085	2.55792	5.21986	6.165	17	.000
Pair 3	totalhappy - Totalanger	6.22222	2.64699	.62390	4.90591	7.53854	9.973	17	.000
Pair 4	totalhappy - Totaldisgust	3.55556	1.75641	.41399	2.68211	4.42900	8.589	17	.000
Pair 5	totalhappy - totalneutral	2.33333	1.81497	.42779	1.43077	3.23590	5.454	17	.000
Pair 6	Totalsad - totalfear	1.72222	3.32204	.78301	.07021	3.37423	2.199	17	.042
Pair 7	Totalsad - Totalanger	4.05556	2.71103	.63900	2.70739	5.40372	6.347	17	.000
Pair 8	Totalsad - Totaldisgust	1.38889	2.40438	.56672	.19322	2.58456	2.451	17	.025
Pair 9	Totalsad - totalneutral	.16667	2.79179	.65803	-1.22166	1.55499	.253	17	.803
Pair 10	totalfear - Totalanger	2.33333	3.58100	.84405	.55255	4.11412	2.764	17	.013
Pair 11	totalfear - Totaldisgust	-.33333	3.06786	.72310	-1.85894	1.19228	-.461	17	.651
Pair 12	totalfear - totalneutral	-1.55556	3.36456	.79303	-3.22871	.11760	-1.962	17	.066
Pair 13	Totalanger - Totaldisgust	-2.66667	2.78652	.65679	-4.05237	-1.28096	-4.060	17	.001
Pair 14	Totalanger - totalneutral	-3.88889	3.02711	.71350	-5.39424	-2.38354	-5.450	17	.000
Pair 15	Totaldisgust - totalneutral	-1.22222	2.55655	.60258	-2.49356	.04912	-2.028	17	.058

a. agegroup = older

Post hoc Tests for Pattern of Recognition Accuracy across Emotions in Older-older adults

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	totalhappy	17.1765	17	.80896	.19620
	Totalsad	13.1176	17	2.42080	.58713
Pair 2	totalhappy	17.1765	17	.80896	.19620
	totalfear	11.9412	17	3.19121	.77398
Pair 3	totalhappy	17.1765	17	.80896	.19620
	Totalanger	9.7059	17	2.99509	.72642
Pair 4	totalhappy	17.1765	17	.80896	.19620
	Totaldisgust	14.7647	17	1.98524	.48149
Pair 5	totalhappy	17.1765	17	.80896	.19620
	totalneutral	15.7647	17	1.78639	.43326
Pair 6	Totalsad	13.1176	17	2.42080	.58713
	totalfear	11.9412	17	3.19121	.77398
Pair 7	Totalsad	13.1176	17	2.42080	.58713
	Totalanger	9.7059	17	2.99509	.72642
Pair 8	Totalsad	13.1176	17	2.42080	.58713
	Totaldisgust	14.7647	17	1.98524	.48149
Pair 9	Totalsad	13.1176	17	2.42080	.58713
	totalneutral	15.7647	17	1.78639	.43326
Pair 10	totalfear	11.9412	17	3.19121	.77398
	Totalanger	9.7059	17	2.99509	.72642
Pair 11	totalfear	11.9412	17	3.19121	.77398
	Totaldisgust	14.7647	17	1.98524	.48149
Pair 12	totalfear	11.9412	17	3.19121	.77398
	totalneutral	15.7647	17	1.78639	.43326
Pair 13	Totalanger	9.7059	17	2.99509	.72642
	Totaldisgust	14.7647	17	1.98524	.48149
Pair 14	Totalanger	9.7059	17	2.99509	.72642
	totalneutral	15.7647	17	1.78639	.43326
Pair 15	Totaldisgust	14.7647	17	1.98524	.48149
	totalneutral	15.7647	17	1.78639	.43326

a. agegroup = veryold

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	totalhappy - Totalsad	4.05882	2.68027	.65006	2.68076	5.43689	6.244	16	.000
Pair 2	totalhappy - totalfear	5.23529	3.07265	.74523	3.65548	6.81510	7.025	16	.000
Pair 3	totalhappy - Totalanger	7.47059	3.06426	.74319	5.89509	9.04609	10.052	16	.000
Pair 4	totalhappy - Totaldisgust	2.41176	2.15229	.52201	1.30516	3.51837	4.620	16	.000
Pair 5	totalhappy - totalneutral	1.41176	2.20960	.53591	.27569	2.54784	2.634	16	.018
Pair 6	Totalsad - totalfear	1.17647	3.45028	.83682	-.59750	2.95044	1.406	16	.179
Pair 7	Totalsad - Totalanger	3.41176	3.00123	.72790	1.86868	4.95485	4.687	16	.000
Pair 8	Totalsad - Totaldisgust	-1.64706	2.34364	.56842	-2.85205	-.44207	-2.898	16	.010
Pair 9	Totalsad - totalneutral	-2.64706	2.39638	.58121	-3.87916	-1.41495	-4.554	16	.000
Pair 10	totalfear - Totalanger	2.23529	3.49159	.84683	.44009	4.03050	2.640	16	.018
Pair 11	totalfear - Totaldisgust	-2.82353	2.92052	.70833	-4.32512	-1.32194	-3.986	16	.001
Pair 12	totalfear - totalneutral	-3.82353	3.59227	.87125	-5.67050	-1.97655	-4.389	16	.000
Pair 13	Totalanger - Totaldisgust	-5.05882	3.21074	.77872	-6.70963	-3.40802	-6.496	16	.000
Pair 14	Totalanger - totalneutral	-6.05882	2.68027	.65006	-7.43689	-4.68076	-9.320	16	.000
Pair 15	Totaldisgust - totalneutral	-1.00000	2.52488	.61237	-2.29817	.29817	-1.633	16	.122

a. agegroup = veryold

Appendix 7.1

Table 7.1

Databases using Video Clips as Stimuli

Name	Authors	Number of stimuli	Emotions represented						Separate audio and faces	OAs represented	Non-English Accent	Colour	Other
			H	S	F	A	D	N					
Multimodal Emotion Recognition Test (MERT)	Bänziger, Grandjean, & Scherer (2009)	120 video clips	✓	✓	✓	✓	✓	✗	✓	✗	✓	✗	
Geneva Emotion Recognition Test (GERT)	Schlegel, Grandjean, & Scherer (2014)	83 video clips	✓	✓	✓	✓	✓	✗	✗		✓	✓	Range of emotions
GEMEP-CS	Bänziger et al., (2012)	145 video clips	✓	✓	✓	✓	✓	✗	✓	✓	✓	✓	Range of emotions
The Emotion Recognition Task	Montagne, Kessels, De Haan, & Perrett (2007)		✓	✓	✓	✓	✓	✓	Morphed faces	Not stated			Over a range of intensities. Surprise also included
Pell	Pell (2002)	132*3 presentation types (396)	✓	✓	✗	✓	✓	✓	✓	✓	✗	✓	
PONS Profile of Nonverbal Sensitivity	Rosenthal, Hall, DiMatteo, Rogers, & Archer, (1979)	220 examples of different attitudes displayed in							✓	✓	✗	✗	Emotive states rather than basic emotions

		face, sounds											
The Cambridge Mindreading (CAM) Face-Voice battery	Golan, Baron-Cohen, & Hill (2006)	100	✓	✓	✓	✓	✓		✓ but not cross-modal	✓	✓	✓	Concepts of an emotion group rather than distinct emotions

Appendix 7.2

The Trials used in the Positive Experiment taken from the GEMEP-CS

Positive
Practice
Angerv&sfemale1.wmv
Amusementv&smale4.wmv
Joyv&sfemale4.wmv
Pridev&smale4.wmv
Experimental
Angerv&smale1.wmv
Angerv&smale2.wmv
Angerv&sfemale2.wmv
Angerv&sfemale3.wmv
Angerv&smale5.wmv
Joyv&sfemale2.wmv
Joyv&sfemale3.wmv
Joyv&smale1.wmv
Joyv&smale2.wmv
Joyv&smale5.wmv
Amusementv&sfemale2.wmv
Amusementv&sfemale3.wmv
Amusementv&smale1.wmv
Amusementv&smale2.wmv
Amusementv&smale5.wmv
Pridev&sfemale2.wmv
Pridev&sfemale3.wmv
Pridev&smale1.wmv
Pridev&smale2.wmv
Pridev&smale5.wmv
Surprisev&sfemale2.wmv
Surprisev&sfemale3.wmv
Surprisev&smale1.wmv
Surprisev&smale2.wmv
Surprisev&smale5.wmv

Appendix 7.3

The Trials used in the Negative Experiment taken from the GEMEP-CS

NEGATIVE
Practice
norm_06col112.wav
norm_01joi112.wav
norm_08peu112.wav
norm_07tri126.wav
Experimental
norm_02joi123.wav
norm_04joi117.wav
norm_09joi112.wav
norm_10joi123.wav
norm_02tri122.wav
norm_04tri111.wav
norm_09tri114.wav
norm_10tri123.wav
norm_02peu111.wav
norm_04peu113.wav
norm_09peu112.wav
norm_10peu115.wav
norm_02col112.wav
norm_04col114.wav
norm_09col113.wav
norm_10col117.wav
norm_02deg123.wav
norm_04deg112.wav
norm_09deg117.wav
norm_10deg119.wav

Appendix 7.4

Pilot study in Phase 2

The main purpose of the pilot study was to determine whether the stimuli could be correctly identified as the target emotion, a measure of content validity, and to assess the ease in which participants could complete the concentric circle measure of social functioning (Lang and Carstensen, 1994). Finally, the pilot uncovered any coding errors in the E prime tasks. Content validity in the current pilot was determined by recognition accuracy over 50% accuracy rate which is above that of chance (1/6 = 17%). It is typical that the validation value is determined as chance but this may vary (Wagner, 1993). In reality an accuracy rate of 17% is low; therefore, to ensure that the encoder is displaying the target emotion effectively for decoding, a higher threshold was set at 50%.

Participants

Eleven participants (3 males and 8 females; mean age = 42.81 years [SD = 16.48]) volunteered for the pilot study. Participants responded to an email request and were students or known to the researcher.

Materials

The nine E prime tasks used for the Phase 2 pilot study are explained in detail in Chapter 7. In summary nine tasks were conducted; six tasks were based on stimuli taken from the GEMEP-CS (Bänziger et al., 2011), which included tasks assessing emotion recognition of positive and negative emotions across three presentation types (dynamic facial expressions, prosodic nonsense sentences and simultaneously presented facial expressions and prosodic sentences). The emotions for the positive experiment were: amusement, anger, joy, pride, and surprise; and for the negative condition: anger, disgust, fear, joy, and sad. A further three tasks were based on stimuli taken from the Pell database (Paulmann & Pell, 2011). Again the tasks measured emotion recognition across three presentation types (dynamic facial expressions, prosodic nonsense sentences and simultaneously presented facial expressions and prosodic sentences) and six emotion types (anger, disgust, happy, sad, surprise and neutral). All of the emotion recognition tasks were computer-based, self-paced and responses were recorded via a six-button response box.

The concentric circles task measures the perceived quality of social relationships and is based on a concept previously used by Lang and Carstensen (1994). In the pilot study the concentric circle task was a paper and pencil task consisting of three circles laid within each other. Participants were required to enter the initial of people close to them on three levels (represented by each circle): those whom they feel very close to, so close they cannot imagine life without them; those whom they do not feel quite as close compared to the inner circle but who are still very important; and those whom they feel less close to but who are still important.

Procedure

Participants were individually tested in a psychology laboratory. Ethical protocol was followed as participants read the participant information form and provided informed consent. They then completed the concentric circles test followed by the nine E prime tasks. The order of the E prime experiments was counterbalanced. The pilot session lasted approximately 45 minutes. Upon completion participants were debriefed.

Results

The Positive Experiment

The GEMEP-CS (Bänziger et al., 2011) database was used to create a series of forced-choice tasks aimed at measuring participant's ability to correctly classify facial expressions as one of six given emotions. The positive experiment particularly assessed adults' ability to make differential judgements between multiple positive emotions, with only one negative emotion included in the forced choice options.

As shown in Table 1 all of the emotion types achieved an accuracy of over 50% with the exception of surprise. Looking at the incorrect judgements surprise was often perceived as neutral. This may have been due to actors varying ability to effectively portray surprise. However, the low score for surprise may be partially explained by the presence of a neutral option in the absence of any neutral stimuli. Given that there was a neutral option participants may have expected to be presented with some neutral expressions and may have opted for neutral when the stimuli seemed ambiguous. In this case the suggested low ability of actors to portray surprise effectively may have led to ambiguity thus participants selected neutral rather than surprise for this emotion type. Removal of the neutral option may increase the accuracy score for surprise.

Table 1

Proportion of Accurate Responses by Emotion and Presentation Type in the Positive Experiment

Presentation mode / Emotion	Facial expressions	Prosody	Facial expressions with prosody
Amusement	.84	.91	.95
Anger	.84	.75	.95
Joy	.58	.49	.60
Pride	.67	.15	.60
Surprise	.27	.24	.42

Note. Red indicates accuracy scores < 50%

Emotion recognition accuracy from facial expressions in the positive experiment.

A total of 275 trials were conducted (11 participants x 5 emotions x 5 trials/actors). Accuracy for classifying facial expressions as the target emotion was 64% (176/275). Table 2 presents an overview of accuracy for each emotion portrayed by each actor. Female actors tended to be able to encode emotions effectively for decoding (with the exception of surprise for one female actor); however, some low scores were observed for the male actors and these were mainly observed for surprise.

Table 2

Emotion Recognition Accuracy on the Positive Face Task by Actor and Emotion (N = 11)

Actor / Emotion	Male 1 (1)	Male 2 (3)	Male 5 (8)	Female 2 (6)	Female 3 (7)	Total (n= 55)
Amusement	6	9	9	11	11	46
Anger	8	10	10	11	7	46
Joy	7	9	1	7	8	32
Pride	3	6	9	10	9	37
Surprise	3	0	3	6	3	15
Total (n=55)	27	34	32	45	38	176/275

Note. Numbers in parentheses are the GEMEP- CS identification code
Red indicates accuracy scores < 50%

Emotion recognition accuracy from prosodic sentences in the positive experiment. Accuracy for classifying prosodic nonsense sentences as the target emotion was 51% (139/275), which just meets the validity criteria set at 50%. However, the proportion of accurate responses per emotion (see Table 1) demonstrates that two of the five emotions failed to meet the expected 50% accuracy target. Indeed accuracy for recognising pride from prosodic sentences fell below that of chance (17%) (see Table 3). It is conceivable, therefore, that prosodic cues of pride are in general difficult to decode or encode. There is little research in the field that includes pride thus it may be interesting to explore whether OAs and YAs share this difficulty and if so do they share it to the same degree.

Furthermore, a lower total accuracy than was observed for the face task may reflect the difficulty in interpreting prosody in a foreign tone. Whilst there is evidence that vocal prosody follows universal rules, albeit with cultural specific cues, to enable decoding in different languages these studies generally refer to basic emotions (e.g. Pell, Monetts, Paulmann, & Kotz, 2009; Scherer, Banse, & Wallbott, 2001; Thompson and Balkwill, 2006). Thus the low accuracy score in the pilot study may reflect the inclusion of emotions (amusement and pride) that are not traditionally considered to be basic emotions (see Ekman, Friesen, & Ellesworth, 1972). However, amusement achieved high accuracy scores so this explanation can only be applied to pride. Moreover, surprise maybe considered a basic emotion but there is conflicting evidence that it meets the basic emotion criteria (Ekman, 1992; Ekman & Cordaro, 2011). If surprise is deemed to be a basic emotion it should have universal rules, thus it should recognised in a foreign accent. Yet the low accuracy in recognising prosodic surprise in the pilot suggests that surprise may not have these universal cues. Furthermore, research aimed at investigating the recognition of emotion prosody across foreign languages has often omitted surprise (e.g. Pell, Monetts, Paulmann, & Kotz, 2009; Scherer, Banse, & Wallbott, 2001; Thompson and Balkwill, 2006). Indeed, Pell, Monetts, Paulmann, and Kotz, (2009) explain that they purposely did not include surprise due to the lack of clarity regarding its status as a basic emotion. Thus, the pilot data reported here seems to support the opinion that prosodic surprise may not be considered as a basic emotion and fails to hold universal cues for decoding; thus, recognition of surprise presented in a foreign accent is difficult. However, the small sample size means that this view should be treated with caution.

Alternative explanations for low scores can be gained by investigating response errors. These suggest that, similar to the facial expressions of surprise, prosodic sentences of pride and surprise were often mistaken as neutral. Again there is a possibility that pride and surprise prosodic sounds are ambiguous, thus participants responded to this uncertainty with a neutral response bias. As suggested for the facial expression task the validity may be improved if the neutral option was omitted from the forced choice options.

Table 3

Emotion Recognition Accuracy on the Positive Prosody Task by Actor and Emotion (N = 11)

Emotion \ Actor	Male 1 (1)	Male 2 (3)	Male 5 (8)	Female 2 (6)	Female 3 (7)	Total (*n* = 55)
Amusement	10	9	9	11	11	50
Anger	4	9	9	9	10	41
Joy	4	10	7	5	1	27
Pride	2	2	1	2	1	8
Surprise	0	0	1	3	9	13
Total (*n* = 55)	20	30	27	30	32	139/275

Note. Numbers in parentheses are the GEMEP- CS identification code
Red indicates accuracy scores < 50%

Inspection of accuracy for each emotion portrayed by each actor suggests that no actor met the classification criteria for content validity across all emotion types (50% accuracy) (see Table 11). As with the facial expression task, prosodic sentences of surprise portrayed by Male 2 were not accurately decoded. Further, Male 1 also failed to have any correct judgements for his portrayal of surprise. Thus the low scores for surprise may result from an inability for actors to effectively portray prosodic surprise. Moreover, accuracy for pride was low across all actors and suggests that either pride in the absence of visual information is difficult to recognise or that the actors were unable to portray pride effectively in the prosodic sentence. However, the current findings are in line with the validation study by Bänziger et al. (2011) as the authors also reported low accuracy for prosodic sentences of pride. As such prosodic pride is likely to have a low score in the experimental phase; however, it is of interest to determine whether OAs and YAs vary in the ability to detect pride in prosodic sentences despite the expected low scores.

Regarding total emotion recognition accuracy our findings reflect those reported in the original GEMEP- CS validity literature (Bänziger et al., 2011). In fact the proportion of correct responses from 20 participants was lower in the validation study compared to our pilot study (.36 and .51 respectively); however, the original GEMEP-CS (Bänziger et al., 2011) did measure additional emotions, which may account for the difference in total scores.

In summary, the results of the pilot study indicate that the prosodic sentences were classified in total above that of chance. Issues regarding decoding of surprise and pride have been observed and these are likely to have low scores in the experimental phase. However, the experiment is a between participants design and so the difficulty is assumed equal to both the YAs and OAs; hence, conclusions can still be drawn for age differences.

Emotion recognition accuracy on the cross-modal task in the positive experiment.

Emotion recognition accuracy on the cross-modal facial expression and prosodic sentence task was 70 %, which was higher than either presentation type alone. Further, total accuracy was above the 50% accuracy threshold so has evidence of content validity (see Table 4). Recognition of surprise achieved 42% accuracy and was the only emotion to fall short of the 50% threshold but this is still above that of chance (17%). Similar to the separate facial expression and prosody tasks participants failed to decode surprise presented by Male 2. In light of this it seems that this actor’s encoding of surprise is not sufficiently effective to enable recognition as surprise. Recognition accuracy for pride and Joy were also low for two of the actors. Despite the lower accuracy scores for some actors, overall the task does appear to have content validity.

Table 4

Emotion Recognition Accuracy on the Cross-modal Positive Task by Actor and Emotion (N = 11)

Emotion \ Actor	Male 1 (1)	Male 2 (3)	Male 5 (8)	Female 2 (6)	Female 3 (7)	Total (*n* = 55)
Amusement	9	10	11	11	11	52
Anger	11	9	10	11	11	52
Joy	3	10	1	10	9	33
Pride	5	5	7	6	10	33
Surprise	3	0	3	8	9	23
Total (*n* = 55)	31	34	32	46	50	193/275

Note. Numbers in parentheses are the GEMEP- CS identification code
Red indicates accuracy scores < 50%

To summarise, the GEMEP-CS (Bänziger et al., 2011) provides a valid measure of emotion recognition for the cross-modal positive task. Some actors were better at encoding the target emotion than others but all had adequate total scores.

To summarise, most of the emotions were correctly classified to a degree greater than 50% suggesting good content validity across the task. Surprise often had the lowest accuracy but the removal of the neutral option may improve recognition accuracy for surprise. The database does provide a suitable basis for the experiment but it is worth noting that scores for surprise and prosodic pride maybe low in the experimental phase.

The Negative Experiment

The GEMEP- CS database was used to create a series of forced-choice tasks aimed at measuring participant's ability to correctly classify stimuli as one of six given emotions. The negative experiment particularly assessed adults' ability to make differential judgements between multiple negative emotions, with only one positive emotion choice.

Table 5

Proportion of Accurate Responses by Emotion and Presentation Type in the Negative Experiment

Presentation mode / Emotion	Facial Expression	Prosody	Facial Expression with Prosody
Anger	.91	.91	.86
Disgust	.48	.45	.73
Joy	.86	.20	.84
Fear	.84	.91	.98
Sad	.45	.61	.61

Note. Red indicates accuracy scores < 50%

Emotion recognition accuracy from facial expressions in the negative experiment.

Participants completed a total of 220 trials (11 participants x 5 emotions x 4 actors) and total accuracy for classifying facial expressions as the target emotion was 71% (156/220). As shown in Table 5 two of the emotion types, disgust and sadness, were marginally short of the set validity threshold of 50%. However, accuracy for these two emotions did exceed that of chance (17%). Thus the experiment has evidence of good content validity.

Table 6 shows the accuracy for each emotion type portrayed by each actor. Accuracy for sadness was low for three of the actors suggesting that there may be some ambiguity in the expression leading to classification errors. Furthermore, no participant was able to recognise expressions of disgust produced by Male 3. Investigation suggests that participants tended to confuse disgust as sadness. The GEMEP-CS has, however, evidence of validity (Bänziger et al., 2011) so this low score may be a result of our small sample size.

Table 6

Emotion Recognition Accuracy on the Negative Face Task by Actor and Emotion (N = 11)

Actor / Emotion	Male 3 (4)	Female 1 (2)	Female 4 (9)	Female 5 (10)	Total (*n* = 44)
Anger	10	11	11	8	40
Disgust	0	7	7	7	21
Fear	8	10	10	9	37
Joy	11	11	11	5	38
Sad	5	4	2	9	20
Total (*n* = 55)	34	43	41	38	156/220

Note. Numbers in parentheses are the GEMEP- CS identification code
Red indicates accuracy scores < 50%

Emotion recognition accuracy from prosodic sentences in the negative experiment.

A total of 220 trials were completed (11 participants x 5 emotions x 4 actors). Accuracy for classifying prosodic nonsense sentences as the target emotion was 62% (136/220), which met the validity criteria set at 50%. However, the proportion of accurate responses per emotion (see Table 1) demonstrates that two of the five emotions, disgust and joy, failed to meet the expected 50% accuracy target. Whilst accuracy for disgust was marginally short of the threshold accuracy for joy was comparatively low. This is surprising considering that previous research demonstrates high scores for recognising a positive emotion from an array of negative emotions (e.g. Mill et al., 2009; Wong et al., 2005). It is possible that low scores reflect interference from the non-native accent despite evidence suggesting that decoding of prosody is achievable across accents (e.g. Pell, Monetts, Paulmann, & Kotz, 2009; Scherer, Banse, & Wallbott, 2001; Thompson and Balkwill, 2006).

Table 7

Emotion Recognition Accuracy on the Negative Prosody Task by Actor and Emotion (N = 11)

Actor / Emotion	Male 3 (4)	Female 1 (2)	Female 4 (9)	Female 5 (10)	Total (n = 44)
Anger	9	11	11	9	40
Disgust	6	4	5	5	20
Fear	11	11	9	9	40
Joy	2	1	4	2	9
Sad	5	10	6	6	27
Total (n = 55)	33	37	35	31	136

Note. Numbers in parentheses are the GEMEP-CS identification code
Red indicates accuracy scores < 50%

Emotion recognition accuracy on the cross-modal task in the negative experiment.

A total of 220 trials were completed (11 participants x 5 emotions x 4 actors). Emotion recognition accuracy when facial expressions and prosodic sentences were simultaneously presented was 80 %, which was higher than either presentation type alone. Moreover, recognition accuracy for each emotion types met the 50% validity criteria (see Table 8). Thus the cross-modal facial expression and prosodic sentence task has evidence of good content validity

Table 8

Emotion Recognition Accuracy on the Cross-modal Negative Task by Actor and Emotion (N = 11)

Emotion \ Actor	Male 3 (4)	Female 1 (2)	Female 4 (9)	Female 5 (10)	Total (n = 44)
Anger	10	10	11	7	38
Disgust	4	9	9	10	32
Fear	11	11	10	11	43
Joy	11	11	11	4	37
Sad	6	10	2	9	27
Total (n = 55)	42	51	43	41	177

Note. Numbers in parentheses are the GEMEP- CS identification code
Red indicates accuracy scores < 50%

Table 8 demonstrates accuracy scores of each emotion type encoded by each actor. Most actors appear to be able to portray each emotion as the target emotion. However, three examples did fall below the 50% threshold and these may lead to lower accuracy in the final experiment. It is worth noting that accuracy for joy was not affected by the poor decoding demonstrated in the prosody condition, thus participants benefited from the visual information and were not detrimentally influenced by the prosodic information in the cross-modal task. This is in line with previous research indicating that emotion processing of non-ambiguous stimuli is more reliant on visual information than audio information (e.g. Collignon et al., 2008).

The Pell Experiment

The database provided by Dr Pell at McGill University provided a measure of emotion recognition across five of the basic emotions (happy, anger, sad, surprise and disgust) as well as neutral expressions (Paulmann & Pell, 2011). The stimuli are presented across three presentation types: dynamic facial expressions, prosodic nonsense sentences and simultaneous presentations of dynamic facial expressions and prosodic sentences (cross-modal). Findings from the current pilot suggest that across presentation types accuracy was above 50% for most of the emotion types (see Table 9). Lower scores typically were observed for the prosody task but all were above that of chance (17%)

Table 9

Proportion of Accurate Responses by Emotion and Presentation Type in the Pell Experiment

Emotion \ Presentation type	Prosody	Facial Expression	Facial Expressions With Prosody
Anger	0.30	0.50	0.45
Disgust	0.30	0.59	0.64
Surprise	0.55	0.55	0.68
Sad	0.73	0.52	0.68
Neutral	0.64	0.68	0.70
Happy	0.25	0.57	0.57

Emotion recognition accuracy from facial expressions in the Pell experiment.

Participants completed a total of 264 facial expression trials using the Pell database (Paulmann & Pell, 2011). This consisted of eleven participants responding to four examples of each of the six emotion types (11 x 4 x 6). Fifty-seven % (150/264) of the facial expression trials were correctly classified as the target emotion, which exceeds the target validity threshold set at 50%. Moreover all emotion types had accuracy rates over 50% (see Table 9). Further investigations looked at the effect of the actor on accuracy (see table 10). Participants had difficulty correctly classifying three emotions portrayed by three of the actors (AH, PB, WB). Of particular interest are the low scores for two of the actors' portrayals of happiness, which is in conflict with much of the emotion literature as happiness is typically described as easily recognised and related to high accuracy scores in emotion recognition tasks (e.g. Kessels, de Haan, & Peerrett, 2007; Kessels, Montagne, Hendriks, Perrett, & de Haan, 2014; Williams et al., 2009). It is possible, therefore, that the actors' portrayal did not effectively represent happiness; thus correctly decoding the expression was difficult. If this were the case then the content validity of the task maybe compromised.

Note. Numbers in parentheses are the GEMEP- CS identification code
Red indicates accuracy scores < 50%

Table 10

Emotion Recognition Accuracy on the Face Pell Task by Actor and Emotion (N = 11)

Actor / Emotion	AH	PK	PB	WB	Total (*N* = 44)
Anger	9	1	11	1	22
Disgust	8	8	3	7	26
Surprise	2	9	4	9	24
Sad	2	7	4	10	23
Neutral	10	6	9	5	30
Happy	3	11	11	0	25
Total (*N* = 66)	34	42	42	32	150/264

Note. Numbers in parentheses are the GEMEP- CS identification code
Red indicates accuracy scores < 50%

Emotion recognition of prosodic sentences in the Pell experiment

Participants completed a total of 264 prosody-based trials using the Pell database (Paulmann & Pell, 2011). This consisted of eleven participants responding to four examples of each of the six emotion types (11 x 4 x 6). Forty-six % (121/264) of the prosodic trials were correctly classified as the target emotion. This is below the set validity threshold of 50% but is above that of chance (17%). Table 9 demonstrates that sentences spoken with happy, angry or disgusted prosodic tones were the most difficult to correctly classify and fell below the target threshold but were above chance.

Further investigations looked at the effect of the actor on accuracy. Table 11 demonstrates that participants had difficulty correctly classifying all emotions portrayed by actor WB, an older male, with the exception of neutral prosody; this finding questions the ability of WB to encode the target emotion effectively to enable decoding. Furthermore, all actors had low scores (< 50 %) for at least two emotion types. This would indicate that there is a possible emotion and actor interaction on the accuracy scores.

Table 11

Emotion Recognition Accuracy on the Prosody Pell Task by Actor and Emotion (N = 11)

Actor / Emotion	AH	PK	PB	WB	Total (*N*= 44)
Anger	1	0	11	1	13
Disgust	2	7	1	3	13
Surprise	6	7	9	2	24
Sad	9	11	10	2	32
Neutral	9	8	3	8	28
Happy	3	3	3	2	11
Total (*N* = 66)	30	36	37	18	121/264

Note. Numbers in parentheses are the GEMEP- CS identification code
Red indicates accuracy scores < 50%

Emotion recognition accuracy on the cross-modal task in the Pell experiment.

As with both the facial expression and prosody only tasks, participants completed a total of 264 trials for the simultaneously presented facial expressions and prosody task. This consisted of eleven participants responding to four examples of each of the six emotion types (11 x 4 x 6). Sixty-two % (164/264) of the facial expression with prosodic sound trials were correctly classified as the target emotion. Table 1 demonstrates that all emotion types had accuracy rates over 50% with the exception of anger. However, anger was only marginally short of the threshold and was above that of chance.

Further investigations looked at the effect of the actor on accuracy (see Table 12). Participants had difficulty correctly classifying anger from actors PK and WB. Further, all actors with the exception of PK were associated with two low scores but the emotion types varied between actors. This questions the actors' ability to portray the target emotion effectively to enable decoding thus reducing the content validity of the task.

Table 12

Emotion Recognition Accuracy on the Cross-modal Pell Task by Actor and Emotion (N = 11)

Emotion \ Actor	AH	PK	PB	WB	Total (N = 44)
Anger	6	1	11	2	20
Disgust	8	9	4	7	28
Surprise	5	9	7	9	30
Sad	5	9	8	8	30
Neutral	11	9	4	7	31
Happy	7	6	10	2	25
Total (N = 66)	42	43	44	35	164

Note. Numbers in parentheses are the GEMEP- CS identification code
Red indicates accuracy scores < 50%

Summary

Accuracy was higher on the cross-modal task than the unimodal tasks. However, accuracy scores varied between emotion types and presentation types. However, accuracy for recognising anger was higher on the face task than the cross-modal and the prosody task. Given that participants had low accuracy for identifying angry prosodic sounds it is possible that the accompanying sound in the cross-modal task may have confused participants into selecting an alternative emotion and thus compromised their performance.

Regarding actors' ability to portray the target emotion WB was consistently related with the lowest accuracy scores for each presentation mode. This implies that the actor may not be accurately portraying the target emotion so content validity maybe compromised. In this manner it may be difficult in the main experiment to determine whether low scores are due to participants' difficulty in decoding the emotion or if the emotion portrayed is not a true representation of the target emotion. To increase the validity of the task WB was removed from the experimental tasks.

Conclusion

With a few exceptions and a few adjustments the nine emotion recognition tasks should have good content validity. Further, low scores for surprise and prosodic pride in the positive experiment, prosodic joy in the negative experiment and anger in the Pell experiment maybe expected and need to be considered when interpreting the results.

Pilot of the Concentric Circles Task

Participants were able to complete this task in line with the instructions. There were no issues in the understanding of the procedure and verbal feedback was positive. All participants had at least some entries in each of the circles but there was as would be expected variations in the quantity in total and between the different levels (circles). Thus this provides an adequate measure of social functioning and will be used in the experimental phase.

Appendix 7.5

Sample characteristics between YAs and younger-older adults

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
Education_years	younger	38	14.32	1.016	.165
	older	16	17.00	2.556	.639
MMSE	younger	38	15.50	.726	.118
	older	16	15.81	.403	.101
SofP	younger	38	21.84	3.492	.566
	older	16	18.13	3.344	.836
Positiveaffect	younger	38	28.50	6.150	.998
	older	16	33.19	6.784	1.696
negativeaffect	younger	38	11.32	1.741	.283
	older	16	10.75	.775	.194
FluidIntel	younger	38	17.42	1.995	.324
	older	16	17.88	2.247	.562
CrystalIntel	younger	38	25.21	2.858	.464
	older	16	36.31	3.341	.835
EIS	younger	38	117.61	10.651	1.728
	older	16	118.81	13.085	3.271
Socialactivity	younger	38	23.89	6.758	1.096
	older	16	30.06	5.053	1.263
CFQ	younger	38	83.24	19.562	3.173
	older	16	81.19	20.031	5.008

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Education_years	Equal variances assumed	6.169	.016	-5.565	52	.000	-2.684	.482	-3.652	-1.716
	Equal variances not assumed			-4.067	17.033	.001	-2.684	.660	-4.076	-1.292
MMSE	Equal variances assumed	11.817	.001	-1.614	52	.112	-.313	.194	-.701	.076
	Equal variances not assumed			-2.016	47.801	.049	-.313	.155	-.624	-.001
SofP	Equal variances assumed	.000	1.000	3.616	52	.001	3.717	1.028	1.654	5.780
	Equal variances not assumed			3.681	29.417	.001	3.717	1.010	1.653	5.781
Positiveaffect	Equal variances assumed	.036	.849	-2.481	52	.016	-4.688	1.889	-8.479	-.896
	Equal variances not assumed			-2.382	25.918	.025	-4.688	1.968	-8.733	-.642
negativeaffect	Equal variances assumed	8.081	.006	1.243	52	.219	.566	.455	-.347	1.479
	Equal variances not assumed			1.652	51.754	.105	.566	.343	-.122	1.253
FluidIntel	Equal variances assumed	.108	.744	-.736	52	.465	-.454	.617	-1.692	.785
	Equal variances not assumed			-.700	25.470	.490	-.454	.648	-1.788	.880
CrystalIntel	Equal variances assumed	.355	.554	-12.394	52	.000	-11.102	.896	-12.899	-9.305
	Equal variances not assumed			-11.621	24.719	.000	-11.102	.955	-13.071	-9.133
EIS	Equal variances assumed	1.437	.236	-.355	52	.724	-1.207	3.399	-8.029	5.614
	Equal variances not assumed			-.326	23.785	.747	-1.207	3.700	-8.846	6.432
Socialactivity	Equal variances assumed	.452	.505	-3.278	52	.002	-6.168	1.881	-9.943	-2.392
	Equal variances not assumed			-3.688	37.483	.001	-6.168	1.673	-9.555	-2.780
CFQ	Equal variances assumed	.134	.715	.349	52	.728	2.049	5.870	-9.731	13.829
	Equal variances not assumed			.346	27.658	.732	2.049	5.929	-10.101	14.200

Sample characteristics between YAs and older-older adults

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
Education_years	younger	38	14.32	1.016	.165
	veryold	17	15.35	3.408	.827
MMSE	younger	38	15.50	.726	.118
	veryold	17	14.82	.883	.214
SofP	younger	38	21.84	3.492	.566
	veryold	17	15.71	3.442	.835
Positiveaffect	younger	38	28.50	6.150	.998
	veryold	17	33.18	6.710	1.628
negativeaffect	younger	38	11.32	1.741	.283
	veryold	17	11.41	2.808	.681
FluidIntel	younger	38	17.42	1.995	.324
	veryold	17	17.00	4.183	1.015
CrystalIntel	younger	38	25.21	2.858	.464
	veryold	17	33.41	3.392	.823
EIS	younger	38	117.61	10.651	1.728
	veryold	17	115.53	15.017	3.642
Socialactivity	younger	38	23.89	6.758	1.096
	veryold	17	28.29	6.449	1.564
CFQ	younger	38	83.24	19.562	3.173
	veryold	17	80.29	14.594	3.539

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Education_years	Equal variances assumed	22.675	.000	-1.729	53	.090	-1.037	.600	-2.241	.166
	Equal variances not assumed			-1.230	17.286	.235	-1.037	.843	-2.813	.739
MMSE	Equal variances assumed	.005	.946	2.985	53	.004	.676	.227	.222	1.131
	Equal variances not assumed			2.768	26.111	.010	.676	.244	.174	1.179
SofP	Equal variances assumed	.036	.850	6.049	53	.000	6.136	1.014	4.102	8.171
	Equal variances not assumed			6.083	31.259	.000	6.136	1.009	4.080	8.193
Positiveaffect	Equal variances assumed	.104	.748	-2.534	53	.014	-4.676	1.845	-8.378	-.975
	Equal variances not assumed			-2.450	28.542	.021	-4.676	1.909	-8.583	-.769
negativeaffect	Equal variances assumed	1.357	.249	-.155	53	.877	-.096	.619	-1.337	1.145
	Equal variances not assumed			-.130	21.704	.898	-.096	.737	-1.626	1.434
FluidIntel	Equal variances assumed	5.853	.019	.508	53	.613	.421	.828	-1.241	2.083
	Equal variances not assumed			.395	19.335	.697	.421	1.065	-1.805	2.647
CrystalIntel	Equal variances assumed	.292	.591	-9.278	53	.000	-8.201	.884	-9.974	-6.428
	Equal variances not assumed			-8.684	26.618	.000	-8.201	.944	-10.140	-6.262
EIS	Equal variances assumed	1.424	.238	.586	53	.560	2.076	3.541	-5.026	9.178
	Equal variances not assumed			.515	23.497	.611	2.076	4.031	-6.254	10.405
Socialactivity	Equal variances assumed	.017	.898	-2.262	53	.028	-4.399	1.945	-8.301	-.498
	Equal variances not assumed			-2.303	32.215	.028	-4.399	1.910	-8.289	-.510
CFQ	Equal variances assumed	2.117	.152	.554	53	.582	2.943	5.312	-7.712	13.598
	Equal variances not assumed			.619	40.692	.539	2.943	4.754	-6.660	12.545

Sample characteristics between younger-older and older-older adults

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
Education_years	older	16	17.00	2.556	.639
	veryold	17	15.35	3.408	.827
MMSE	older	16	15.81	.403	.101
	veryold	17	14.82	.883	.214
SofP	older	16	18.13	3.344	.836
	veryold	17	15.71	3.442	.835
Positiveaffect	older	16	33.19	6.784	1.696
	veryold	17	33.18	6.710	1.628
negativeaffect	older	16	10.75	.775	.194
	veryold	17	11.41	2.808	.681
FluidIntel	older	16	17.88	2.247	.562
	veryold	17	17.00	4.183	1.015
CrystalIntel	older	16	36.31	3.341	.835
	veryold	17	33.41	3.392	.823
EIS	older	16	118.81	13.085	3.271
	veryold	17	115.53	15.017	3.642
Socialactivity	older	16	30.06	5.053	1.263
	veryold	17	28.29	6.449	1.564
CFQ	older	16	81.19	20.031	5.008
	veryold	17	80.29	14.594	3.539

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Education_years	Equal variances assumed	1.752	.195	1.563	31	.128	1.647	1.054	-.503	3.797
	Equal variances not assumed			1.576	29.571	.126	1.647	1.045	-.488	3.782
MMSE	Equal variances assumed	3.788	.061	4.094	31	.000	.989	.242	.496	1.482
	Equal variances not assumed			4.179	22.686	.000	.989	.237	.499	1.479
SofP	Equal variances assumed	.030	.865	2.046	31	.049	2.419	1.182	.007	4.831
	Equal variances not assumed			2.048	30.965	.049	2.419	1.181	.009	4.829
Positiveaffect	Equal variances assumed	.009	.927	.005	31	.996	.011	2.350	-4.782	4.804
	Equal variances not assumed			.005	30.833	.996	.011	2.351	-4.784	4.806
negativeaffect	Equal variances assumed	5.550	.025	-.910	31	.370	-.662	.727	-2.145	.821
	Equal variances not assumed			-.935	18.563	.362	-.662	.708	-2.146	.822
FluidIntel	Equal variances assumed	2.967	.095	.742	31	.464	.875	1.180	-1.532	3.282
	Equal variances not assumed			.754	24.826	.458	.875	1.160	-1.514	3.264
CrystalIntel	Equal variances assumed	.001	.971	2.473	31	.019	2.901	1.173	.508	5.293
	Equal variances not assumed			2.474	30.931	.019	2.901	1.172	.509	5.292
EIS	Equal variances assumed	.008	.927	.668	31	.509	3.283	4.917	-6.744	13.311
	Equal variances not assumed			.671	30.828	.507	3.283	4.896	-6.704	13.270
Socialactivity	Equal variances assumed	.285	.598	.873	31	.389	1.768	2.026	-2.363	5.900
	Equal variances not assumed			.880	30.044	.386	1.768	2.011	-2.337	5.874
CFQ	Equal variances assumed	2.971	.095	.147	31	.884	.893	6.074	-11.494	13.281
	Equal variances not assumed			.146	27.335	.885	.893	6.132	-11.682	13.469

Appendix 7.6

Participant Information

Emotion Perception in Older Adults; the Influence of Stimuli Type and Experimental Task
Participant Information

I am a PhD research student at Sheffield Hallam University investigating the development of emotion perception in adulthood. We live in a social world where we continually receive information to process and respond to. A vital part of this processing system is our ability to recognise emotions from faces and voices. This ability allows us to respond in an appropriate manner thus preserving our social competence. Evidence suggests that older adults perform differently to younger adults in their recognition of emotion from facial expressions, and sounds when they are presented separately but may perform equally when the two are simultaneously presented. Much of the previous research has used tasks that may not reflect real life processing. My research aims to assess if older adults benefit from multiple sensory channels using dynamic stimuli that are more representative of the real world. This will increase our understanding of emotion perception development.

Who Can Take Part?
The study requires two groups of healthy, adult participants: adults 18-30 years old and adults aged 60 plus. The research will be conducted at the university so participants need to have the means to get to Sheffield Hallam University. Although some tasks will be computer based participants **do not** need to be proficient with computers.

What will you have to do?
Participants will be required to complete three sets of tasks each with several subtasks.

Set 1. Questionnaires: Participants will complete several questionnaires asking questions regarding demographic information, health, and social functioning; the questionnaires require the participant to indicate their answer by ticking or circling the appropriate response.

Set 2. Non computer-based tasks: Participants will be asked to undertake several tasks including; providing a verbal definition to a series of presented words; completing a string of pattern matrices where the participant is shown a set of pictures with one picture missing and is asked which of a number of options will complete the matrix and to change the order of some numbers. Furthermore, participants will be asked some set questions regarding time and place orientation.

Set 3. Computer-based tasks: Participants will be asked to decide which of the six given categories the presented stimuli belongs to. The stimuli will be presented on a computer screen in the form of dynamic faces, sounds and combined faces with sound.

The session should last for approximately 1.5 – 2 hours with a refreshment break in the middle.

Ethics

The Faculty Research Ethics Committee, Sheffield Hallam University, has approved the research. All information is coded to protect anonymity of the data. . The researcher and her supervisors will have access to the raw data but this may be shared in future for research purposes. For security the collected data will be kept in a locked cupboard within the university grounds. Where data is collected away from the university the researcher will lock the information in a drawer until it can be taken to the university. Electronic data will be stored on a encrypted memory stick. In keeping with ethical regulations all participants have the right to withdraw their data up to a week post collection and have the right to refuse to answer any question, and may refuse to reveal information they feel uncomfortable disclosing. Furthermore, all participants have the right to stop the study at any time.

I am interested what do I do now?

You are under no obligation to take part in this research; however, if you require more information please contact myself, Nicola Dimelow:

Email n.dimelow@shu.ac.uk or phone 01142255734.

Or if you are happy with the information provided please complete the following consent form.

Thank you for your interest.

Nicola Dimelow

Appendix 7.7

Consent Form

Consent Form: Emotion Perception in Older Adults; the Influence of Stimuli Type and Experimental Task

By signing this form I agree that I understand:

1. The purpose of the research
2. What I will be required to do
3. That I have the right to withdraw my data up to a week post collection
4. All data will be anonymous and confidential
5. I do have the right to refuse to answer any question/s
6. That the anonymised data (ensuring the removal of any identifiable information) may be used in other research projects.

Name:

Signature:

Age:

Gender:

Date:

Appendix 7.8

Standardised Instructions for the Computer-based Tasks in Phase 2

Emotion Recognition from Facial Expressions
Standardised Instructions.

You will see a series of video clips one at a time. Looking at the facial expressions you need to decide which primary emotion is being displayed: Happy, Sad, Fear, Anger or Disgust. Some faces display no emotion and these are Neutral. The options will be presented to you on the screen so you do not need to try to remember them. Also the options will be presented with a corresponding number and this is the number you enter using the response box.

For example in the following display:

1	2	3	4	5	6
Happy	Sad	Surprise	Anger	Disgust	Neutral

If you think the face is displaying anger you would enter 4.

Please note this is just an example and in the task you undertake the response keys for a particular category maybe different from this example so please look at the response options displayed on your task.

The task starts with some instructions and when you are ready you can start a practice trial at the end of this you may want to ask some questions before commencing with the actual real task. You are asked to answer as accurately and quickly as possible.

Do you have any questions?
Are you ready to begin?

Emotion Recognition from Facial Expressions and Sounds
Standardised Instructions.

You will see a series of video clips one at a time. By paying attention to the facial expressions and sounds you need to decide which primary emotion is being displayed: Happy, Sad, Surprise, Anger, Disgust. Some clips may display no emotion and these are called Neutral. The options will be presented to you on the screen so you do not need to try to remember them. Also the options will be presented with a corresponding number and this is the number you enter using the response box.

For example in the following display:

1	2	3	4	5	6
Happy	Sad	Surprise	Anger	Disgust	Neutral

If you think the face is displaying anger you would enter 4.

Please note this is just an example and in the task you undertake the response keys for a particular category maybe different from this example so please look at the response options displayed on your task.

The task starts with some instructions and when you are ready you can start a practice trial at the end of this you may want to ask some questions before commencing with the actual real task. You are asked to answer as accurately and quickly as possible.

Do you have any questions?
Are you ready to begin?

Emotion Recognition from Sounds
Standardised Instructions.

You will hear a series of audio clips one at a time. By paying attention to the sounds you need to decide which primary emotion is being portrayed: Happy, Sad, Surprise, Anger or Disgust. Some sounds may display no emotion and these are Neutral. The options will be presented to you on the screen so you do not need to try to remember them. Also the options will be presented with a corresponding number and this is the number you enter using the response box.
For example in the following display:

1	2	3	4	5	6
Happy	Sad	Surprise	Anger	Disgust	Neutral

If you think the face is displaying anger you would enter 4.

Please note this is just an example and in the task you undertake the response keys for a particular category maybe different from this example so please look at the response options displayed on your task.
The task starts with some instructions and when you are ready you can start a practice trial at the end of this you may want to ask some questions before commencing with the actual real task. You are asked to answer as accurately and quickly as possible.

Do you have any questions?
Are you ready to begin?

Appendix 7.9

Debrief

<u>Participant Debrief for Study: Emotion Perception in Older Adults; the Influence of Stimuli Type and Experimental Task</u>

Thank you for participating in this research. If you have any questions regarding what you have done please do not hesitate to ask.

The purpose of the study is to investigate if age affects the way people perceive emotion when the information is provided either by facial expressions, sounds and when the two sensory cues are presented together. Finally, a number of tasks were undertaken to measure cognitive behaviours such as speed of processing and intelligence, as well as measures of individual differences including social functioning and emotion intelligence. The purpose for this was to try to establish if any of these factors contribute to any age related differences in emotion perception.
If you would like to contact the research team at any point to talk about the research or if you would like a copy of the results then please email:

Nicola Dimelow; email: n.dimelow@shu.ac.uk ; or phone 01142255734.
Once again thank you for your assistance.

Yours Sincerely

Nicola Dimelow BSc MSc

Appendix 7.10

Data Preparation Phase 2

Missing data was dealt with by mean substitution (one younger and one older adult speed of processing score; one older adult fluid intelligence score). Histograms and Z scores were inspected for outliers. For the standardised tasks outliers were adjusted to one data point above or below the next nearest score in the data set. This applied to one older adult who scored 21 for negative affect so the score was adjusted to 15. A few extreme scores were detected on the experimental emotion tasks but due to the small scale these could not be adjusted and removing the data points would reduce statistical power so these scores were retained in the analysis (GEMEP positive face with sound condition anger 6 scores at 3/5; amusement at 0/5). Tests of normality demonstrated that most data points were acceptable for parametric analysis as skew did not exceed 1.96 ($p > .05$) with the exception of 5 items (younger adults: sad on the Pell face and sound condition skew = 2.40; anger on the GEMEP positive face with sound condition 2.27; anger on the GEMEP positive face condition 2.56; older adults: fear on the GEMEP negative face with sound condition -2.23; fear on the GEMEP negative face -2.63). However, parametric tests were conducted, as ANOVA analysis is robust to slight deviations from normality (Field, 2012). Non-parametric tests were run to check the reliability of parametric t-tests and these produced similar results to the parametric tests and the both sets of results mirrored each other regarding which comparisons were significant or non significant.

Younger Adults' Descriptive Statistics with Normality Measures for GEMEP Positive Face

Emotion type	*Min (/5)*	*Max (/5)*	*M*	*SD*	*skew*	*kurtosis*	*Shapiro Wilk*
Anger	2	5	4.68	0.62	-2.56	3.38	<.001
Joy	0	5	2.34	1.28	0.13	-0.87	.014
Amusement	1	5	3.37	1.22	-0.39	0.79	.003
Pride	1	5	3.11	1.23	-0.21	-1.09	.001
Surprise	0	5	2.55	1.43	-0.02	-0.70	.030
Total (max. = 25)	9	23	16.05	3.68	-0.05	-0.34	.207

Older Adults' Descriptive Statistics with Normality Measures for GEMEP Positive Face

Emotion type	*Min (/5)*	*Max (/5)*	*M*	*SD*	*skew*	*kurtosis*	*Shapiro Wilk*
Anger	3	5	4.30	0.77	-0.56	-1.03	<.001
Joy	0	5	2.58	1.28	-0.28	-0.63	.037
Amusement	1	5	3.82	1.21	-1.09	0.63	<.001
Pride	0	5	2.45	1.28	-0.18	-0.73	.032
Surprise	0	5	2.39	1.32	0.16	-0.60	.077
Total (max. = 25)	8	22	15.55	3.23	-0.14	-0.31	.698

Younger Adults' Descriptive Statistics with Normality Measures for GEMEP Positive Sounds

Emotion type	*Min (/5)*	*Max (/5)*	*M*	*SD*	*skew*	*kurtosis*	*Shapiro Wilk*
Anger	2	5	4.16	0.92	-0.77	-1.35	<.001
Joy	0	5	2.11	1.11	0.41	0.23	.012
Amusement	0	5	3.76	1.42	-1.22	0.89	<.001
Pride	0	3	1.16	1.00	0.18	-1.22	<.001
Surprise	0	5	2.39	1.26	0.21	-0.45	.033
Total (max. = 25)	8	19	13.58	3.17	0.09	-0.89	.171

Older Adults' Descriptive Statistics with Normality Measures for GEMEP Positive Sounds

Emotion type	*Min (/5)*	*Max (/5)*	*M*	*SD*	*skew*	*kurtosis*	*Shapiro Wilk*
Anger	1	5	3.52	1.33	-0.38	-1.21	.001
Joy	0	4	1.55	1.18	0.25	-0.59	.004
Amusement	2	5	3.91	1.16	-0.59	-1.13	<.001
Pride	0	4	0.94	1.12	0.99	0.22	<.001
Surprise	0	4	2.27	1.04	-0.06	-0.60	.012
Total (max. = 25)	7	19	12.18	2.94	0.45	0.45	.0.92

Younger Adults' Descriptive Statistics with Normality Measures for GEMEP Positive Face with Sound Condition

Emotion type	*Min (/5)*	*Max (/5)*	*M*	*SD*	*skew*	*kurtosis*	*Shapiro Wilk*
Anger	4	5	4.87	0.34	-2.27	3.33	<.001
Joy	0	5	2.63	1.23	0.77	0.45	0.35
Amusement	0	5	4.03	1.44	-1.42	0.95	<.001
Pride	1	5	3.00	1.27	0.08	-1.23	.001
Surprise	0	5	3.05	1.11	0.36	0.23	.008
Total (max. = 25)	11	24	15.55	3.23	-0.15	-0.64	.293

Older Adults' Descriptive Statistics with Normality Measures for GEMEP Positive Face with Sound Condition

Emotion type	*Min (/5)*	*Max (/5)*	*M*	*SD*	*skew*	*kurtosis*	*Shapiro Wilk*
Anger	3	5	4.67	0.69	-1.85	1.92	<.001
Joy	0	5	2.58	1.25	0.72	0.15	0.27
Amusement	1	5	4.18	1.04	-1.44	1.79	<.001
Pride	0	5	2.48	1.42	0.03	-0.63	.079
Surprise	0	5	3.24	1.35	-0.31	-.0.40	.010
Total (max. = 25)	10	24	17.15	3.50	-0.06	-0.58	.644

Younger Adults' Descriptive Statistics with Normality Measures for GEMEP Negative Face

Emotion type	*Min (/4)*	*Max (/4)*	*M*	*SD*	*skew*	*kurtosis*	*Shapiro Wilk*
Joy	3	4	3.45	0.50	0.22	-2.06	<.001
Sad	0	4	2.76	1.15	-0.86	0.08	<.001
Fear	0	4	3.53	0.80	-2.63	9.55	<.001
Anger	3	4	3.76	0.43	-1.29	-0.36	<.001
Disgust	0	4	2.16	1.17	-0.22	-0.99	.002
Total (max. = 20)	11	20	15.66	1.99	-0.21	0.20	.237

Older Adults' Descriptive Statistics with Normality Measures for GEMEP Negative Face

Emotion type	*Min (/4)*	*Max (/4)*	*M*	*SD*	*skew*	*kurtosis*	*Shapiro Wilk*
Joy	3	4	3.55	0.50	-0.19	-2.09	<.001
Sad	1	4	3.06	0.86	-0.43	-0.76	<.001
Fear	1	4	3.24	0.90	-0.79	0.60	<.001
Anger	2	4	3.55	0.75	-1.33	0.19	<.001
Disgust	0	4	2.03	1.24	0.05	-0.79	.014
Total (max. = 20)	11	19	15.42	2.41	-0.04	-1.10	.028

Younger Adults' Descriptive Statistics with Normality Measures for GEMEP Negative Sounds

Emotion type	*Min (/4)*	*Max (/4)*	*M*	*SD*	*skew*	*kurtosis*	*Shapiro Wilk*
Joy	0	4	2.00	1.19	-0.10	-0.68	.008
Sad	1	4	3.39	0.95	1.30	0.40	<.001

Fear	1	4	3.55	0.72	-1.77	3.22	<.001
Anger	1	4	3.39	0.75	-1.21	1.37	<.001
Disgust	0	4	1.84	1.39	0.30	-1.13	.001
Total (max. = 20)	8	19	14.18	3.11	-1.14	-0.79	.191

Older Adults' Descriptive Statistics with Normality Measures for GEMEP Negative Sounds

	Min (/4)	*Max (/4)*	*M*	*SD*	*skew*	*kurtosis*	*Shapiro Wilk*
Joy	3	4	3.53	0.51	-0.11	-2.10	<.001
Sad	0	4	3.24	1.00	-1.20	1.16	<.001
Fear	1	4	3.66	0.75	-2.23	4.38	<.001
Anger	2	4	3.74	0.50	-1.77	2.49	<.001
Disgust	0	4	2.53	1.20	-0.16	-1.17	.001
Total (max. = 20)	12	20	16.68	2.18	-0.36	-0.50	.117

Younger Adults' Descriptive Statistics with Normality Measures for GEMEP Negative Face with Sound Condition

Emotion type	*Min (/4)*	*Max (/4)*	*M*	*SD*	*skew*	*kurtosis*	*Shapiro Wilk*
Joy	0	3	0.70	0.98	1.30	0.63	<.001
Sad	1	4	3.33	0.82	-1.07	0.58	<.001
Fear	1	4	3.03	1.10	-0.81	-0.69	<.001
Anger	1	4	3.00	0.97	-0.44	-0.99	<.001
Disgust	0	4	1.24	1.03	0.75	0.29	.001
Total (max. = 20)	5	17	11.30	2.72	0.40	0.02	.403

Older Adults' Descriptive Statistics with Normality Measures for GEMEP Negative Face with Sound Condition

Emotion type	*Min (/4)*	*Max (/4)*	*M*	*SD*	*skew*	*kurtosis*	*Shapiro Wilk*
Joy	2	4	3.36	0.55	-0.02	-0.84	<.001
Sad	2	4	3.52	0.62	-0.90	-0.10	<.001

Fear	2	4	3.58	0.61	-1.17	0.44	<.001
Anger	1	4	3.48	0.71	1.60	3.28	<.001
Disgust	0	4	2.70	1.16	-0.64	-0.59	.001
Total (max. = 20)	12	20	16.63	1.85	-0.50	0.04	.249

Appendix 7.11

Table 7.11.1

Missing Data for Positive Tasks in Phase 2 by Older Adults

Presentation Type	Positive Cross-modal						Positive Face						Positive Sounds					
	Missing RT		Errors		Accuracy		Missing RT		Errors		Accuracy		Missing RT		Errors		Accuracy	
	N	**%**	N	**%**	N	**%**	N	**%**	N	**%**	**N**	**%**	N	**%**	N	**%**	N	**%**
Emotion Type																		
Anger	0`	**0**	11	**7**	154	**93**	4	**2**	19	**12**	142	**86**	6	**4**	43	**26**	116	**70**
Joy	5	**3**	75	**45**	85	**52**	2	**1**	78	**47**	85	**52**	14	**8**	100	**61**	51	**31**
Amusement	4	**2**	23	**14**	138	**84**	5	**3**	34	**21**	126	**76**	2	**1**	34	**21**	129	**93**
Pride	8	**5**	75	**45**	82	**50**	7	**4**	77	**47**	81	**49**	15	**9**	119	**72**	31	**19**
Surprise	14	**8**	44	**27**	107	**65**	25	**15**	61	**37**	79	**48**	10	**6**	80	**48**	75	**45**

Total	31	**4**	228	**28**	566	**69**	43	**5**	269	**33**	513	**62**	47	**6**	376	**46**	402	**49**

Note. Maximum accuracy for each emotion type in a specific presentation type = 165, maximum total for each presentation type = 825

Presentation Type	Positive Cross-modal	Positive Face	Positive Sounds

Table 7.11.2

Missing Data for Positive Tasks in Phase 2 by Younger Adults

	Negative Cross-modal						Negative Face						Negative Sounds					
	Missing RT		Errors		Accuracy		Missing RT		Errors		Accuracy		Missing RT		Errors		Accuracy	
	N	**%**	N	**%**	N	**%**	N	**%**	N	**%**	**N**	**%**	N	**%**	N	**%**	N	**%**
Emotion Type																		
Anger	0`	**0**	5	**3**	185	**93**	0`	**0**	11	**6**	179	**94**	0	**0**	32	**17**	158	**83**
Joy	0	**0**	90	**47**	100	**52**	0	**0**	101	**53**	89	**47**	2	**1**	108	**57**	80	**43**
Amusement	0	**0**	37	**19**	153	**84**	0	**0**	62	**33**	128	**67**	0	**0**	47	**25**	143	**75**
Pride	0	**0**	76	**40**	114	**50**	0	**0**	72	**38**	118	**62**	0	**0**	146	**77**	44	**23**
Surprise	1	**1**	73	**38**	116	**65**	2	**1**	91	**48**	97	**51**	1	**1**	98	**52**	91	**48**
Total	1	**0**	281	**30**	668	**69**	2	**0**	337	**35**	611	**64**	3	**0**	431	**45**	516	**54**

Note. Maximum accuracy for each emotion type in a specific presentation type = 190, maximum total for each presentation

Table 7.11.3

Missing Data for Negative Tasks in Phase 2 by Older Adults

	Missing RT		Errors		Accuracy		Missing RT		Errors		Accuracy		Missing RT		Errors		Accuracy	
	N	**%**	N	**%**	N	**%**	N	**%**	N	**%**	**N**	**%**	N	**%**	N	**%**	N	**%**
Emotion Type																		
Joy	5	**4**	16	**12**	111	**84**	2`	**2**	13	**10**	117	**89**	4	**3**	99	**75**	29	**22**
Sad	1	**1**	15	**11**	116	**88**	1	**1**	30	**23**	101	**77**	4	**3**	18	**14**	110	**83**
Fear	0	**0**	14	**11**	118	**89**	0	**0**	25	**20**	107	**81**	0	**0**	32	**24**	100	**76**
Anger	0	**0**	17	**13**	115	**87**	2	**2**	13	**10**	117	**89**	1	**1**	32	**24**	99	**75**
Disgust	1	**1**	42	**32**	89	**67**	0	**0**	54	**41**	78	**59**	5	**4**	86	**65**	41	**31**
Total	7	**1**	104	**16**	549	**83**	5	**1**	135	**20**	520	**79**	14	**2**	267	**40**	379	**57**

Note. Maximum accuracy for each emotion type in a specific presentation type = 132, maximum total for each presentation type = 660

Table 7.11.4

Missing Data for Negative Tasks in Phase 2 by Younger Adults

Note. Maximum accuracy for each emotion type in a specific presentation type = 152, maximum total for each presentation type = 760

Presentation Type	Negative Cross-modal						Negative Face						Negative Sounds					
	Missing RT		Errors		Accuracy		Missing RT		Errors		Accuracy		Missing RT		Errors		Accuracy	
	N	**%**	N	**%**	N	**%**	N	**%**	N	**%**	**N**	**%**	N	%	N	**%**	N	**%**
Emotion Type																		
Joy	0	**0**	18	**12**	134	**84**	1`	**1**	20	**13**	131	**86**	0	0	76	**50**	76	**50**
Sad	0	**0**	29	**19**	123	**88**	0	**0**	47	**31**	105	**69**	0	0	23	**15**	129	**85**
Fear	0	**0**	13	**9**	139	**89**	0	**0**	18	**12**	134	**88**	0	0	19	**13**	133	**88**
Anger	0	**0**	10	**7**	142	**87**	0	**0**	9	**6**	143	**94**	0	0	23	**15**	129	**85**
Disgust	1	**1**	55	**36**	96	**67**	0	**0**	43	**28**	109	**72**	0	0	82	**54**	70	**46**
Total	1	**0**	125	**16**	634	**83**	1	**0**	137	**18**	622	**82**	0	0	223	**40**	537	**71**

Appendix 7.12

SPSS output for Positive Experiment in Phase 2

2*5*3 ANOVA Comparing between YAs and OAs

Descriptive Statistics

	Agegroup	Mean	Std. Deviation	N
Gemeppositivefandsanger	younger	4.8684	.34257	38
	older	4.6667	.69222	33
	Total	4.7746	.53977	71
Gemeppositivefandsjoy	younger	2.6316	1.23946	38
	older	2.5758	1.25076	33
	Total	2.6056	1.23611	71
Gemeppositivefandsamsusemnt	younger	4.0263	1.44235	38
	older	4.1818	1.04447	33
	Total	4.0986	1.26666	71
Gemeppositivefandspride	younger	3.0000	1.27343	38
	older	2.4848	1.41689	33
	Total	2.7606	1.35715	71
Gemeppositivefandssurprise	younger	3.0526	1.11373	38
	older	3.2424	1.34699	33
	Total	3.1408	1.22236	71
Gemeppositivefaceanger	younger	4.6842	.61973	38
	older	4.3030	.76994	33
	Total	4.5070	.71461	71
Gemepositivefacejoy	younger	2.3421	1.27928	38
	older	2.5758	1.27550	33
	Total	2.4507	1.27379	71
Gemepositivefaceamusement	younger	3.3684	1.21746	38
	older	3.8182	1.21075	33
	Total	3.5775	1.22663	71
Gemepositivefacepride	younger	3.1053	1.22562	38
	older	2.4545	1.27698	33
	Total	2.8028	1.28307	71
Gemepositivefacesurprise	younger	2.5526	1.42748	38
	older	2.3939	1.32144	33
	Total	2.4789	1.37175	71
Gemeppositivesoundanger	younger	4.1579	.91611	38
	older	3.5152	1.32574	33
	Total	3.8592	1.16246	71
Gemeppositivesoundjoy	younger	2.1053	1.10989	38
	older	1.5455	1.17502	33
	Total	1.8451	1.16678	71
Gemeppositivesoundamusement	younger	3.7632	1.42249	38
	older	3.9091	1.15552	33
	Total	3.8310	1.29820	71
Gemeppositivesoundpride	younger	1.1579	1.00071	38
	older	.9394	1.11634	33
	Total	1.0563	1.05407	71
Gemeppositivesoundsurprise	younger	2.3947	1.26362	38
	older	2.2727	1.03901	33
	Total	2.3380	1.15812	71

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Presnetation	.993	.496	2	.780	.993	1.000	.500
emotion	.841	11.658	9	.233	.918	.990	.250
Presnetation * emotion	.539	40.911	35	.228	.888	1.000	.125

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Agegroup
Within Subjects Design: Presnetation + emotion + Presnetation * emotion

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Presnetation	Sphericity Assumed	146.408	2	73.204	74.156	.000	.518	148.311	1.000
	Greenhouse-Geisser	146.408	1.986	73.736	74.156	.000	.518	147.241	1.000
	Huynh-Feldt	146.408	2.000	73.204	74.156	.000	.518	148.311	1.000
	Lower-bound	146.408	1.000	146.408	74.156	.000	.518	74.156	1.000
Presnetation * Agegroup	Sphericity Assumed	2.047	2	1.024	1.037	.357	.015	2.074	.228
	Greenhouse-Geisser	2.047	1.986	1.031	1.037	.357	.015	2.059	.228
	Huynh-Feldt	2.047	2.000	1.024	1.037	.357	.015	2.074	.228
	Lower-bound	2.047	1.000	2.047	1.037	.312	.015	1.037	.171
Error(Presnetation)	Sphericity Assumed	136.229	138	.987					
	Greenhouse-Geisser	136.229	137.004	.994					
	Huynh-Feldt	136.229	138.000	.987					
	Lower-bound	136.229	69.000	1.974					
emotion	Sphericity Assumed	811.161	4	202.790	122.418	.000	.640	489.672	1.000
	Greenhouse-Geisser	811.161	3.673	220.850	122.418	.000	.640	449.628	1.000
	Huynh-Feldt	811.161	3.961	204.775	122.418	.000	.640	484.926	1.000
	Lower-bound	811.161	1.000	811.161	122.418	.000	.640	122.418	1.000
emotion * Agegroup	Sphericity Assumed	17.955	4	4.489	2.710	.031	.038	10.839	.747
	Greenhouse-Geisser	17.955	3.673	4.889	2.710	.035	.038	9.953	.719
	Huynh-Feldt	17.955	3.961	4.533	2.710	.031	.038	10.734	.744
	Lower-bound	17.955	1.000	17.955	2.710	.104	.038	2.710	.368
Error(emotion)	Sphericity Assumed	457.205	276	1.657					
	Greenhouse-Geisser	457.205	253.430	1.804					
	Huynh-Feldt	457.205	273.325	1.673					
	Lower-bound	457.205	69.000	6.626					
Presnetation * emotion	Sphericity Assumed	84.311	8	10.539	11.909	.000	.147	95.273	1.000
	Greenhouse-Geisser	84.311	7.107	11.863	11.909	.000	.147	84.640	1.000
	Huynh-Feldt	84.311	8.000	10.539	11.909	.000	.147	95.273	1.000
	Lower-bound	84.311	1.000	84.311	11.909	.001	.147	11.909	.925
Presnetation * emotion * Agegroup	Sphericity Assumed	9.460	8	1.183	1.336	.223	.019	10.690	.616
	Greenhouse-Geisser	9.460	7.107	1.331	1.336	.230	.019	9.497	.577
	Huynh-Feldt	9.460	8.000	1.183	1.336	.223	.019	10.690	.616
	Lower-bound	9.460	1.000	9.460	1.336	.252	.019	1.336	.207
Error (Presnetation*emotion)	Sphericity Assumed	488.489	552	.885					
	Greenhouse-Geisser	488.489	490.397	.996					
	Huynh-Feldt	488.489	552.000	.885					
	Lower-bound	488.489	69.000	7.080					

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	9985.422	1	9985.422	2047.396	.000	.967	2047.396	1.000
Agegroup	6.402	1	6.402	1.313	.256	.019	1.313	.204
Error	336.522	69	4.877					

a. Computed using alpha = .05

Post hoc Tests for Main effect of Presentation Type

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemeppositivefaceandsoundtotal	17.3803	71	3.55514	.42192
	Gemepositivefacetotal	15.8169	71	3.46125	.41078
Pair 2	Gemeppositivefaceandsoundtotal	17.3803	71	3.55514	.42192
	Gemeppositivesoundtotal	12.9296	71	3.12284	.37061
Pair 3	Gemepositivefacetotal	15.8169	71	3.46125	.41078
	Gemeppositivesoundtotal	12.9296	71	3.12284	.37061

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Gemeppositivefaceandsoundtotal - Gemepositivefacetotal	1.56338	3.02245	.35870	.84798	2.27878	4.358	70	.000
Pair 2	Gemeppositivefaceandsoundtotal - Gemeppositivesoundtotal	4.45070	3.28107	.38939	3.67409	5.22732	11.430	70	.000
Pair 3	Gemepositivefacetotal - Gemeppositivesoundtotal	2.88732	3.11929	.37019	2.14900	3.62565	7.800	70	.000

Post hoc Tests for Main effect of Emotion Type

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	totapositivelanger	13.1408	71	1.67584	.19889
	totalpositivejoy	6.9014	71	2.73159	.32418
Pair 2	totapositivelanger	13.1408	71	1.67584	.19889
	totalpositiveamusement	11.5070	71	3.10701	.36873
Pair 3	totapositivelanger	13.1408	71	1.67584	.19889
	totalpositivepride	6.6197	71	2.79472	.33167
Pair 4	totapositivelanger	13.1408	71	1.67584	.19889
	totalpositivesurprise	7.9577	71	2.70680	.32124
Pair 5	totalpositivejoy	6.9014	71	2.73159	.32418
	totalpositiveamusement	11.5070	71	3.10701	.36873
Pair 6	totalpositivejoy	6.9014	71	2.73159	.32418
	totalpositivepride	6.6197	71	2.79472	.33167
Pair 7	totalpositivejoy	6.9014	71	2.73159	.32418
	totalpositivesurprise	7.9577	71	2.70680	.32124
Pair 8	totalpositiveamusement	11.5070	71	3.10701	.36873
	totalpositivepride	6.6197	71	2.79472	.33167
Pair 9	totalpositiveamusement	11.5070	71	3.10701	.36873
	totalpositivesurprise	7.9577	71	2.70680	.32124
Pair 10	totalpositivepride	6.6197	71	2.79472	.33167
	totalpositivesurprise	7.9577	71	2.70680	.32124

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	totapositivelanger - totalpositivejoy	6.23944	3.00697	.35686	5.52770	6.95117	17.484	70	.000
Pair 2	totapositivelanger - totalpositiveamusement	1.63380	3.38585	.40183	.83239	2.43522	4.066	70	.000
Pair 3	totapositivelanger - totalpositivepride	6.52113	3.06062	.36323	5.79669	7.24556	17.953	70	.000
Pair 4	totapositivelanger - totalpositivesurprise	5.18310	3.12734	.37115	4.44287	5.92333	13.965	70	.000
Pair 5	totalpositivejoy - totalpositiveamusement	-4.60563	3.48252	.41330	-5.42993	-3.78133	-11.144	70	.000
Pair 6	totalpositivejoy - totalpositivepride	.28169	2.62506	.31154	-.33965	.90303	.904	70	.369
Pair 7	totalpositivejoy - totalpositivesurprise	-1.05634	3.40121	.40365	-1.86139	-.25129	-2.617	70	.011
Pair 8	totalpositiveamusement - totalpositivepride	4.88732	3.42907	.40696	4.07568	5.69897	12.009	70	.000
Pair 9	totalpositiveamusement - totalpositivesurprise	3.54930	3.03215	.35985	2.83160	4.26700	9.863	70	.000
Pair 10	totalpositivepride - totalpositivesurprise	-1.33803	3.25990	.38688	-2.10963	-.56642	-3.459	70	.001

Post hoc Tests for Age Group Emotion Type Interaction*

Comparing Accuracy Between YAs and OAs

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
totapositivelanger	younger	38	13.7105	1.16033	.18823
	older	33	12.4848	1.93845	.33744
totalpositivejoy	younger	38	7.0789	2.62402	.42567
	older	33	6.6970	2.87755	.50092
totalpositiveamusement	younger	38	11.1579	3.34927	.54332
	older	33	11.9091	2.79915	.48727
totalpositivepride	younger	38	7.2632	2.61683	.42451
	older	33	5.8788	2.84778	.49573
totalpositivesurprise	younger	38	8.0000	2.79961	.45416
	older	33	7.9091	2.63822	.45926

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
totapositivelanger	Equal variances assumed	10.231	.002	3.281	69	.002	1.22568	.37356	.48046	1.97090
	Equal variances not assumed			3.172	50.762	.003	1.22568	.38639	.44988	2.00148
totalpositivejoy	Equal variances assumed	1.159	.286	.585	69	.561	.38198	.65305	-.92082	1.68478
	Equal variances not assumed			.581	65.406	.563	.38198	.65735	-.93070	1.69465
totalpositiveamusement	Equal variances assumed	1.167	.284	-1.016	69	.313	-.75120	.73913	-2.22572	.72333
	Equal variances not assumed			-1.029	68.910	.307	-.75120	.72982	-2.20717	.70478
totalpositivepride	Equal variances assumed	.243	.624	2.134	69	.036	1.38437	.64873	.09019	2.67855
	Equal variances not assumed			2.121	65.620	.038	1.38437	.65265	.08116	2.68758
totalpositivesurprise	Equal variances assumed	.015	.904	.140	69	.889	.09091	.64863	-1.20308	1.38490
	Equal variances not assumed			.141	68.518	.888	.09091	.64589	-1.19777	1.37959

The pattern of recognition accuracy across emotion types in YAs

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	totapositivelanger - totalpositivejoy	6.63158	2.60375	.42238	5.77575	7.48741	15.700	37	.000
Pair 2	totapositivelanger - totalpositiveamusement	2.55263	3.18525	.51672	1.50567	3.59960	4.940	37	.000
Pair 3	totapositivelanger - totalpositivepride	6.44737	2.52230	.40917	5.61831	7.27643	15.757	37	.000
Pair 4	totapositivelanger - totalpositivesurprise	5.71053	2.84660	.46178	4.77487	6.64618	12.366	37	.000
Pair 5	totalpositivejoy - totalpositiveamusement	-4.07895	3.35617	.54444	-5.18209	-2.97580	-7.492	37	.000
Pair 6	totalpositivejoy - totalpositivepride	-.18421	2.73965	.44443	-1.08471	.71629	-.414	37	.681
Pair 7	totalpositivejoy - totalpositivesurprise	-.92105	2.76446	.44845	-1.82971	-.01240	-2.054	37	.047
Pair 8	totalpositiveamusement - totalpositivepride	3.89474	3.29446	.53443	2.81187	4.97760	7.288	37	.000
Pair 9	totalpositiveamusement - totalpositivesurprise	3.15789	3.00923	.48816	2.16878	4.14700	6.469	37	.000
Pair 10	totalpositivepride - totalpositivesurprise	-.73684	2.90092	.47059	-1.69035	.21667	-1.566	37	.126

a. Agegroup = younger

The pattern of recognition accuracy across emotion types in OAs

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	totapositivelanger - totalpositivejoy	5.78788	3.39814	.59154	4.58295	6.99281	9.784	32	.000
Pair 2	totapositivelanger - totalpositiveamusement	.57576	3.34506	.58230	-.61035	1.76186	.989	32	.330
Pair 3	totapositivelanger - totalpositivepride	6.60606	3.62232	.63057	5.32164	7.89048	10.476	32	.000
Pair 4	totapositivelanger - totalpositivesurprise	4.57576	3.36369	.58554	3.38305	5.76847	7.815	32	.000
Pair 5	totalpositivejoy - totalpositiveamusement	-5.21212	3.57734	.62273	-6.48059	-3.94365	-8.370	32	.000
Pair 6	totalpositivejoy - totalpositivepride	.81818	2.41680	.42071	-.03878	1.67514	1.945	32	.061
Pair 7	totalpositivejoy - totalpositivesurprise	-1.21212	4.05245	.70544	-2.64906	.22481	-1.718	32	.095
Pair 8	totalpositiveamusement - totalpositivepride	6.03030	3.26425	.56823	4.87285	7.18775	10.612	32	.000
Pair 9	totalpositiveamusement - totalpositivesurprise	4.00000	3.04138	.52944	2.92157	5.07843	7.555	32	.000
Pair 10	totalpositivepride - totalpositivesurprise	-2.03030	3.54863	.61774	-3.28859	-.77201	-3.287	32	.002

a. Agegroup = older

*Post hoc tests Investigating the Emotion Type*Presentation Type Interaction*

Anger

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemeppositivefandsanger	4.7746	71	.53977	.06406
	Gemeppositivefaceanger	4.5070	71	.71461	.08481
Pair 2	Gemeppositivefandsanger	4.7746	71	.53977	.06406
	Gemeppositivesoundanger	3.8592	71	1.16246	.13796
Pair 3	Gemeppositivefaceanger	4.5070	71	.71461	.08481
	Gemeppositivesoundanger	3.8592	71	1.16246	.13796

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Gemeppositivefandsanger - Gemeppositivefaceanger	.26761	.84444	.10022	.06773	.46748	2.670	70	.009
Pair 2	Gemeppositivefandsanger - Gemeppositivesoundanger	.91549	1.21592	.14430	.62769	1.20330	6.344	70	.000
Pair 3	Gemeppositivefaceanger - Gemeppositivesoundanger	.64789	1.20829	.14340	.36189	.93388	4.518	70	.000

Joy

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemeppositivefandsjoy	2.6056	71	1.23611	.14670
	Gemepositivefacejoy	2.4507	71	1.27379	.15117
Pair 2	Gemeppositivefandsjoy	2.6056	71	1.23611	.14670
	Gemeppositivesoundjoy	1.8451	71	1.16678	.13847
Pair 3	Gemepositivefacejoy	2.4507	71	1.27379	.15117
	Gemeppositivesoundjoy	1.8451	71	1.16678	.13847

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Gemeppositivefandsjoy - Gemepositivefacejoy	.15493	1.26093	.14964	-.14353	.45339	1.035	70	.304
Pair 2	Gemeppositivefandsjoy - Gemeppositivesoundjoy	.76056	1.39862	.16599	.42952	1.09161	4.582	70	.000
Pair 3	Gemepositivefacejoy - Gemeppositivesoundjoy	.60563	1.58996	.18869	.22930	.98197	3.210	70	.002

Amusement

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemeppositivefandsamsusemnt	4.0986	71	1.26666	.15032
	Gemepositivefaceamusement	3.5775	71	1.22663	.14557
Pair 2	Gemeppositivefandsamsusemnt	4.0986	71	1.26666	.15032
	Gemeppositivesoundamusement	3.8310	71	1.29820	.15407
Pair 3	Gemepositivefaceamusement	3.5775	71	1.22663	.14557
	Gemeppositivesoundamusement	3.8310	71	1.29820	.15407

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Gemeppositivefandsamsusemnt - Gemepositivefaceamusement	.52113	1.27458	.15126	.21944	.82281	3.445	70	.001
Pair 2	Gemeppositivefandsamsusemnt - Gemeppositivesoundamusement	.26761	1.25308	.14871	-.02899	.56421	1.799	70	.076
Pair 3	Gemepositivefaceamusement - Gemeppositivesoundamusement	-.25352	1.23887	.14703	-.54676	.03972	-1.724	70	.089

Pride

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemeppositivefandspride	2.7606	71	1.35715	.16106
	Gemepositivefacepride	2.8028	71	1.28307	.15227
Pair 2	Gemeppositivefandspride	2.7606	71	1.35715	.16106
	Gemeppositivesoundamusement	3.8310	71	1.29820	.15407
Pair 3	Gemepositivefacepride	2.8028	71	1.28307	.15227
	Gemeppositivesoundpride	1.0563	71	1.05407	.12510

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Gemeppositivefandspride - Gemepositivefacepride	-.04225	1.25853	.14936	-.34014	.25564	-.283	70	.778
Pair 2	Gemeppositivefandspride - Gemeppositivesoundamusement	-1.07042	1.61532	.19170	-1.45276	-.68808	-5.584	70	.000
Pair 3	Gemepositivefacepride - Gemeppositivesoundpride	1.74648	1.46110	.17340	1.40064	2.09232	10.072	70	.000

Surprise

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemeppositivefandssurprise	3.1408	71	1.22236	.14507
	Gemepositivefacesurprise	2.4789	71	1.37175	.16280
Pair 2	Gemeppositivefandssurprise	3.1408	71	1.22236	.14507
	Gemeppositivesoundsurprise	2.3380	71	1.15812	.13744
Pair 3	Gemepositivefacesurprise	2.4789	71	1.37175	.16280
	Gemeppositivesoundsurprise	2.3380	71	1.15812	.13744

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Gemeppositivefandssurprise - Gemepositivefacesurprise	.66197	1.38300	.16413	.33462	.98932	4.033	70	.000
Pair 2	Gemeppositivefandssurprise - Gemeppositivesoundsurprise	.80282	1.42046	.16858	.46660	1.13903	4.762	70	.000
Pair 3	Gemepositivefacesurprise - Gemeppositivesoundsurprise	.14085	1.70122	.20190	-.26183	.54352	.698	70	.488

3*3*5 ANOVA Comparing across Three Age Groups

Descriptive Statistics

	Agegroup	Mean	Std. Deviation	N
Gemeppositivefandsanger	younger	4.8684	.34257	38
	older	4.5625	.81394	16
	veryold	4.7647	.56230	17
	Total	4.7746	.53977	71
Gemeppositivefandsjoy	younger	2.6316	1.23946	38
	older	2.5625	1.03078	16
	veryold	2.5882	1.46026	17
	Total	2.6056	1.23611	71
Gemeppositivefandsamsusemnt	younger	4.0263	1.44235	38
	older	4.0000	1.03280	16
	veryold	4.3529	1.05719	17
	Total	4.0986	1.26666	71
Gemeppositivefandspride	younger	3.0000	1.27343	38
	older	2.5000	1.15470	16
	veryold	2.4706	1.66274	17
	Total	2.7606	1.35715	71
Gemeppositivefandssurprise	younger	3.0526	1.11373	38
	older	3.5625	1.26326	16
	veryold	2.9412	1.39062	17
	Total	3.1408	1.22236	71
Gemeppositivefaceanger	younger	4.6842	.61973	38
	older	4.4375	.81394	16
	veryold	4.1765	.72761	17
	Total	4.5070	.71461	71
Gemepositivefacejoy	younger	2.3421	1.27928	38
	older	2.4375	1.31498	16
	veryold	2.7059	1.26317	17
	Total	2.4507	1.27379	71
Gemepositivefaceamusement	younger	3.3684	1.21746	38
	older	4.0000	1.03280	16
	veryold	3.6471	1.36662	17
	Total	3.5775	1.22663	71
Gemepositivefacepride	younger	3.1053	1.22562	38
	older	2.5000	1.21106	16
	veryold	2.4118	1.37199	17
	Total	2.8028	1.28307	71
Gemepositivefacesurprise	younger	2.5526	1.42748	38
	older	2.3750	1.31022	16
	veryold	2.4118	1.37199	17
	Total	2.4789	1.37175	71
Gemeppositivesoundanger	younger	4.1579	.91611	38
	older	3.5625	1.45917	16
	veryold	3.4706	1.23073	17
	Total	3.8592	1.16246	71
Gemeppositivesoundjoy	younger	2.1053	1.10989	38
	older	1.6875	1.40089	16
	veryold	1.4118	.93934	17
	Total	1.8451	1.16678	71
Gemeppositivesoundamusement	younger	3.7632	1.42249	38
	older	4.1250	.95743	16
	veryold	3.7059	1.31171	17
	Total	3.8310	1.29820	71
Gemeppositivesoundpride	younger	1.1579	1.00071	38
	older	1.1250	1.25831	16
	veryold	.7647	.97014	17
	Total	1.0563	1.05407	71
Gemeppositivesoundsurprise	younger	2.3947	1.26362	38
	older	2.3750	.95743	16
	veryold	2.1765	1.13111	17
	Total	2.3380	1.15812	71

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
presnetation	.994	.387	2	.824	.994	1.000	.500
emotion	.841	11.474	9	.245	.918	1.000	.250
presnetation * emotion	.538	40.352	35	.247	.887	1.000	.125

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Agegroup
Within Subjects Design: presnetation + emotion + presnetation * emotion

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
presnetation	Sphericity Assumed	135.338	2	67.669	68.281	.000	.501	136.562	1.000
	Greenhouse-Geisser	135.338	1.989	68.059	68.281	.000	.501	135.780	1.000
	Huynh-Feldt	135.338	2.000	67.669	68.281	.000	.501	136.562	1.000
	Lower-bound	135.338	1.000	135.338	68.281	.000	.501	68.281	1.000
presnetation * Agegroup	Sphericity Assumed	3.495	4	.874	.882	.477	.025	3.526	.275
	Greenhouse-Geisser	3.495	3.977	.879	.882	.476	.025	3.506	.274
	Huynh-Feldt	3.495	4.000	.874	.882	.477	.025	3.526	.275
	Lower-bound	3.495	2.000	1.747	.882	.419	.025	1.763	.196
Error(presnetation)	Sphericity Assumed	134.781	136	.991					
	Greenhouse-Geisser	134.781	135.221	.997					
	Huynh-Feldt	134.781	136.000	.991					
	Lower-bound	134.781	68.000	1.982					
emotion	Sphericity Assumed	712.453	4	178.113	106.208	.000	.610	424.830	1.000
	Greenhouse-Geisser	712.453	3.673	193.955	106.208	.000	.610	390.131	1.000
	Huynh-Feldt	712.453	4.000	178.113	106.208	.000	.610	424.830	1.000
	Lower-bound	712.453	1.000	712.453	106.208	.000	.610	106.208	1.000
emotion * Agegroup	Sphericity Assumed	19.009	8	2.376	1.417	.189	.040	11.335	.639
	Greenhouse-Geisser	19.009	7.347	2.587	1.417	.196	.040	10.409	.611
	Huynh-Feldt	19.009	8.000	2.376	1.417	.189	.040	11.335	.639
	Lower-bound	19.009	2.000	9.504	1.417	.250	.040	2.834	.294
Error(emotion)	Sphericity Assumed	456.152	272	1.677					
	Greenhouse-Geisser	456.152	249.784	1.826					
	Huynh-Feldt	456.152	272.000	1.677					
	Lower-bound	456.152	68.000	6.708					
presnetation * emotion	Sphericity Assumed	67.489	8	8.436	9.513	.000	.123	76.100	1.000
	Greenhouse-Geisser	67.489	7.093	9.515	9.513	.000	.123	67.469	1.000
	Huynh-Feldt	67.489	8.000	8.436	9.513	.000	.123	76.100	1.000
	Lower-bound	67.489	1.000	67.489	9.513	.003	.123	9.513	.860
presnetation * emotion * Agegroup	Sphericity Assumed	15.509	16	.969	1.093	.358	.031	17.488	.735
	Greenhouse-Geisser	15.509	14.185	1.093	1.093	.361	.031	15.505	.694
	Huynh-Feldt	15.509	16.000	.969	1.093	.358	.031	17.488	.735
	Lower-bound	15.509	2.000	7.755	1.093	.341	.031	2.186	.234
Error (presnetation*emotion)	Sphericity Assumed	482.440	544	.887					
	Greenhouse-Geisser	482.440	482.298	1.000					
	Huynh-Feldt	482.440	544.000	.887					
	Lower-bound	482.440	68.000	7.095					

a. Computed using alpha = .05

Appendix 7.13

SPSS output for Negative Experiment in Phase 2

2*3*5 ANOVA Comparing between YAs and OAs

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
presenation	.845	11.480	2	.003	.866	.899	.500
negativeemotion	.563	38.775	9	.000	.796	.851	.250
presenation * negativeemotion	.420	57.395	35	.010	.849	.964	.125

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Agegroup
Within Subjects Design: presenation + negativeemotion + presenation * negativeemotion

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
presenation	Sphericity Assumed	115.008	2	57.504	87.763	.000	.560	175.526	1.000
	Greenhouse-Geisser	115.008	1.731	66.437	87.763	.000	.560	151.925	1.000
	Huynh-Feldt	115.008	1.797	63.987	87.763	.000	.560	157.742	1.000
	Lower-bound	115.008	1.000	115.008	87.763	.000	.560	87.763	1.000
presenation * Agegroup	Sphericity Assumed	17.746	2	8.873	13.542	.000	.164	27.085	.998
	Greenhouse-Geisser	17.746	1.731	10.252	13.542	.000	.164	23.443	.995
	Huynh-Feldt	17.746	1.797	9.874	13.542	.000	.164	24.340	.996
	Lower-bound	17.746	1.000	17.746	13.542	.000	.164	13.542	.952
Error(presenation)	Sphericity Assumed	90.421	138	.655					
	Greenhouse-Geisser	90.421	119.445	.757					
	Huynh-Feldt	90.421	124.019	.729					
	Lower-bound	90.421	69.000	1.310					
negativeemotion	Sphericity Assumed	289.941	4	72.485	65.333	.000	.486	261.333	1.000
	Greenhouse-Geisser	289.941	3.183	91.084	65.333	.000	.486	207.971	1.000
	Huynh-Feldt	289.941	3.404	85.188	65.333	.000	.486	222.364	1.000
	Lower-bound	289.941	1.000	289.941	65.333	.000	.486	65.333	1.000
negativeemotion * Agegroup	Sphericity Assumed	11.661	4	2.915	2.628	.035	.037	10.510	.732
	Greenhouse-Geisser	11.661	3.183	3.663	2.628	.048	.037	8.364	.657
	Huynh-Feldt	11.661	3.404	3.426	2.628	.044	.037	8.943	.679
	Lower-bound	11.661	1.000	11.661	2.628	.110	.037	2.628	.359
Error(negativeemotion)	Sphericity Assumed	306.213	276	1.109					
	Greenhouse-Geisser	306.213	219.643	1.394					
	Huynh-Feldt	306.213	234.844	1.304					
	Lower-bound	306.213	69.000	4.438					
presenation * negativeemotion	Sphericity Assumed	160.462	8	20.058	38.059	.000	.355	304.469	1.000
	Greenhouse-Geisser	160.462	6.788	23.638	38.059	.000	.355	258.354	1.000
	Huynh-Feldt	160.462	7.715	20.798	38.059	.000	.355	293.626	1.000
	Lower-bound	160.462	1.000	160.462	38.059	.000	.355	38.059	1.000
presenation * negativeemotion * Agegroup	Sphericity Assumed	10.663	8	1.333	2.529	.010	.035	20.233	.915
	Greenhouse-Geisser	10.663	6.788	1.571	2.529	.016	.035	17.168	.875
	Huynh-Feldt	10.663	7.715	1.382	2.529	.011	.035	19.512	.907
	Lower-bound	10.663	1.000	10.663	2.529	.116	.035	2.529	.348
Error (presenation*negativeemotion)	Sphericity Assumed	290.916	552	.527					
	Greenhouse-Geisser	290.916	468.393	.621					
	Huynh-Feldt	290.916	532.342	.546					
	Lower-bound	290.916	69.000	4.216					

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	9514.155	1	9514.155	4313.042	.000	.984	4313.042	1.000
Agegroup	11.778	1	11.778	5.339	.024	.072	5.339	.625
Error	152.207	69	2.206					

a. Computed using alpha = .05

Post hoc Tests for Main effect of Presentation Type

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemepnegativefandsoundtotal	16.6620	71	2.02092	.23984
	Gemepnegativefacetotal	15.5493	71	2.18298	.25907
Pair 2	Gemepnegativefandsoundtotal	16.6620	71	2.02092	.23984
	Gemepnegativesoundtotal	12.8451	71	3.25422	.38620
Pair 3	Gemepnegativefacetotal	15.5493	71	2.18298	.25907
	Gemepnegativesoundtotal	12.8451	71	3.25422	.38620

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Gemepnegativefandsoundtotal - Gemepnegativefacetotal	1.11268	2.07398	.24614	.62177	1.60358	4.521	70	.000
Pair 2	Gemepnegativefandsoundtotal - Gemepnegativesoundtotal	3.81690	2.89980	.34414	3.13053	4.50327	11.091	70	.000
Pair 3	Gemepnegativefacetotal - Gemepnegativesoundtotal	2.70423	3.23549	.38398	1.93840	3.47005	7.043	70	.000

Post hoc Tests for Age Group Presentation Type Interaction*

Comparing Between YAs and OAs

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
Gemepnegativefandsoundtotal	younger	38	16.6842	2.18230	.35402
	older	33	16.6364	1.85098	.32221
Gemepnegativefacetotal	younger	38	15.6579	1.99020	.32285
	older	33	15.4242	2.41131	.41975
Gemepnegativesoundtotal	younger	38	14.1842	3.10932	.50440
	older	33	11.3030	2.72127	.47371

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Gemepnegativefandsoundtotal	Equal variances assumed	1.191	.279	.099	69	.922	.04785	.48431	-.91832	1.01402
	Equal variances not assumed			.100	68.968	.921	.04785	.47870	-.90713	1.00283
Gemepnegativefacetotal	Equal variances assumed	4.478	.038	.447	69	.656	.23365	.52243	-.80856	1.27587
	Equal variances not assumed			.441	62.226	.661	.23365	.52955	-.82483	1.29214
Gemepnegativesoundtotal	Equal variances assumed	.741	.392	4.125	69	.000	2.88118	.69855	1.48761	4.27475
	Equal variances not assumed			4.164	68.993	.000	2.88118	.69197	1.50074	4.26162

The pattern of recognition accuracy across presentation types in YAs

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemepnegativefandsoundtotal	16.6842	38	2.18230	.35402
	Gemepnegativefacetotal	15.6579	38	1.99020	.32285
Pair 2	Gemepnegativefandsoundtotal	16.6842	38	2.18230	.35402
	Gemepnegativesoundtotal	14.1842	38	3.10932	.50440
Pair 3	Gemepnegativefacetotal	15.6579	38	1.99020	.32285
	Gemepnegativesoundtotal	14.1842	38	3.10932	.50440

a. Agegroup = younger

Paired Samples Test[a]

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Gemepnegativefandsoundtotal - Gemepnegativefacetotal	1.02632	1.97945	.32111	.37569	1.67694	3.196	37	.003
Pair 2	Gemepnegativefandsoundtotal - Gemepnegativesoundtotal	2.50000	2.57588	.41786	1.65333	3.34667	5.983	37	.000
Pair 3	Gemepnegativefacetotal - Gemepnegativesoundtotal	1.47368	3.11697	.50564	.44916	2.49821	2.914	37	.006

a. Agegroup = younger

The pattern of recognition accuracy across presentation types in OAs

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemepnegativefandsoundtotal	16.6364	33	1.85098	.32221
	Gemepnegativefacetotal	15.4242	33	2.41131	.41975
Pair 2	Gemepnegativefandsoundtotal	16.6364	33	1.85098	.32221
	Gemepnegativesoundtotal	11.3030	33	2.72127	.47371
Pair 3	Gemepnegativefacetotal	15.4242	33	2.41131	.41975
	Gemepnegativesoundtotal	11.3030	33	2.72127	.47371

a. Agegroup = older

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Gemepnegativefandsoundtotal - Gemepnegativefacetotal	1.21212	2.20451	.38376	.43044	1.99381	3.159	32	.003
Pair 2	Gemepnegativefandsoundtotal - Gemepnegativesoundtotal	5.33333	2.50832	.43664	4.44392	6.22274	12.214	32	.000
Pair 3	Gemepnegativefacetotal - Gemepnegativesoundtotal	4.12121	2.79237	.48609	3.13108	5.11134	8.478	32	.000

a. Agegroup = older

Post hoc Tests for Main effect of Emotion Type

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	totalnegativejoy - totalnegativesadness	-1.29577	2.85554	.33889	-1.97167	-.61988	-3.824	70	.000
Pair 2	totalnegativejoy - totalnegativefear	-1.98592	1.78480	.21182	-2.40837	-1.56346	-9.376	70	.000
Pair 3	totalnegativejoy - totalnegativeanger	-2.15493	2.09522	.24866	-2.65086	-1.65900	-8.666	70	.000
Pair 4	totalnegativejoy - totalnegativedisgust	2.07042	3.02996	.35959	1.35324	2.78760	5.758	70	.000
Pair 5	totalnegativesadness - totalnegativefear	-.69014	2.48189	.29455	-1.27759	-.10269	-2.343	70	.022
Pair 6	totalnegativesadness - totalnegativeanger	-.85915	2.74276	.32551	-1.50836	-.20995	-2.639	70	.010
Pair 7	totalnegativesadness - totalnegativedisgust	3.36620	3.31335	.39322	2.58194	4.15045	8.561	70	.000
Pair 8	totalnegativefear - totalnegativeanger	-.16901	1.82824	.21697	-.60175	.26372	-.779	70	.439
Pair 9	totalnegativefear - totalnegativedisgust	4.05634	2.75104	.32649	3.40518	4.70750	12.424	70	.000
Pair 10	totalnegativeanger - totalnegativedisgust	4.22535	2.76301	.32791	3.57136	4.87935	12.886	70	.000

Post hoc Tests for Age Group Emotion Type Interaction*

Comparing Between YAs and OAs

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
totalnegativejoy	younger	38	8.9737	1.44235	.23398
	older	33	7.6061	1.41287	.24595
totalnegativesadness	younger	38	9.3947	2.46642	.40011
	older	33	9.9091	1.50756	.26243
totalnegativefear	younger	38	10.7368	1.48295	.24057
	older	33	9.8485	1.69781	.29555
totalnegativeanger	younger	38	10.8947	1.29008	.20928
	older	33	10.0303	1.91188	.33282
totalnegativedisgust	younger	38	6.5263	3.04681	.49426
	older	33	5.9697	2.74414	.47769

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
totalnegativejoy	Equal variances assumed	.022	.881	4.023	69	.000	1.36762	.33997	.68941	2.04584
	Equal variances not assumed			4.029	67.978	.000	1.36762	.33947	.69022	2.04502
totalnegativesadness	Equal variances assumed	5.273	.025	-1.040	69	.302	-.51435	.49434	-1.50053	.47182
	Equal variances not assumed			-1.075	62.342	.287	-.51435	.47849	-1.47074	.44203
totalnegativefear	Equal variances assumed	.935	.337	2.354	69	.021	.88836	.37744	.13539	1.64132
	Equal variances not assumed			2.331	64.110	.023	.88836	.38108	.12708	1.64963
totalnegativeanger	Equal variances assumed	5.046	.028	2.258	69	.027	.86443	.38277	.10084	1.62803
	Equal variances not assumed			2.199	54.887	.032	.86443	.39315	.07651	1.65235
totalnegativedisgust	Equal variances assumed	.706	.404	.804	69	.424	.55662	.69251	-.82490	1.93814
	Equal variances not assumed			.810	68.898	.421	.55662	.68737	-.81469	1.92793

The pattern of recognition accuracy across emotion types in YAs

Paired Samples Test[a]

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	totalnegativejoy - totalnegativesadness	-.42105	3.27671	.53155	-1.49808	.65598	-.792	37	.433
Pair 2	totalnegativejoy - totalnegativefear	-1.76316	1.63466	.26518	-2.30046	-1.22586	-6.649	37	.000
Pair 3	totalnegativejoy - totalnegativeanger	-1.92105	1.69867	.27556	-2.47939	-1.36271	-6.971	37	.000
Pair 4	totalnegativejoy - totalnegativedisgust	2.44737	3.02867	.49131	1.45187	3.44287	4.981	37	.000
Pair 5	totalnegativesadness - totalnegativefear	-1.34211	2.57090	.41706	-2.18714	-.49707	-3.218	37	.003
Pair 6	totalnegativesadness - totalnegativeanger	-1.50000	2.83558	.45999	-2.43203	-.56797	-3.261	37	.002
Pair 7	totalnegativesadness - totalnegativedisgust	2.86842	3.59558	.58328	1.68658	4.05026	4.918	37	.000
Pair 8	totalnegativefear - totalnegativeanger	-.15789	1.71679	.27850	-.72219	.40640	-.567	37	.574
Pair 9	totalnegativefear - totalnegativedisgust	4.21053	2.74264	.44491	3.30904	5.11201	9.464	37	.000
Pair 10	totalnegativeanger - totalnegativedisgust	4.36842	2.85147	.46257	3.43117	5.30568	9.444	37	.000

a. Agegroup = younger

The pattern of recognition accuracy across emotion types in OAs

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	totalnegativejoy - totalnegativesadness	-2.30303	1.86220	.32417	-2.96334	-1.64272	-7.104	32	.000
Pair 2	totalnegativejoy - totalnegativefear	-2.24242	1.93698	.33719	-2.92925	-1.55560	-6.650	32	.000
Pair 3	totalnegativejoy - totalnegativeanger	-2.42424	2.47526	.43089	-3.30193	-1.54655	-5.626	32	.000
Pair 4	totalnegativejoy - totalnegativedisgust	1.63636	3.01888	.52552	.56592	2.70681	3.114	32	.004
Pair 5	totalnegativesadness - totalnegativefear	.06061	2.17858	.37924	-.71188	.83310	.160	32	.874
Pair 6	totalnegativesadness - totalnegativeanger	-.12121	2.47181	.43029	-.99768	.75525	-.282	32	.780
Pair 7	totalnegativesadness - totalnegativedisgust	3.93939	2.90409	.50554	2.90965	4.96914	7.793	32	.000
Pair 8	totalnegativefear - totalnegativeanger	-.18182	1.97570	.34393	-.88237	.51874	-.529	32	.601
Pair 9	totalnegativefear - totalnegativedisgust	3.87879	2.79237	.48609	2.88866	4.86892	7.980	32	.000
Pair 10	totalnegativeanger - totalnegativedisgust	4.06061	2.69188	.46860	3.10611	5.01510	8.665	32	.000

a. Agegroup = older

*Post hoc Tests Investigating the Emotion Type*Presentation Type Interaction*

Joy

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemepnegativefaceandsoundjoy	3.4507	71	.52885	.06276
	Gemepnegativefacejoy	3.4930	71	.50351	.05976
Pair 2	Gemepnegativefaceandsoundjoy	3.4507	71	.52885	.06276
	Gemepnegativesoundjoy	1.3944	71	1.27031	.15076
Pair 3	Gemepnegativefacejoy	3.4930	71	.50351	.05976
	Gemepnegativesoundjoy	1.3944	71	1.27031	.15076

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Gemepnegativefaceandsoundjoy - Gemepnegativefacejoy	-.04225	.61960	.07353	-.18891	.10440	-.575	70	.567
Pair 2	Gemepnegativefaceandsoundjoy - Gemepnegativesoundjoy	2.05634	1.31895	.15653	1.74415	2.36853	13.137	70	.000
Pair 3	Gemepnegativefacejoy - Gemepnegativesoundjoy	2.09859	1.35388	.16068	1.77813	2.41905	13.061	70	.000

Sad

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemepnegativefaceandsoundsad	3.3662	71	.84919	.10078
	Gemepnegativefacesad	2.9014	71	1.03032	.12228
Pair 2	Gemepnegativefaceandsoundsad	3.3662	71	.84919	.10078
	Gemepnegativesoundsad	3.3662	71	.88220	.10470
Pair 3	Gemepnegativefacesad	2.9014	71	1.03032	.12228
	Gemepnegativesoundsad	3.3662	71	.88220	.10470

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Gemepnegativefaceandsoundsad - Gemepnegativefacesad	.46479	1.03966	.12338	.21871	.71087	3.767	70	.000
Pair 2	Gemepnegativefaceandsoundsad - Gemepnegativesoundsad	.00000	1.01419	.12036	-.24005	.24005	.000	70	1.000
Pair 3	Gemepnegativefacesad - Gemepnegativesoundsad	-.46479	1.11907	.13281	-.72967	-.19991	-3.500	70	.001

Fear

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemepnegativefaceandsoundfear	3.6197	71	.68382	.08115
	Gemepnegativefacefear	3.3944	71	.85321	.10126
Pair 2	Gemepnegativefaceandsoundfear	3.6197	71	.68382	.08115
	Gemepnegativesoundfear	3.3099	71	.95006	.11275
Pair 3	Gemepnegativefacefear	3.3944	71	.85321	.10126
	Gemepnegativesoundfear	3.3099	71	.95006	.11275

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Gemepnegativefaceandsoundfear - Gemepnegativefacefear	.22535	1.11095	.13185	-.03760	.48831	1.709	70	.092
Pair 2	Gemepnegativefaceandsoundfear - Gemepnegativesoundfear	.30986	1.11601	.13245	.04570	.57401	2.340	70	.022
Pair 3	Gemepnegativefacefear - Gemepnegativesoundfear	.08451	1.06565	.12647	-.16773	.33674	.668	70	.506

Anger

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemepnegativefaceandsoundanger	3.6197	71	.61797	.07334
	Gemepnegativefaceanger	3.6620	71	.60813	.07217
Pair 2	Gemepnegativefaceandsoundanger	3.6197	71	.61797	.07334
	Gemepnegativesoundanger	3.2113	71	.87693	.10407
Pair 3	Gemepnegativefaceanger	3.6620	71	.60813	.07217
	Gemepnegativesoundanger	3.2113	71	.87693	.10407

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Gemepnegativefaceandsoundanger - Gemepnegativefaceanger	-.04225	.66411	.07882	-.19945	.11494	-.536	70	.594
Pair 2	Gemepnegativefaceandsoundanger - Gemepnegativesoundanger	.40845	.88765	.10535	.19835	.61855	3.877	70	.000
Pair 3	Gemepnegativefaceanger - Gemepnegativesoundanger	.45070	.77069	.09146	.26828	.63312	4.928	70	.000

Disgust

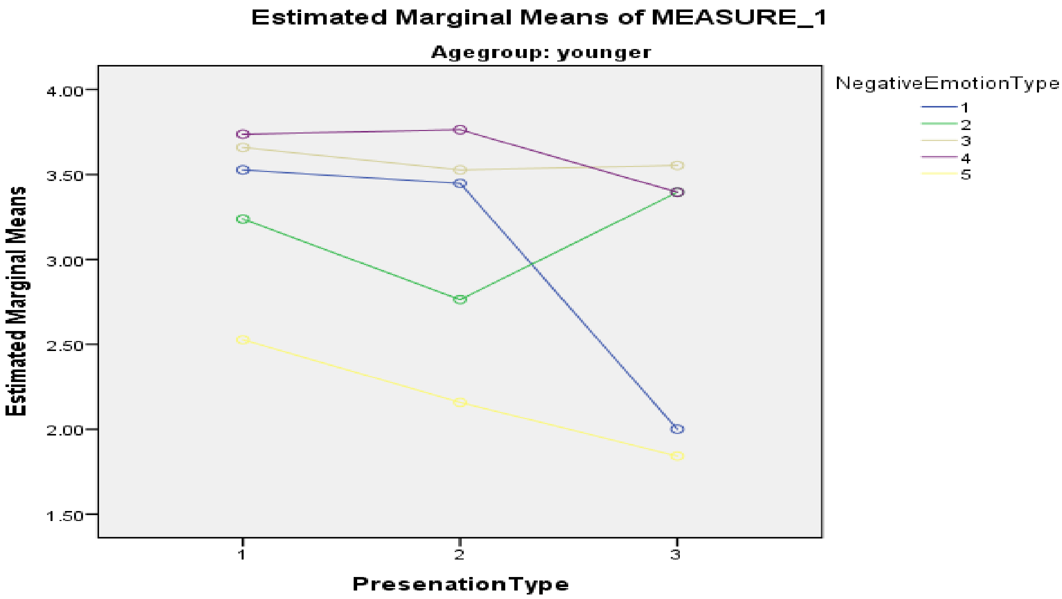
Paired Samples Statistics

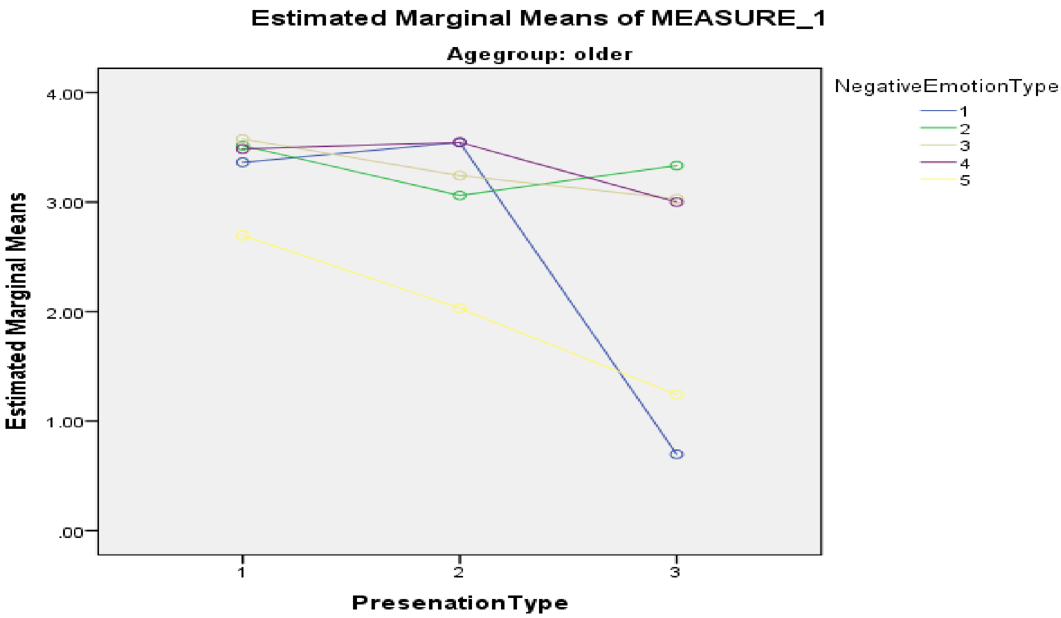
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemepnegativefaceandsounddisgust	2.6056	71	1.17691	.13967
	Gemepnegativefacedisgust	2.0986	71	1.19708	.14207
Pair 2	Gemepnegativefaceandsounddisgust	2.6056	71	1.17691	.13967
	Gemepnegativesounddisgust	1.5634	71	1.26189	.14976
Pair 3	Gemepnegativefacedisgust	2.0986	71	1.19708	.14207
	Gemepnegativesounddisgust	1.5634	71	1.26189	.14976

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Gemepnegativefaceandsounddisgust - Gemepnegativefacedisgust	.50704	1.16953	.13880	.23022	.78387	3.653	70	.000
Pair 2	Gemepnegativefaceandsounddisgust - Gemepnegativesounddisgust	1.04225	1.23562	.14664	.74979	1.33472	7.108	70	.000
Pair 3	Gemepnegativefacedisgust - Gemepnegativesounddisgust	.53521	1.38183	.16399	.20814	.86229	3.264	70	.002

Age Group* Emotion Type*Presentation Type Interaction





The Negative Face Task

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
negativefaceonly71	.594	35.167	9	.000	.816	.873	.250

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Agegroup
Within Subjects Design: negativefaceonly71

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
negativefaceonly71	Sphericity Assumed	112.482	4	28.121	39.118	.000	.362
	Greenhouse-Geisser	112.482	3.262	34.477	39.118	.000	.362
	Huynh-Feldt	112.482	3.493	32.200	39.118	.000	.362
	Lower-bound	112.482	1.000	112.482	39.118	.000	.362
negativefaceonly71 * Agegroup	Sphericity Assumed	4.088	4	1.022	1.422	.227	.020
	Greenhouse-Geisser	4.088	3.262	1.253	1.422	.235	.020
	Huynh-Feldt	4.088	3.493	1.170	1.422	.232	.020
	Lower-bound	4.088	1.000	4.088	1.422	.237	.020
Error (negativefaceonly71)	Sphericity Assumed	198.408	276	.719			
	Greenhouse-Geisser	198.408	225.112	.881			
	Huynh-Feldt	198.408	241.034	.823			
	Lower-bound	198.408	69.000	2.875			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	3412.644	1	3412.644	3539.733	.000	.981
Agegroup	.193	1	.193	.200	.656	.003
Error	66.523	69	.964			

The Negative Prosodic Sentence Task

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
negativesound71	.852	10.759	9	.293	.932	1.000	.250

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Agegroup
Within Subjects Design: negativesound71

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
negativesound71	Sphericity Assumed	288.997	4	72.249	85.582	.000	.554	342.328	1.000
	Greenhouse-Geisser	288.997	3.728	77.524	85.582	.000	.554	319.035	1.000
	Huynh-Feldt	288.997	4.000	72.249	85.582	.000	.554	342.328	1.000
	Lower-bound	288.997	1.000	288.997	85.582	.000	.554	85.582	1.000
negativesound71 * Agegroup	Sphericity Assumed	14.654	4	3.663	4.339	.002	.059	17.358	.930
	Greenhouse-Geisser	14.654	3.728	3.931	4.339	.003	.059	16.177	.916
	Huynh-Feldt	14.654	4.000	3.663	4.339	.002	.059	17.358	.930
	Lower-bound	14.654	1.000	14.654	4.339	.041	.059	4.339	.538
Error (negativesound71)	Sphericity Assumed	233.003	276	.844					
	Greenhouse-Geisser	233.003	257.220	.906					
	Huynh-Feldt	233.003	276.000	.844					
	Lower-bound	233.003	69.000	3.377					

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	2294.641	1	2294.641	1331.222	.000	.951	1331.222	1.000
Agegroup	29.323	1	29.323	17.012	.000	.198	17.012	.982
Error	118.936	69	1.724					

a. Computed using alpha = .05

Post hoc tests investigating the main effect of emotion

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Gemepnegativesoundjoy - Gemepnegativesoundsad	-1.97183	1.52101	.18051	-2.33185	-1.61181	-10.924	70	.000
Pair 2	Gemepnegativesoundjoy - Gemepnegativesoundfear	-1.91549	1.23920	.14707	-2.20881	-1.62218	-13.025	70	.000
Pair 3	Gemepnegativesoundjoy - Gemepnegativesoundanger	-1.81690	1.41734	.16821	-2.15238	-1.48142	-10.802	70	.000
Pair 4	Gemepnegativesoundjoy - Gemepnegativesounddisgust	-.16901	1.48310	.17601	-.52006	.18203	-.960	70	.340
Pair 5	Gemepnegativesoundsad - Gemepnegativesoundfear	.05634	1.15743	.13736	-.21762	.33030	.410	70	.683
Pair 6	Gemepnegativesoundsad - Gemepnegativesoundanger	.15493	1.23806	.14693	-.13811	.44797	1.054	70	.295
Pair 7	Gemepnegativesoundsad - Gemepnegativesounddisgust	1.80282	1.45032	.17212	1.45953	2.14610	10.474	70	.000
Pair 8	Gemepnegativesoundfear - Gemepnegativesoundanger	.09859	1.09746	.13024	-.16117	.35836	.757	70	.452
Pair 9	Gemepnegativesoundfear - Gemepnegativesounddisgust	1.74648	1.33864	.15887	1.42963	2.06333	10.993	70	.000
Pair 10	Gemepnegativesoundanger - Gemepnegativesounddisgust	1.64789	1.28839	.15290	1.34293	1.95285	10.777	70	.000

Post hoc tests investigating the Age Group*Emotion Type interaction

Comparing between YAs and OAs

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
Gemepnegativesoundjoy	younger	38	2.0000	1.18550	.19231
	older	33	.6970	.98377	.17125
Gemepnegativesoundsad	younger	38	3.3947	.94553	.15339
	older	33	3.3333	.81650	.14213
Gemepnegativesoundfear	younger	38	3.5526	.72400	.11745
	older	33	3.0303	1.10354	.19210
Gemepnegativesoundanger	younger	38	3.3947	.75479	.12244
	older	33	3.0000	.96825	.16855
Gemepnegativesounddisgust	younger	38	1.8421	1.38576	.22480
	older	33	1.2424	1.03169	.17959

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Gemepnegativesoundjoy	Equal variances assumed	.331	.567	4.994	69	.000	1.30303	.26092	.78250	1.82356
	Equal variances not assumed			5.060	68.872	.000	1.30303	.25751	.78929	1.81677
Gemepnegativesoundsad	Equal variances assumed	.992	.323	.291	69	.772	.06140	.21130	-.36013	.48294
	Equal variances not assumed			.294	68.999	.770	.06140	.20911	-.35577	.47858
Gemepnegativesoundfear	Equal variances assumed	5.347	.024	2.387	69	.020	.52233	.21884	.08575	.95891
	Equal variances not assumed			2.320	53.883	.024	.52233	.22516	.07089	.97377
Gemepnegativesoundanger	Equal variances assumed	1.826	.181	1.928	69	.058	.39474	.20473	-.01368	.80316
	Equal variances not assumed			1.895	60.189	.063	.39474	.20833	-.02196	.81143
Gemepnegativesounddisgust	Equal variances assumed	4.902	.030	2.042	69	.045	.59968	.29369	.01379	1.18557
	Equal variances not assumed			2.084	67.507	.041	.59968	.28773	.02544	1.17392

The pattern of recognition accuracy across emotion types in YAs

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Gemepnegativesoundjoy - Gemepnegativesoundsad	-1.39474	1.49846	.24308	-1.88727	-.90221	-5.738	37	.000
Pair 2	Gemepnegativesoundjoy - Gemepnegativesoundfear	-1.55263	1.10765	.17968	-1.91671	-1.18856	-8.641	37	.000
Pair 3	Gemepnegativesoundjoy - Gemepnegativesoundanger	-1.39474	1.30569	.21181	-1.82391	-.96557	-6.585	37	.000
Pair 4	Gemepnegativesoundjoy - Gemepnegativesounddisgust	.15789	1.56872	.25448	-.35773	.67352	.620	37	.539
Pair 5	Gemepnegativesoundsad - Gemepnegativesoundfear	-.15789	1.05334	.17087	-.50412	.18833	-.924	37	.361
Pair 6	Gemepnegativesoundsad - Gemepnegativesoundanger	.00000	1.16248	.18858	-.38210	.38210	.000	37	1.000
Pair 7	Gemepnegativesoundsad - Gemepnegativesounddisgust	1.55263	1.58877	.25773	1.03042	2.07485	6.024	37	.000
Pair 8	Gemepnegativesoundfear - Gemepnegativesoundanger	.15789	.78933	.12805	-.10155	.41734	1.233	37	.225
Pair 9	Gemepnegativesoundfear - Gemepnegativesounddisgust	1.71053	1.39319	.22600	1.25260	2.16846	7.569	37	.000
Pair 10	Gemepnegativesoundanger - Gemepnegativesounddisgust	1.55263	1.30896	.21234	1.12239	1.98288	7.312	37	.000

a. Agegroup = younger

The pattern of recognition accuracy across emotion types in OAs

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Gemepnegativesoundjoy - Gemepnegativesoundsad	-2.63636	1.27029	.22113	-3.08679	-2.18594	-11.922	32	.000
Pair 2	Gemepnegativesoundjoy - Gemepnegativesoundfear	-2.33333	1.26656	.22048	-2.78243	-1.88423	-10.583	32	.000
Pair 3	Gemepnegativesoundjoy - Gemepnegativesoundanger	-2.30303	1.40278	.24419	-2.80044	-1.80562	-9.431	32	.000
Pair 4	Gemepnegativesoundjoy - Gemepnegativesounddisgust	-.54545	1.30122	.22651	-1.00685	-.08406	-2.408	32	.022
Pair 5	Gemepnegativesoundsad - Gemepnegativesoundfear	.30303	1.23705	.21534	-.13561	.74167	1.407	32	.169
Pair 6	Gemepnegativesoundsad - Gemepnegativesoundanger	.33333	1.31498	.22891	-.13294	.79960	1.456	32	.155
Pair 7	Gemepnegativesoundsad - Gemepnegativesounddisgust	2.09091	1.23399	.21481	1.65336	2.52846	9.734	32	.000
Pair 8	Gemepnegativesoundfear - Gemepnegativesoundanger	.03030	1.38033	.24028	-.45914	.51975	.126	32	.900
Pair 9	Gemepnegativesoundfear - Gemepnegativesounddisgust	1.78788	1.29319	.22512	1.32933	2.24643	7.942	32	.000
Pair 10	Gemepnegativesoundanger - Gemepnegativesounddisgust	1.75758	1.27550	.22204	1.30530	2.20985	7.916	32	.000

a. Agegroup = older

The Negative Cross-modal Task

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
negativefaceandsound	.547	40.645	9	.000	.733	.780	.250

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Agegroup
Within Subjects Design: negativefaceandsound

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
negativefaceandsound	Sphericity Assumed	48.923	4	12.231	20.370	.000	.228	81.480	1.000
	Greenhouse-Geisser	48.923	2.930	16.695	20.370	.000	.228	59.692	1.000
	Huynh-Feldt	48.923	3.119	15.687	20.370	.000	.228	63.530	1.000
	Lower-bound	48.923	1.000	48.923	20.370	.000	.228	20.370	.994
negativefaceandsound * Agegroup	Sphericity Assumed	3.582	4	.896	1.492	.205	.021	5.966	.460
	Greenhouse-Geisser	3.582	2.930	1.223	1.492	.219	.021	4.371	.386
	Huynh-Feldt	3.582	3.119	1.149	1.492	.216	.021	4.652	.400
	Lower-bound	3.582	1.000	3.582	1.492	.226	.021	1.492	.226
Error (negativefaceandsound)	Sphericity Assumed	165.719	276	.600					
	Greenhouse-Geisser	165.719	202.196	.820					
	Huynh-Feldt	165.719	215.196	.770					
	Lower-bound	165.719	69.000	2.402					

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	3921.879	1	3921.879	4733.471	.000	.986	4733.471	1.000
Agegroup	.008	1	.008	.010	.922	.000	.010	.051
Error	57.169	69	.829					

a. Computed using alpha = .05

*Joy*Age Group*

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Joypresntation	.580	37.061	2	.000	.704	.725	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Agegroup
Within Subjects Design: Joypresntation

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Joypresntation	Sphericity Assumed	212.215	2	106.107	201.399	.000	.745	402.798	1.000
	Greenhouse-Geisser	212.215	1.408	150.690	201.399	.000	.745	283.628	1.000
	Huynh-Feldt	212.215	1.450	146.384	201.399	.000	.745	291.970	1.000
	Lower-bound	212.215	1.000	212.215	201.399	.000	.745	201.399	1.000
Joypresntation * Agegroup	Sphericity Assumed	19.614	2	9.807	18.614	.000	.212	37.228	1.000
	Greenhouse-Geisser	19.614	1.408	13.927	18.614	.000	.212	26.214	.998
	Huynh-Feldt	19.614	1.450	13.529	18.614	.000	.212	26.985	.999
	Lower-bound	19.614	1.000	19.614	18.614	.000	.212	18.614	.989
Error(Joypresntation)	Sphericity Assumed	72.705	138	.527					
	Greenhouse-Geisser	72.705	97.172	.748					
	Huynh-Feldt	72.705	100.030	.727					
	Lower-bound	72.705	69.000	1.054					

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	1618.354	1	1618.354	2378.370	.000	.972	2378.370	1.000
Agegroup	11.012	1	11.012	16.183	.000	.190	16.183	.978
Error	46.951	69	.680					

a. Computed using alpha = .05

Comparing Accuracy for Joy across Presentation Types Between YAs and OAs

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
Gemepnegativefaceandsoundjoy	younger	38	3.5263	.50601	.08209
	older	33	3.3636	.54876	.09553
Gemepnegativefacejoy	younger	38	3.4474	.50390	.08174
	older	33	3.5455	.50565	.08802
Gemepnegativesoundjoy	younger	38	2.0000	1.18550	.19231
	older	33	.6970	.98377	.17125

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Gemepnegativefaceandsoundjoy	Equal variances assumed	.007	.935	1.299	69	.198	.16268	.12522	-.08714	.41249
	Equal variances not assumed			1.292	65.716	.201	.16268	.12595	-.08881	.41417
Gemepnegativefacejoy	Equal variances assumed	.014	.906	-.817	69	.417	-.09809	.12009	-.33767	.14150
	Equal variances not assumed			-.817	67.546	.417	-.09809	.12012	-.33782	.14165
Gemepnegativesoundjoy	Equal variances assumed	.331	.567	4.994	69	.000	1.30303	.26092	.78250	1.82356
	Equal variances not assumed			5.060	68.872	.000	1.30303	.25751	.78929	1.81677

The Pattern for Recognising Joy across Presentation Types in YAs

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemepnegativefaceandsoundjoy	3.5263	38	.50601	.08209
	Gemepnegativefacejoy	3.4474	38	.50390	.08174
Pair 2	Gemepnegativefaceandsoundjoy	3.5263	38	.50601	.08209
	Gemepnegativesoundjoy	2.0000	38	1.18550	.19231
Pair 3	Gemepnegativefacejoy	3.4474	38	.50390	.08174
	Gemepnegativesoundjoy	2.0000	38	1.18550	.19231

a. Agegroup = younger

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Gemepnegativefaceandsoundjoy - Gemepnegativefacejoy	.07895	.53935	.08749	-.09833	.25623	.902	37	.373
Pair 2	Gemepnegativefaceandsoundjoy - Gemepnegativesoundjoy	1.52632	1.30977	.21247	1.09580	1.95683	7.184	37	.000
Pair 3	Gemepnegativefacejoy - Gemepnegativesoundjoy	1.44737	1.28814	.20896	1.02397	1.87077	6.926	37	.000

a. Agegroup = younger

The Pattern for Recognising Joy across Presentation Types in OAs

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemepnegativefaceandsoundjoy	3.3636	33	.54876	.09553
	Gemepnegativefacejoy	3.5455	33	.50565	.08802
Pair 2	Gemepnegativefaceandsoundjoy	3.3636	33	.54876	.09553
	Gemepnegativesoundjoy	.6970	33	.98377	.17125
Pair 3	Gemepnegativefacejoy	3.5455	33	.50565	.08802
	Gemepnegativesoundjoy	.6970	33	.98377	.17125

a. Agegroup = older

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Gemepnegativefaceandsoundjoy - Gemepnegativefacejoy	-.18182	.68258	.11882	-.42385	.06021	-1.530	32	.136
Pair 2	Gemepnegativefaceandsoundjoy - Gemepnegativesoundjoy	2.66667	1.05079	.18292	2.29407	3.03926	14.578	32	.000
Pair 3	Gemepnegativefacejoy - Gemepnegativesoundjoy	2.84848	1.00378	.17474	2.49256	3.20441	16.302	32	.000

a. Agegroup = older

*Sad*Age Group*

Descriptive Statistics

	Agegroup	Mean	Std. Deviation	N
Gemepnegativefaceandsoundsad	younger	3.2368	.99822	38
	older	3.5152	.61853	33
	Total	3.3662	.84919	71
Gemepnegativefacesad	younger	2.7632	1.14925	38
	older	3.0606	.86384	33
	Total	2.9014	1.03032	71
Gemepnegativesoundsad	younger	3.3947	.94553	38
	older	3.3333	.81650	33
	Total	3.3662	.88220	71

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
sadpresentation	.986	.937	2	.626	.987	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Agegroup
Within Subjects Design: sadpresentation

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
sadpresentation	Sphericity Assumed	9.890	2	4.945	8.863	.000	.114	17.725	.970
	Greenhouse-Geisser	9.890	1.973	5.013	8.863	.000	.114	17.486	.968
	Huynh-Feldt	9.890	2.000	4.945	8.863	.000	.114	17.725	.970
	Lower-bound	9.890	1.000	9.890	8.863	.004	.114	8.863	.835
sadpresentation * Agegroup	Sphericity Assumed	1.440	2	.720	1.290	.279	.018	2.580	.276
	Greenhouse-Geisser	1.440	1.973	.730	1.290	.278	.018	2.545	.274
	Huynh-Feldt	1.440	2.000	.720	1.290	.279	.018	2.580	.276
	Lower-bound	1.440	1.000	1.440	1.290	.260	.018	1.290	.202
Error(sadpresentation)	Sphericity Assumed	77.002	138	.558					
	Greenhouse-Geisser	77.002	136.137	.566					
	Huynh-Feldt	77.002	138.000	.558					
	Lower-bound	77.002	69.000	1.116					

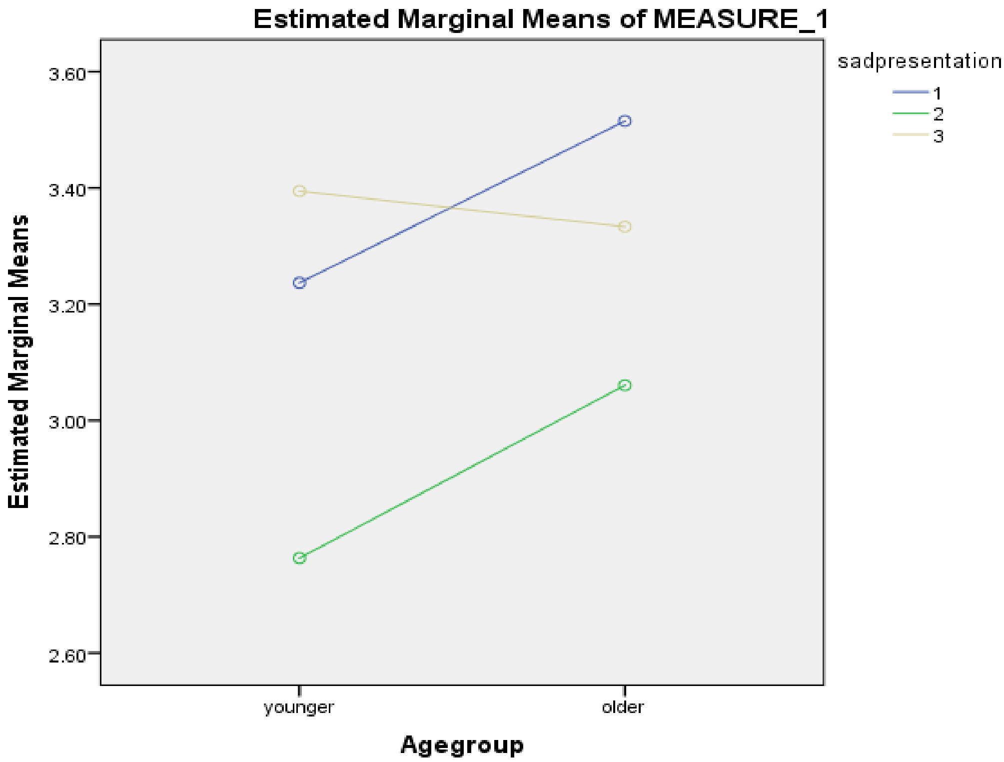
a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	2193.839	1	2193.839	1524.900	.000	.957	1524.900	1.000
Agegroup	1.558	1	1.558	1.083	.302	.015	1.083	.177
Error	99.269	69	1.439					

a. Computed using alpha = .05


Estimated Marginal Means of MEASURE_1
sadpresentation
1
2
3
Estimated Marginal Means
3.60
3.40
3.20
3.00
2.80
2.60
younger
older
Agegroup

*Fear*Age Group*

Descriptive Statistics

	Agegroup	Mean	Std. Deviation	N
Gemepnegativefaceandsoundfear	younger	3.6579	.74530	38
	older	3.5758	.61392	33
	Total	3.6197	.68382	71
Gemepnegativefacefear	younger	3.5263	.79651	38
	older	3.2424	.90244	33
	Total	3.3944	.85321	71
Gemepnegativesoundfear	younger	3.5526	.72400	38
	older	3.0303	1.10354	33
	Total	3.3099	.95006	71

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
fearpresenation	.997	.184	2	.912	.997	1.000	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Agegroup
Within Subjects Design: fearpresenation

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
fearpresenation	Sphericity Assumed	3.969	2	1.984	3.314	.039	.046	6.627	.620
	Greenhouse-Geisser	3.969	1.995	1.990	3.314	.039	.046	6.609	.619
	Huynh-Feldt	3.969	2.000	1.984	3.314	.039	.046	6.627	.620
	Lower-bound	3.969	1.000	3.969	3.314	.073	.046	3.314	.435
fearpresenation * Agegroup	Sphericity Assumed	1.715	2	.858	1.432	.242	.020	2.864	.303
	Greenhouse-Geisser	1.715	1.995	.860	1.432	.242	.020	2.856	.302
	Huynh-Feldt	1.715	2.000	.858	1.432	.242	.020	2.864	.303
	Lower-bound	1.715	1.000	1.715	1.432	.236	.020	1.432	.219
Error(fearpresenation)	Sphericity Assumed	82.642	138	.599					
	Greenhouse-Geisser	82.642	137.628	.600					
	Huynh-Feldt	82.642	138.000	.599					
	Lower-bound	82.642	69.000	1.198					

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	2494.787	1	2494.787	2974.589	.000	.977	2974.589	1.000
Agegroup	4.646	1	4.646	5.540	.021	.074	5.540	.641
Error	57.870	69	.839					

a. Computed using alpha = .05

1. Agegroup

Measure: MEASURE_1

			95% Confidence Interval	
Agegroup	Mean	Std. Error	Lower Bound	Upper Bound
younger	3.579	.086	3.408	3.750
older	3.283	.092	3.099	3.466

*Anger*Age Group*

Descriptive Statistics

	Agegroup	Mean	Std. Deviation	N
Gemepnegativefaceandsoundanger	younger	3.7368	.50319	38
	older	3.4848	.71244	33
	Total	3.6197	.61797	71
Gemepnegativefaceanger	younger	3.7632	.43085	38
	older	3.5455	.75378	33
	Total	3.6620	.60813	71
Gemepnegativesoundanger	younger	3.3947	.75479	38
	older	3.0000	.96825	33
	Total	3.2113	.87693	71

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
angerpresnetation	.892	7.771	2	.021	.903	.939	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Agegroup
Within Subjects Design: angerpresnetation

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
angerpresnetation	Sphericity Assumed	8.987	2	4.494	14.687	.000	.175	29.374	.999
	Greenhouse-Geisser	8.987	1.805	4.979	14.687	.000	.175	26.511	.998
	Huynh-Feldt	8.987	1.878	4.787	14.687	.000	.175	27.575	.998
	Lower-bound	8.987	1.000	8.987	14.687	.000	.175	14.687	.966
angerpresnetation * Agegroup	Sphericity Assumed	.311	2	.156	.509	.602	.007	1.018	.132
	Greenhouse-Geisser	.311	1.805	.173	.509	.584	.007	.919	.128
	Huynh-Feldt	.311	1.878	.166	.509	.591	.007	.955	.130
	Lower-bound	.311	1.000	.311	.509	.478	.007	.509	.108
Error(angerpresnetation)	Sphericity Assumed	42.224	138	.306					
	Greenhouse-Geisser	42.224	124.550	.339					
	Huynh-Feldt	42.224	129.550	.326					
	Lower-bound	42.224	69.000	.612					

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	2577.808	1	2577.808	2988.576	.000	.977	2988.576	1.000
Agegroup	4.399	1	4.399	5.100	.027	.069	5.100	.605
Error	59.516	69	.863					

a. Computed using alpha = .05

1. Agegroup

Measure: MEASURE_1

			95% Confidence Interval	
Agegroup	Mean	Std. Error	Lower Bound	Upper Bound
younger	3.632	.087	3.458	3.805
older	3.343	.093	3.157	3.530

*Disgust*Age Group*

Descriptive Statistics

	Agegroup	Mean	Std. Deviation	N
Gemepnegativefaceandsounddisgust	younger	2.5263	1.20218	38
	older	2.6970	1.15879	33
	Total	2.6056	1.17691	71
Gemepnegativefacedisgust	younger	2.1579	1.17465	38
	older	2.0303	1.23705	33
	Total	2.0986	1.19708	71
Gemepnegativesounddisgust	younger	1.8421	1.38576	38
	older	1.2424	1.03169	33
	Total	1.5634	1.26189	71

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
disgustpresenation	.954	3.230	2	.199	.956	.996	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Agegroup
Within Subjects Design: disgustpresenation

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
disgustpresenation	Sphericity Assumed	40.409	2	20.205	26.116	.000	.275	52.232	1.000
	Greenhouse-Geisser	40.409	1.911	21.142	26.116	.000	.275	49.916	1.000
	Huynh-Feldt	40.409	1.993	20.276	26.116	.000	.275	52.047	1.000
	Lower-bound	40.409	1.000	40.409	26.116	.000	.275	26.116	.999
disgustpresenation * Agegroup	Sphericity Assumed	5.329	2	2.665	3.444	.035	.048	6.889	.638
	Greenhouse-Geisser	5.329	1.911	2.788	3.444	.037	.048	6.583	.624
	Huynh-Feldt	5.329	1.993	2.674	3.444	.035	.048	6.864	.637
	Lower-bound	5.329	1.000	5.329	3.444	.068	.048	3.444	.448
Error (disgustpresenation)	Sphericity Assumed	106.764	138	.774					
	Greenhouse-Geisser	106.764	131.881	.810					
	Huynh-Feldt	106.764	137.513	.776					
	Lower-bound	106.764	69.000	1.547					

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

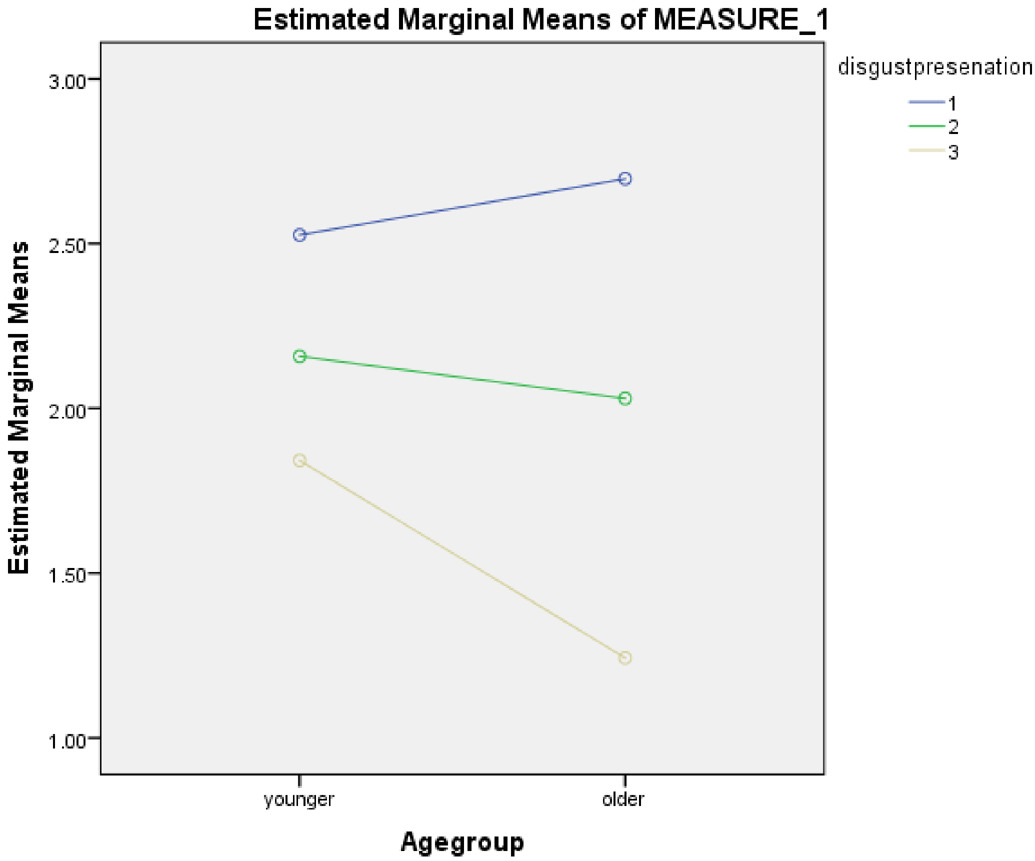
Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	919.308	1	919.308	325.603	.000	.825	325.603	1.000
Agegroup	1.824	1	1.824	.646	.424	.009	.646	.124
Error	194.814	69	2.823					

a. Computed using alpha = .05

1. Agegroup

Measure: MEASURE_1

			95% Confidence Interval	
Agegroup	Mean	Std. Error	Lower Bound	Upper Bound
younger	2.175	.157	1.861	2.489
older	1.990	.169	1.653	2.327



Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
Gemepnegativefaceandsounddisgust	younger	38	2.5263	1.20218	.19502
	older	33	2.6970	1.15879	.20172
Gemepnegativefacedisgust	younger	38	2.1579	1.17465	.19055
	older	33	2.0303	1.23705	.21534
Gemepnegativesounddisgust	younger	38	1.8421	1.38576	.22480
	older	33	1.2424	1.03169	.17959

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Gemepnegativefaceandsounddisgust	Equal variances assumed	.527	.470	-.607	69	.546	-.17065	.28131	-.73186	.39055
	Equal variances not assumed			-.608	68.226	.545	-.17065	.28058	-.73050	.38920
Gemepnegativefacedisgust	Equal variances assumed	.133	.716	.445	69	.657	.12759	.28649	-.44393	.69912
	Equal variances not assumed			.444	66.481	.659	.12759	.28755	-.44644	.70162
Gemepnegativesounddisgust	Equal variances assumed	4.902	.030	2.042	69	.045	.59968	.29369	.01379	1.18557
	Equal variances not assumed			2.084	67.507	.041	.59968	.28773	.02544	1.17392

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemepnegativefaceandsounddisgust	2.5263	38	1.20218	.19502
	Gemepnegativefacedisgust	2.1579	38	1.17465	.19055
Pair 2	Gemepnegativefaceandsounddisgust	2.5263	38	1.20218	.19502
	Gemepnegativesounddisgust	1.8421	38	1.38576	.22480
Pair 3	Gemepnegativefacedisgust	2.1579	38	1.17465	.19055
	Gemepnegativesounddisgust	1.8421	38	1.38576	.22480

a. Agegroup = younger

Paired Samples Test[a]

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Gemepnegativefaceandsounddisgust - Gemepnegativefacedisgust	.36842	1.21746	.19750	-.03175	.76859	1.865	37	.070
Pair 2	Gemepnegativefaceandsounddisgust - Gemepnegativesounddisgust	.68421	1.18790	.19270	.29376	1.07466	3.551	37	.001
Pair 3	Gemepnegativefacedisgust - Gemepnegativesounddisgust	.31579	1.43518	.23282	-.15594	.78752	1.356	37	.183

a. Agegroup = younger

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemepnegativefaceandsounddisgust	2.6970	33	1.15879	.20172
	Gemepnegativefacedisgust	2.0303	33	1.23705	.21534
Pair 2	Gemepnegativefaceandsounddisgust	2.6970	33	1.15879	.20172
	Gemepnegativesounddisgust	1.2424	33	1.03169	.17959
Pair 3	Gemepnegativefacedisgust	2.0303	33	1.23705	.21534
	Gemepnegativesounddisgust	1.2424	33	1.03169	.17959

a. Agegroup = older

Paired Samples Test[a]

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Gemepnegativefaceandsounddisgust - Gemepnegativefacedisgust	.66667	1.10868	.19300	.27355	1.05979	3.454	32	.002
Pair 2	Gemepnegativefaceandsounddisgust - Gemepnegativesounddisgust	1.45455	1.17502	.20455	1.03790	1.87119	7.111	32	.000
Pair 3	Gemepnegativefacedisgust - Gemepnegativesounddisgust	.78788	1.29319	.22512	.32933	1.24643	3.500	32	.001

a. Agegroup = older

3*3*5 ANOVA Comparing across Three Age Groups

Descriptive Statistics

	Agegroup	Mean	Std. Deviation	N
Gemepnegativefaceandsoundjoy	younger	3.5263	.50601	38
	older	3.3750	.50000	16
	veryold	3.3529	.60634	17
	Total	3.4507	.52885	71
Gemepnegativefaceandsoundsad	younger	3.2368	.99822	38
	older	3.4375	.62915	16
	veryold	3.5882	.61835	17
	Total	3.3662	.84919	71
Gemepnegativefaceandsoundfear	younger	3.6579	.74530	38
	older	3.5000	.63246	16
	veryold	3.6471	.60634	17
	Total	3.6197	.68382	71
Gemepnegativefaceandsoundanger	younger	3.7368	.50319	38
	older	3.5625	.62915	16
	veryold	3.4118	.79521	17
	Total	3.6197	.61797	71
Gemepnegativefaceandsounddisgust	younger	2.5263	1.20218	38
	older	2.7500	1.18322	16
	veryold	2.6471	1.16946	17
	Total	2.6056	1.17691	71

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
presnetation	.838	11.817	2	.003	.861	.907	.500
emotion	.554	39.195	9	.000	.792	.860	.250
presnetation * emotion	.411	57.942	35	.009	.843	.974	.125

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Agegroup
Within Subjects Design: presnetation + emotion + presnetation * emotion

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
presnetation	Sphericity Assumed	126.137	2	63.069	96.348	.000	.586	192.696	1.000
	Greenhouse-Geisser	126.137	1.722	73.266	96.348	.000	.586	165.876	1.000
	Huynh-Feldt	126.137	1.814	69.531	96.348	.000	.586	174.785	1.000
	Lower-bound	126.137	1.000	126.137	96.348	.000	.586	96.348	1.000
presnetation * Agegroup	Sphericity Assumed	19.143	4	4.786	7.311	.000	.177	29.244	.995
	Greenhouse-Geisser	19.143	3.443	5.559	7.311	.000	.177	25.173	.990
	Huynh-Feldt	19.143	3.628	5.276	7.311	.000	.177	26.526	.992
	Lower-bound	19.143	2.000	9.571	7.311	.001	.177	14.622	.928
Error(presnetation)	Sphericity Assumed	89.024	136	.655					
	Greenhouse-Geisser	89.024	117.071	.760					
	Huynh-Feldt	89.024	123.359	.722					
	Lower-bound	89.024	68.000	1.309					
emotion	Sphericity Assumed	253.048	4	63.262	56.464	.000	.454	225.855	1.000
	Greenhouse-Geisser	253.048	3.170	79.832	56.464	.000	.454	178.975	1.000
	Huynh-Feldt	253.048	3.441	73.549	56.464	.000	.454	194.266	1.000
	Lower-bound	253.048	1.000	253.048	56.464	.000	.454	56.464	1.000
emotion * Agegroup	Sphericity Assumed	13.125	8	1.641	1.464	.170	.041	11.715	.657
	Greenhouse-Geisser	13.125	6.339	2.070	1.464	.188	.041	9.283	.579
	Huynh-Feldt	13.125	6.881	1.907	1.464	.182	.041	10.076	.606
	Lower-bound	13.125	2.000	6.563	1.464	.238	.041	2.929	.303
Error(emotion)	Sphericity Assumed	304.749	272	1.120					
	Greenhouse-Geisser	304.749	215.543	1.414					
	Huynh-Feldt	304.749	233.958	1.303					
	Lower-bound	304.749	68.000	4.482					
presnetation * emotion	Sphericity Assumed	160.200	8	20.025	38.083	.000	.359	304.663	1.000
	Greenhouse-Geisser	160.200	6.748	23.742	38.083	.000	.359	256.966	1.000
	Huynh-Feldt	160.200	7.789	20.568	38.083	.000	.359	296.616	1.000
	Lower-bound	160.200	1.000	160.200	38.083	.000	.359	38.083	1.000
presnetation * emotion * Agegroup	Sphericity Assumed	15.529	16	.971	1.846	.023	.051	29.532	.953
	Greenhouse-Geisser	15.529	13.495	1.151	1.846	.032	.051	24.909	.922
	Huynh-Feldt	15.529	15.577	.997	1.846	.024	.051	28.752	.949
	Lower-bound	15.529	2.000	7.764	1.846	.166	.051	3.692	.372
Error (presnetation*emotion)	Sphericity Assumed	286.051	544	.526					
	Greenhouse-Geisser	286.051	458.834	.623					
	Huynh-Feldt	286.051	529.632	.540					
	Lower-bound	286.051	68.000	4.207					

a. Computed using alpha = .05

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	8013.186	1	8013.186	3602.367	.000	.981	3602.367	1.000
Agegroup	12.724	2	6.362	2.860	.064	.078	5.720	.543
Error	151.261	68	2.224					

a. Computed using alpha = .05

Post hoc Tests for Age Group Presentation Type Interaction*

The pattern of recognition accuracy across presentation types in YAs

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemepnegativefandsoundtotal	16.6842	38	2.18230	.35402
	Gemepnegativefacetotal	15.6579	38	1.99020	.32285
Pair 2	Gemepnegativefandsoundtotal	16.6842	38	2.18230	.35402
	Gemepnegativesoundtotal	14.1842	38	3.10932	.50440
Pair 3	Gemepnegativefacetotal	15.6579	38	1.99020	.32285
	Gemepnegativesoundtotal	14.1842	38	3.10932	.50440

a. Agegroup = younger

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Gemepnegativefandsoundtotal - Gemepnegativefacetotal	1.02632	1.97945	.32111	.37569	1.67694	3.196	37	.003
Pair 2	Gemepnegativefandsoundtotal - Gemepnegativesoundtotal	2.50000	2.57588	.41786	1.65333	3.34667	5.983	37	.000
Pair 3	Gemepnegativefacetotal - Gemepnegativesoundtotal	1.47368	3.11697	.50564	.44916	2.49821	2.914	37	.006

a. Agegroup = younger

The pattern of recognition accuracy across presentation types in younger-older adults

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemepnegativefandsoundtotal	16.6250	16	2.27669	.56917
	Gemepnegativefacetotal	14.8125	16	2.25740	.56435
Pair 2	Gemepnegativefandsoundtotal	16.6250	16	2.27669	.56917
	Gemepnegativesoundtotal	11.2500	16	3.04412	.76103
Pair 3	Gemepnegativefacetotal	14.8125	16	2.25740	.56435
	Gemepnegativesoundtotal	11.2500	16	3.04412	.76103

a. Agegroup = older

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Gemepnegativefandsoundtotal - Gemepnegativefacetotal	1.81250	2.19754	.54938	.64152	2.98348	3.299	15	.005
Pair 2	Gemepnegativefandsoundtotal - Gemepnegativesoundtotal	5.37500	2.36291	.59073	4.11590	6.63410	9.099	15	.000
Pair 3	Gemepnegativefacetotal - Gemepnegativesoundtotal	3.56250	2.85117	.71279	2.04322	5.08178	4.998	15	.000

a. Agegroup = older

The pattern of recognition accuracy across presentation types in older-older adults

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemepnegativefandsoundtotal	16.6471	17	1.41161	.34237
	Gemepnegativefacetotal	16.0000	17	2.47487	.60025
Pair 2	Gemepnegativefandsoundtotal	16.6471	17	1.41161	.34237
	Gemepnegativesoundtotal	11.3529	17	2.47339	.59988
Pair 3	Gemepnegativefacetotal	16.0000	17	2.47487	.60025
	Gemepnegativesoundtotal	11.3529	17	2.47339	.59988

a. Agegroup = veryold

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Gemepnegativefandsoundtotal - Gemepnegativefacetotal	.64706	2.11959	.51408	-.44273	1.73685	1.259	16	.226
Pair 2	Gemepnegativefandsoundtotal - Gemepnegativesoundtotal	5.29412	2.71027	.65734	3.90062	6.68761	8.054	16	.000
Pair 3	Gemepnegativefacetotal - Gemepnegativesoundtotal	4.64706	2.71434	.65832	3.25147	6.04264	7.059	16	.000

a. Agegroup = veryold

Comparing Between Age Groups

YAs and younger-older adults

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
Gemepnegativefandsoundtotal	younger	38	16.6842	2.18230	.35402
	older	16	16.6250	2.27669	.56917
Gemepnegativefacetotal	younger	38	15.6579	1.99020	.32285
	older	16	14.8125	2.25740	.56435
Gemepnegativesoundtotal	younger	38	14.1842	3.10932	.50440
	older	16	11.2500	3.04412	.76103

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Gemepnegativefandsoundtotal	Equal variances assumed	.060	.808	.090	52	.929	.05921	.65861	-1.26238	1.38080
	Equal variances not assumed			.088	27.200	.930	.05921	.67029	-1.31563	1.43405
Gemepnegativefacetotal	Equal variances assumed	1.267	.266	1.370	52	.177	.84539	.61714	-.39299	2.08378
	Equal variances not assumed			1.300	25.325	.205	.84539	.65017	-.49279	2.18358
Gemepnegativesoundtotal	Equal variances assumed	.001	.970	3.186	52	.002	2.93421	.92108	1.08594	4.78248
	Equal variances not assumed			3.214	28.818	.003	2.93421	.91301	1.06639	4.80203

YAs and older-older adults

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
Gemepnegativefandsoundtotal	younger	38	16.6842	2.18230	.35402
	veryold	17	16.6471	1.41161	.34237
Gemepnegativefacetotal	younger	38	15.6579	1.99020	.32285
	veryold	17	16.0000	2.47487	.60025
Gemepnegativesoundtotal	younger	38	14.1842	3.10932	.50440
	veryold	17	11.3529	2.47339	.59988

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Gemepnegativefandsoundtotal	Equal variances assumed	4.216	.045	.064	53	.949	.03715	.57817	-1.12251	1.19681
	Equal variances not assumed			.075	45.843	.940	.03715	.49249	-.95426	1.02857
Gemepnegativefacetotal	Equal variances assumed	2.860	.097	-.546	53	.587	-.34211	.62678	-1.59926	.91505
	Equal variances not assumed			-.502	25.668	.620	-.34211	.68156	-1.74396	1.05975
Gemepnegativesoundtotal	Equal variances assumed	1.732	.194	3.310	53	.002	2.83127	.85549	1.11537	4.54717
	Equal variances not assumed			3.612	38.335	.001	2.83127	.78376	1.24509	4.41745

Younger-older and older-older

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
Gemepnegativefandsoundtotal	older	16	16.6250	2.27669	.56917
	veryold	17	16.6471	1.41161	.34237
Gemepnegativefacetotal	older	16	14.8125	2.25740	.56435
	veryold	17	16.0000	2.47487	.60025
Gemepnegativesoundtotal	older	16	11.2500	3.04412	.76103
	veryold	17	11.3529	2.47339	.59988

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Gemepnegativefandsoundtotal	Equal variances assumed	4.536	.041	-.034	31	.973	-.02206	.65503	-1.35800	1.31388
	Equal variances not assumed			-.033	24.777	.974	-.02206	.66421	-1.39065	1.34653
Gemepnegativefacetotal	Equal variances assumed	.268	.609	-1.437	31	.161	-1.18750	.82625	-2.87265	.49765
	Equal variances not assumed			-1.441	30.973	.160	-1.18750	.82388	-2.86788	.49288
Gemepnegativesoundtotal	Equal variances assumed	1.336	.257	-.107	31	.916	-.10294	.96285	-2.06668	1.86080
	Equal variances not assumed			-.106	28.952	.916	-.10294	.96903	-2.08498	1.87910

*Post hoc Tests Investigating Age Group*Emotion Type Interaction*

Comparing between YAs and younger-older adults

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
TotalJoynegative	younger	38	8.9737	1.44235	.23398
	older	16	7.6875	1.66208	.41552
TotalSadnegative	younger	38	9.3947	2.46642	.40011
	older	16	9.7500	1.52753	.38188
Totalfearnegative	younger	38	10.7368	1.48295	.24057
	older	16	9.5000	1.93218	.48305
Totalangernegative	younger	38	10.8947	1.29008	.20928
	older	16	9.7500	1.94936	.48734
Totaldisgustnegative	younger	38	6.5263	3.04681	.49426
	older	16	6.0000	2.87518	.71880

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TotalJoynegative	Equal variances assumed	.421	.519	2.860	52	.006	1.28618	.44972	.38376	2.18861
	Equal variances not assumed			2.697	25.002	.012	1.28618	.47687	.30406	2.26831
TotalSadnegative	Equal variances assumed	2.530	.118	-.533	52	.596	-.35526	.66649	-1.69268	.98215
	Equal variances not assumed			-.642	44.344	.524	-.35526	.55310	-1.46972	.75919
Totalfearnegative	Equal variances assumed	2.604	.113	2.553	52	.014	1.23684	.48438	.26486	2.20882
	Equal variances not assumed			2.292	22.795	.031	1.23684	.53963	.11997	2.35372
Totalangernegative	Equal variances assumed	4.946	.031	2.544	52	.014	1.14474	.45004	.24167	2.04780
	Equal variances not assumed			2.158	20.756	.043	1.14474	.53037	.04097	2.24850
Totaldisgustnegative	Equal variances assumed	.034	.854	.589	52	.558	.52632	.89356	-1.26674	2.31937
	Equal variances not assumed			.603	29.834	.551	.52632	.87233	-1.25563	2.30826

Comparing between YAs and older-older adults

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
TotalJoynegative	younger	38	8.9737	1.44235	.23398
	veryold	17	7.5294	1.17886	.28592
TotalSadnegative	younger	38	9.3947	2.46642	.40011
	veryold	17	10.0588	1.51948	.36853
Totalfearnegative	younger	38	10.7368	1.48295	.24057
	veryold	17	10.1765	1.42457	.34551
Totalangernegative	younger	38	10.8947	1.29008	.20928
	veryold	17	10.2941	1.89620	.45990
Totaldisgustnegative	younger	38	6.5263	3.04681	.49426
	veryold	17	5.9412	2.70348	.65569

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TotalJoynegative	Equal variances assumed	.895	.348	3.618	53	.001	1.44427	.39921	.64356	2.24499
	Equal variances not assumed			3.909	37.361	.000	1.44427	.36945	.69594	2.19261
TotalSadnegative	Equal variances assumed	3.543	.065	-1.024	53	.311	-.66409	.64878	-1.96537	.63719
	Equal variances not assumed			-1.221	47.444	.228	-.66409	.54396	-1.75813	.42996
Totalfearnegative	Equal variances assumed	.010	.922	1.310	53	.196	.56037	.42763	-.29735	1.41810
	Equal variances not assumed			1.331	32.019	.193	.56037	.42101	-.29718	1.41792
Totalangernegative	Equal variances assumed	2.325	.133	1.373	53	.176	.60062	.43742	-.27673	1.47797
	Equal variances not assumed			1.189	22.888	.247	.60062	.50527	-.44490	1.64614
Totaldisgustnegative	Equal variances assumed	1.217	.275	.680	53	.499	.58514	.86001	-1.13982	2.31009
	Equal variances not assumed			.713	34.528	.481	.58514	.82111	-1.08262	2.25290

Comparing Between younger-older and older-older adults

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
TotalJoynegative	older	16	7.6875	1.66208	.41552
	veryold	17	7.5294	1.17886	.28592
TotalSadnegative	older	16	9.7500	1.52753	.38188
	veryold	17	10.0588	1.51948	.36853
Totalfearnegative	older	16	9.5000	1.93218	.48305
	veryold	17	10.1765	1.42457	.34551
Totalangernegative	older	16	9.7500	1.94936	.48734
	veryold	17	10.2941	1.89620	.45990
Totaldisgustnegative	older	16	6.0000	2.87518	.71880
	veryold	17	5.9412	2.70348	.65569

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TotalJoynegative	Equal variances assumed	1.855	.183	.317	31	.754	.15809	.49919	-.86002	1.17620
	Equal variances not assumed			.313	26.911	.756	.15809	.50438	-.87698	1.19316
TotalSadnegative	Equal variances assumed	.135	.716	-.582	31	.565	-.30882	.53062	-1.39102	.77338
	Equal variances not assumed			-.582	30.858	.565	-.30882	.53070	-1.39140	.77376
Totalfearnegative	Equal variances assumed	1.975	.170	-1.150	31	.259	-.67647	.58843	-1.87657	.52363
	Equal variances not assumed			-1.139	27.521	.265	-.67647	.59389	-1.89396	.54102
Totalangernegative	Equal variances assumed	.190	.666	-.813	31	.423	-.54412	.66950	-1.90957	.82134
	Equal variances not assumed			-.812	30.750	.423	-.54412	.67008	-1.91120	.82297
Totaldisgustnegative	Equal variances assumed	.696	.411	.061	31	.952	.05882	.97106	-1.92167	2.03932
	Equal variances not assumed			.060	30.531	.952	.05882	.97293	-1.92672	2.04437

The pattern of recogntion across emotion types in YAs

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	TotalJoynegative	8.9737	38	1.44235	.23398
	TotalSadnegative	9.3947	38	2.46642	.40011
Pair 2	TotalJoynegative	8.9737	38	1.44235	.23398
	Totalfearnegative	10.7368	38	1.48295	.24057
Pair 3	TotalJoynegative	8.9737	38	1.44235	.23398
	Totalangernegative	10.8947	38	1.29008	.20928
Pair 4	TotalJoynegative	8.9737	38	1.44235	.23398
	Totaldisgustnegative	6.5263	38	3.04681	.49426
Pair 5	TotalSadnegative	9.3947	38	2.46642	.40011
	Totalfearnegative	10.7368	38	1.48295	.24057
Pair 6	TotalSadnegative	9.3947	38	2.46642	.40011
	Totalangernegative	10.8947	38	1.29008	.20928
Pair 7	TotalSadnegative	9.3947	38	2.46642	.40011
	Totaldisgustnegative	6.5263	38	3.04681	.49426
Pair 8	Totalfearnegative	10.7368	38	1.48295	.24057
	Totalangernegative	10.8947	38	1.29008	.20928
Pair 9	Totalfearnegative	10.7368	38	1.48295	.24057
	Totaldisgustnegative	6.5263	38	3.04681	.49426
Pair 10	Totalangernegative	10.8947	38	1.29008	.20928
	Totaldisgustnegative	6.5263	38	3.04681	.49426

a. Agegroup = younger

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	TotalJoynegative - TotalSadnegative	-.42105	3.27671	.53155	-1.49808	.65598	-.792	37	.433
Pair 2	TotalJoynegative - Totalfearnegative	-1.76316	1.63466	.26518	-2.30046	-1.22586	-6.649	37	.000
Pair 3	TotalJoynegative - Totalangernegative	-1.92105	1.69867	.27556	-2.47939	-1.36271	-6.971	37	.000
Pair 4	TotalJoynegative - Totaldisgustnegative	2.44737	3.02867	.49131	1.45187	3.44287	4.981	37	.000
Pair 5	TotalSadnegative - Totalfearnegative	-1.34211	2.57090	.41706	-2.18714	-.49707	-3.218	37	.003
Pair 6	TotalSadnegative - Totalangernegative	-1.50000	2.83558	.45999	-2.43203	-.56797	-3.261	37	.002
Pair 7	TotalSadnegative - Totaldisgustnegative	2.86842	3.59558	.58328	1.68658	4.05026	4.918	37	.000
Pair 8	Totalfearnegative - Totalangernegative	-.15789	1.71679	.27850	-.72219	.40640	-.567	37	.574
Pair 9	Totalfearnegative - Totaldisgustnegative	4.21053	2.74264	.44491	3.30904	5.11201	9.464	37	.000
Pair 10	Totalangernegative - Totaldisgustnegative	4.36842	2.85147	.46257	3.43117	5.30568	9.444	37	.000

a. Agegroup = younger

The pattern of recogntion across emotion types in younger-older adults

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	TotalJoynegative	7.6875	16	1.66208	.41552
	TotalSadnegative	9.7500	16	1.52753	.38188
Pair 2	TotalJoynegative	7.6875	16	1.66208	.41552
	Totalfearnegative	9.5000	16	1.93218	.48305
Pair 3	TotalJoynegative	7.6875	16	1.66208	.41552
	Totalangernegative	9.7500	16	1.94936	.48734
Pair 4	TotalJoynegative	7.6875	16	1.66208	.41552
	Totaldisgustnegative	6.0000	16	2.87518	.71880
Pair 5	TotalSadnegative	9.7500	16	1.52753	.38188
	Totalfearnegative	9.5000	16	1.93218	.48305
Pair 6	TotalSadnegative	9.7500	16	1.52753	.38188
	Totalangernegative	9.7500	16	1.94936	.48734
Pair 7	TotalSadnegative	9.7500	16	1.52753	.38188
	Totaldisgustnegative	6.0000	16	2.87518	.71880
Pair 8	Totalfearnegative	9.5000	16	1.93218	.48305
	Totalangernegative	9.7500	16	1.94936	.48734
Pair 9	Totalfearnegative	9.5000	16	1.93218	.48305
	Totaldisgustnegative	6.0000	16	2.87518	.71880
Pair 10	Totalangernegative	9.7500	16	1.94936	.48734
	Totaldisgustnegative	6.0000	16	2.87518	.71880

a. Agegroup = older

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	TotalJoynegative - TotalSadnegative	-2.06250	1.91377	.47844	-3.08227	-1.04273	-4.311	15	.001
Pair 2	TotalJoynegative - Totalfearnegative	-1.81250	1.79699	.44925	-2.77005	-.85495	-4.035	15	.001
Pair 3	TotalJoynegative - Totalangernegative	-2.06250	2.43499	.60875	-3.36001	-.76499	-3.388	15	.004
Pair 4	TotalJoynegative - Totaldisgustnegative	1.68750	2.91476	.72869	.13433	3.24067	2.316	15	.035
Pair 5	TotalSadnegative - Totalfearnegative	.25000	2.43584	.60896	-1.04797	1.54797	.411	15	.687
Pair 6	TotalSadnegative - Totalangernegative	.00000	2.63312	.65828	-1.40309	1.40309	.000	15	1.000
Pair 7	TotalSadnegative - Totaldisgustnegative	3.75000	3.10913	.77728	2.09326	5.40674	4.825	15	.000
Pair 8	Totalfearnegative - Totalangernegative	-.25000	2.23607	.55902	-1.44152	.94152	-.447	15	.661
Pair 9	Totalfearnegative - Totaldisgustnegative	3.50000	2.65832	.66458	2.08348	4.91652	5.266	15	.000
Pair 10	Totalangernegative - Totaldisgustnegative	3.75000	2.90975	.72744	2.19950	5.30050	5.155	15	.000

a. Agegroup = older

The pattern of recogntion across emotion types in older-older adults

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	TotalJoynegative	7.5294	17	1.17886	.28592
	TotalSadnegative	10.0588	17	1.51948	.36853
Pair 2	TotalJoynegative	7.5294	17	1.17886	.28592
	Totalfearnegative	10.1765	17	1.42457	.34551
Pair 3	TotalJoynegative	7.5294	17	1.17886	.28592
	Totalangernegative	10.2941	17	1.89620	.45990
Pair 4	TotalJoynegative	7.5294	17	1.17886	.28592
	Totaldisgustnegative	5.9412	17	2.70348	.65569
Pair 5	TotalSadnegative	10.0588	17	1.51948	.36853
	Totalfearnegative	10.1765	17	1.42457	.34551
Pair 6	TotalSadnegative	10.0588	17	1.51948	.36853
	Totalangernegative	10.2941	17	1.89620	.45990
Pair 7	TotalSadnegative	10.0588	17	1.51948	.36853
	Totaldisgustnegative	5.9412	17	2.70348	.65569
Pair 8	Totalfearnegative	10.1765	17	1.42457	.34551
	Totalangernegative	10.2941	17	1.89620	.45990
Pair 9	Totalfearnegative	10.1765	17	1.42457	.34551
	Totaldisgustnegative	5.9412	17	2.70348	.65569
Pair 10	Totalangernegative	10.2941	17	1.89620	.45990
	Totaldisgustnegative	5.9412	17	2.70348	.65569

a. Agegroup = veryold

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	TotalJoynegative - TotalSadnegative	-2.52941	1.84112	.44654	-3.47603	-1.58280	-5.665	16	.000
Pair 2	TotalJoynegative - Totalfearnegative	-2.64706	2.02920	.49215	-3.69038	-1.60374	-5.379	16	.000
Pair 3	TotalJoynegative - Totalangernegative	-2.76471	2.53795	.61554	-4.06960	-1.45981	-4.491	16	.000
Pair 4	TotalJoynegative - Totaldisgustnegative	1.58824	3.20271	.77677	-.05845	3.23492	2.045	16	.058
Pair 5	TotalSadnegative - Totalfearnegative	-.11765	1.96476	.47653	-1.12784	.89254	-.247	16	.808
Pair 6	TotalSadnegative - Totalangernegative	-.23529	2.38562	.57860	-1.46187	.99128	-.407	16	.690
Pair 7	TotalSadnegative - Totaldisgustnegative	4.11765	2.78124	.67455	2.68767	5.54763	6.104	16	.000
Pair 8	Totalfearnegative - Totalangernegative	-.11765	1.76360	.42774	-1.02441	.78911	-.275	16	.787
Pair 9	Totalfearnegative - Totaldisgustnegative	4.23529	2.94808	.71501	2.71953	5.75106	5.923	16	.000
Pair 10	Totalangernegative - Totaldisgustnegative	4.35294	2.52342	.61202	3.05552	5.65036	7.112	16	.000

a. Agegroup = veryold

Post hoc Tests Investigating the Age Group*Emotion Type Interaction on the Prosodic Sentence Task

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemepnegativesoundjoy	2.0000	38	1.18550	.19231
	Gemepnegativesoundsad	3.3947	38	.94553	.15339
Pair 2	Gemepnegativesoundjoy	2.0000	38	1.18550	.19231
	Gemepnegativesoundfear	3.5526	38	.72400	.11745
Pair 3	Gemepnegativesoundjoy	2.0000	38	1.18550	.19231
	Gemepnegativesoundanger	3.3947	38	.75479	.12244
Pair 4	Gemepnegativesoundjoy	2.0000	38	1.18550	.19231
	Gemepnegativesounddisgust	1.8421	38	1.38576	.22480
Pair 5	Gemepnegativesoundsad	3.3947	38	.94553	.15339
	Gemepnegativesoundfear	3.5526	38	.72400	.11745
Pair 6	Gemepnegativesoundsad	3.3947	38	.94553	.15339
	Gemepnegativesoundanger	3.3947	38	.75479	.12244
Pair 7	Gemepnegativesoundsad	3.3947	38	.94553	.15339
	Gemepnegativesounddisgust	1.8421	38	1.38576	.22480
Pair 8	Gemepnegativesoundfear	3.5526	38	.72400	.11745
	Gemepnegativesoundanger	3.3947	38	.75479	.12244
Pair 9	Gemepnegativesoundfear	3.5526	38	.72400	.11745
	Gemepnegativesounddisgust	1.8421	38	1.38576	.22480
Pair 10	Gemepnegativesoundanger	3.3947	38	.75479	.12244
	Gemepnegativesounddisgust	1.8421	38	1.38576	.22480

a. Agegroup = younger

Paired Samples Test[a]

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Gemepnegativesoundjoy - Gemepnegativesoundsad	-1.39474	1.49846	.24308	-1.88727	-.90221	-5.738	37	.000
Pair 2	Gemepnegativesoundjoy - Gemepnegativesoundfear	-1.55263	1.10765	.17968	-1.91671	-1.18856	-8.641	37	.000
Pair 3	Gemepnegativesoundjoy - Gemepnegativesoundanger	-1.39474	1.30569	.21181	-1.82391	-.96557	-6.585	37	.000
Pair 4	Gemepnegativesoundjoy - Gemepnegativesounddisgust	.15789	1.56872	.25448	-.35773	.67352	.620	37	.539
Pair 5	Gemepnegativesoundsad - Gemepnegativesoundfear	-.15789	1.05334	.17087	-.50412	.18833	-.924	37	.361
Pair 6	Gemepnegativesoundsad - Gemepnegativesoundanger	.00000	1.16248	.18858	-.38210	.38210	.000	37	1.000
Pair 7	Gemepnegativesoundsad - Gemepnegativesounddisgust	1.55263	1.58877	.25773	1.03042	2.07485	6.024	37	.000
Pair 8	Gemepnegativesoundfear - Gemepnegativesoundanger	.15789	.78933	.12805	-.10155	.41734	1.233	37	.225
Pair 9	Gemepnegativesoundfear - Gemepnegativesounddisgust	1.71053	1.39319	.22600	1.25260	2.16846	7.569	37	.000
Pair 10	Gemepnegativesoundanger - Gemepnegativesounddisgust	1.55263	1.30896	.21234	1.12239	1.98288	7.312	37	.000

a. Agegroup = younger

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemepnegativesoundjoy	.8125	16	1.10868	.27717
	Gemepnegativesoundsad	3.3750	16	.71880	.17970
Pair 2	Gemepnegativesoundjoy	.8125	16	1.10868	.27717
	Gemepnegativesoundfear	2.9375	16	1.12361	.28090
Pair 3	Gemepnegativesoundjoy	.8125	16	1.10868	.27717
	Gemepnegativesoundanger	2.6875	16	1.07819	.26955
Pair 4	Gemepnegativesoundjoy	.8125	16	1.10868	.27717
	Gemepnegativesounddisgust	1.4375	16	1.15289	.28822
Pair 5	Gemepnegativesoundsad	3.3750	16	.71880	.17970
	Gemepnegativesoundfear	2.9375	16	1.12361	.28090
Pair 6	Gemepnegativesoundsad	3.3750	16	.71880	.17970
	Gemepnegativesoundanger	2.6875	16	1.07819	.26955
Pair 7	Gemepnegativesoundsad	3.3750	16	.71880	.17970
	Gemepnegativesounddisgust	1.4375	16	1.15289	.28822
Pair 8	Gemepnegativesoundfear	2.9375	16	1.12361	.28090
	Gemepnegativesoundanger	2.6875	16	1.07819	.26955
Pair 9	Gemepnegativesoundfear	2.9375	16	1.12361	.28090
	Gemepnegativesounddisgust	1.4375	16	1.15289	.28822
Pair 10	Gemepnegativesoundanger	2.6875	16	1.07819	.26955
	Gemepnegativesounddisgust	1.4375	16	1.15289	.28822

a. Agegroup = older

Paired Samples Test[a]

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Gemepnegativesoundjoy - Gemepnegativesoundsad	-2.56250	1.36473	.34118	-3.28972	-1.83528	-7.511	15	.000
Pair 2	Gemepnegativesoundjoy - Gemepnegativesoundfear	-2.12500	1.20416	.30104	-2.76665	-1.48335	-7.059	15	.000
Pair 3	Gemepnegativesoundjoy - Gemepnegativesoundanger	-1.87500	1.58640	.39660	-2.72033	-1.02967	-4.728	15	.000
Pair 4	Gemepnegativesoundjoy - Gemepnegativesounddisgust	-.62500	1.36015	.34004	-1.34977	.09977	-1.838	15	.086
Pair 5	Gemepnegativesoundsad - Gemepnegativesoundfear	.43750	1.15289	.28822	-.17683	1.05183	1.518	15	.150
Pair 6	Gemepnegativesoundsad - Gemepnegativesoundanger	.68750	1.40089	.35022	-.05898	1.43398	1.963	15	.068
Pair 7	Gemepnegativesoundsad - Gemepnegativesounddisgust	1.93750	1.34009	.33502	1.22342	2.65158	5.783	15	.000
Pair 8	Gemepnegativesoundfear - Gemepnegativesoundanger	.25000	1.52753	.38188	-.56396	1.06396	.655	15	.523
Pair 9	Gemepnegativesoundfear - Gemepnegativesounddisgust	1.50000	1.09545	.27386	.91628	2.08372	5.477	15	.000
Pair 10	Gemepnegativesoundanger - Gemepnegativesounddisgust	1.25000	1.39044	.34761	.50908	1.99092	3.596	15	.003

a. Agegroup = older

Paired Samples Statistics[a]

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Gemepnegativesoundjoy	.5882	17	.87026	.21107
	Gemepnegativesoundsad	3.2941	17	.91956	.22303
Pair 2	Gemepnegativesoundjoy	.5882	17	.87026	.21107
	Gemepnegativesoundfear	3.1176	17	1.11144	.26956
Pair 3	Gemepnegativesoundjoy	.5882	17	.87026	.21107
	Gemepnegativesoundanger	3.2941	17	.77174	.18718
Pair 4	Gemepnegativesoundjoy	.5882	17	.87026	.21107
	Gemepnegativesounddisgust	1.0588	17	.89935	.21812
Pair 5	Gemepnegativesoundsad	3.2941	17	.91956	.22303
	Gemepnegativesoundfear	3.1176	17	1.11144	.26956
Pair 6	Gemepnegativesoundsad	3.2941	17	.91956	.22303
	Gemepnegativesoundanger	3.2941	17	.77174	.18718
Pair 7	Gemepnegativesoundsad	3.2941	17	.91956	.22303
	Gemepnegativesounddisgust	1.0588	17	.89935	.21812
Pair 8	Gemepnegativesoundfear	3.1176	17	1.11144	.26956
	Gemepnegativesoundanger	3.2941	17	.77174	.18718
Pair 9	Gemepnegativesoundfear	3.1176	17	1.11144	.26956
	Gemepnegativesounddisgust	1.0588	17	.89935	.21812
Pair 10	Gemepnegativesoundanger	3.2941	17	.77174	.18718
	Gemepnegativesounddisgust	1.0588	17	.89935	.21812

a. Agegroup = veryold

Paired Samples Test[a]

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Gemepnegativesoundjoy - Gemepnegativesoundsad	-2.70588	1.21268	.29412	-3.32938	-2.08238	-9.200	16	.000
Pair 2	Gemepnegativesoundjoy - Gemepnegativesoundfear	-2.52941	1.32842	.32219	-3.21242	-1.84640	-7.851	16	.000
Pair 3	Gemepnegativesoundjoy - Gemepnegativesoundanger	-2.70588	1.10480	.26795	-3.27392	-2.13785	-10.098	16	.000
Pair 4	Gemepnegativesoundjoy - Gemepnegativesounddisgust	-.47059	1.28051	.31057	-1.12897	.18779	-1.515	16	.149
Pair 5	Gemepnegativesoundsad - Gemepnegativesoundfear	.17647	1.33395	.32353	-.50938	.86232	.545	16	.593
Pair 6	Gemepnegativesoundsad - Gemepnegativesoundanger	.00000	1.17260	.28440	-.60290	.60290	.000	16	1.000
Pair 7	Gemepnegativesoundsad - Gemepnegativesounddisgust	2.23529	1.14725	.27825	1.64543	2.82515	8.033	16	.000
Pair 8	Gemepnegativesoundfear - Gemepnegativesoundanger	-.17647	1.23669	.29994	-.81232	.45938	-.588	16	.565
Pair 9	Gemepnegativesoundfear - Gemepnegativesounddisgust	2.05882	1.43486	.34800	1.32109	2.79656	5.916	16	.000
Pair 10	Gemepnegativesoundanger - Gemepnegativesounddisgust	2.23529	.97014	.23529	1.73649	2.73410	9.500	16	.000

a. Agegroup = veryold

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
Gemepnegativesoundjoy	younger	38	2.0000	1.18550	.19231
	older	16	.8125	1.10868	.27717
Gemepnegativesoundsad	younger	38	3.3947	.94553	.15339
	older	16	3.3750	.71880	.17970
Gemepnegativesoundfear	younger	38	3.5526	.72400	.11745
	older	16	2.9375	1.12361	.28090
Gemepnegativesoundanger	younger	38	3.3947	.75479	.12244
	older	16	2.6875	1.07819	.26955
Gemepnegativesounddisgust	younger	38	1.8421	1.38576	.22480
	older	16	1.4375	1.15289	.28822

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Gemepnegativesoundjoy	Equal variances assumed	.008	.928	3.424	52	.001	1.18750	.34685	.49149	1.88351
	Equal variances not assumed			3.520	30.092	.001	1.18750	.33735	.49862	1.87638
Gemepnegativesoundsad	Equal variances assumed	1.642	.206	.075	52	.941	.01974	.26408	-.51017	.54964
	Equal variances not assumed			.084	36.883	.934	.01974	.23626	-.45902	.49850
Gemepnegativesoundfear	Equal variances assumed	2.766	.102	2.404	52	.020	.61513	.25587	.10168	1.12858
	Equal variances not assumed			2.020	20.450	.057	.61513	.30447	-.01908	1.24935
Gemepnegativesoundanger	Equal variances assumed	5.851	.019	2.757	52	.008	.70724	.25649	.19256	1.22192
	Equal variances not assumed			2.389	21.459	.026	.70724	.29605	.09236	1.32212
Gemepnegativesounddisgust	Equal variances assumed	1.359	.249	1.026	52	.309	.40461	.39422	-.38646	1.19567
	Equal variances not assumed			1.107	33.739	.276	.40461	.36552	-.33844	1.14765

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
Gemepnegativesoundjoy	younger	38	2.0000	1.18550	.19231
	veryold	17	.5882	.87026	.21107
Gemepnegativesoundsad	younger	38	3.3947	.94553	.15339
	veryold	17	3.2941	.91956	.22303
Gemepnegativesoundfear	younger	38	3.5526	.72400	.11745
	veryold	17	3.1176	1.11144	.26956
Gemepnegativesoundanger	younger	38	3.3947	.75479	.12244
	veryold	17	3.2941	.77174	.18718
Gemepnegativesounddisgust	younger	38	1.8421	1.38576	.22480
	veryold	17	1.0588	.89935	.21812

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Gemepnegativesoundjoy	Equal variances assumed	1.001	.322	4.399	53	.000	1.41176	.32093	.76805	2.05548
	Equal variances not assumed			4.944	41.288	.000	1.41176	.28554	.83522	1.98831
Gemepnegativesoundsad	Equal variances assumed	.115	.736	.368	53	.715	.10062	.27363	-.44821	.64945
	Equal variances not assumed			.372	31.653	.713	.10062	.27068	-.45097	.65221
Gemepnegativesoundfear	Equal variances assumed	6.666	.013	1.734	53	.089	.43498	.25081	-.06808	.93805
	Equal variances not assumed			1.479	22.304	.153	.43498	.29404	-.17433	1.04430
Gemepnegativesoundanger	Equal variances assumed	.060	.807	.454	53	.652	.10062	.22174	-.34414	.54538
	Equal variances not assumed			.450	30.230	.656	.10062	.22367	-.35602	.55726
Gemepnegativesounddisgust	Equal variances assumed	6.185	.016	2.132	53	.038	.78328	.36733	.04652	1.52004
	Equal variances not assumed			2.501	45.730	.016	.78328	.31323	.15268	1.41388

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
Gemepnegativesoundjoy	older	16	.8125	1.10868	.27717
	veryold	17	.5882	.87026	.21107
Gemepnegativesoundsad	older	16	3.3750	.71880	.17970
	veryold	17	3.2941	.91956	.22303
Gemepnegativesoundfear	older	16	2.9375	1.12361	.28090
	veryold	17	3.1176	1.11144	.26956
Gemepnegativesoundanger	older	16	2.6875	1.07819	.26955
	veryold	17	3.2941	.77174	.18718
Gemepnegativesounddisgust	older	16	1.4375	1.15289	.28822
	veryold	17	1.0588	.89935	.21812

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Gemepnegativesoundjoy	Equal variances assumed	1.392	.247	.649	31	.521	.22426	.34581	-.48101	.92954
	Equal variances not assumed			.644	28.467	.525	.22426	.34839	-.48885	.93738
Gemepnegativesoundsad	Equal variances assumed	.692	.412	.280	31	.781	.08088	.28858	-.50769	.66945
	Equal variances not assumed			.282	30.021	.780	.08088	.28641	-.50403	.66580
Gemepnegativesoundfear	Equal variances assumed	.168	.685	-.463	31	.647	-.18015	.38919	-.97390	.61361
	Equal variances not assumed			-.463	30.834	.647	-.18015	.38932	-.97435	.61405
Gemepnegativesoundanger	Equal variances assumed	3.529	.070	-1.867	31	.071	-.60662	.32487	-1.26919	.05596
	Equal variances not assumed			-1.849	27.056	.075	-.60662	.32816	-1.27989	.06665
Gemepnegativesounddisgust	Equal variances assumed	1.381	.249	1.056	31	.299	.37868	.35871	-.35293	1.11028
	Equal variances not assumed			1.048	28.376	.304	.37868	.36146	-.36129	1.11864

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
Gemepnegativesoundtotal	younger	38	14.1842	3.10932	.50440
	veryold	17	11.3529	2.47339	.59988

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Gemepnegativesoundtotal	Equal variances assumed	1.732	.194	3.310	53	.002	2.83127	.85549	1.11537	4.54717
	Equal variances not assumed			3.612	38.335	.001	2.83127	.78376	1.24509	4.41745

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
Gemepnegativesoundtotal	older	16	11.2500	3.04412	.76103
	veryold	17	11.3529	2.47339	.59988

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Gemepnegativesoundtotal	Equal variances assumed	1.336	.257	-.107	31	.916	-.10294	.96285	-2.06668	1.86080
	Equal variances not assumed			-.106	28.952	.916	-.10294	.96903	-2.08498	1.87910

Group Statistics

	Agegroup	N	Mean	Std. Deviation	Std. Error Mean
Gemepnegativesoundtotal	younger	38	14.1842	3.10932	.50440
	older	16	11.2500	3.04412	.76103

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Gemepnegativesoundtotal	Equal variances assumed	.001	.970	3.186	52	.002	2.93421	.92108	1.08594	4.78248
	Equal variances not assumed			3.214	28.818	.003	2.93421	.91301	1.06639	4.80203

Appendix 7.14

Correlations of Measures of Social Functioning, Emotion Intelligence and Emotion Recognition

Correlations

		EIS	Socialactivity	CFQ	Gemeppositiv efandsanger	Gemeppositiv efandsjoy	Gemeppositiv efandsamsus emnt	Gemeppositiv efandspride	Gemeppositiv efandssurpris e	Gemeppositiv efaceandsou ndtotal
EIS	Pearson Correlation	1	.239*	.344**	.195	.171	-.021	.234*	-.071	.146
	Sig. (2-tailed)		.045	.003	.103	.155	.863	.050	.559	.223
	N	71	71	71	71	71	71	71	71	71
Socialactivity	Pearson Correlation	.239*	1	.246*	-.084	.231	.006	.129	.047	.136
	Sig. (2-tailed)	.045		.039	.487	.052	.960	.282	.695	.260
	N	71	71	71	71	71	71	71	71	71
CFQ	Pearson Correlation	.344**	.246*	1	.253*	.170	-.034	.207	.174	.225
	Sig. (2-tailed)	.003	.039		.033	.156	.778	.083	.146	.060
	N	71	71	71	71	71	71	71	71	71
Gemeppositivefandsanger	Pearson Correlation	.195	-.084	.253*	1	.100	-.051	.179	-.081	.209
	Sig. (2-tailed)	.103	.487	.033		.405	.675	.136	.501	.080
	N	71	71	71	71	71	71	71	71	71
Gemeppositivefandsjoy	Pearson Correlation	.171	.231	.170	.100	1	.217	.471**	.122	.662**
	Sig. (2-tailed)	.155	.052	.156	.405		.069	.000	.309	.000
	N	71	71	71	71	71	71	71	71	71
Gemeppositivefandsamsusemnt	Pearson Correlation	-.021	.006	-.034	-.051	.217	1	.346**	.397**	.693**
	Sig. (2-tailed)	.863	.960	.778	.675	.069		.003	.001	.000
	N	71	71	71	71	71	71	71	71	71
Gemeppositivefandspride	Pearson Correlation	.234*	.129	.207	.179	.471**	.346**	1	.184	.759**
	Sig. (2-tailed)	.050	.282	.083	.136	.000	.003		.124	.000
	N	71	71	71	71	71	71	71	71	71
Gemeppositivefandssurprise	Pearson Correlation	-.071	.047	.174	-.081	.122	.397**	.184	1	.586**
	Sig. (2-tailed)	.559	.695	.146	.501	.309	.001	.124		.000
	N	71	71	71	71	71	71	71	71	71
Gemeppositivefaceandsoundtotal	Pearson Correlation	.146	.136	.225	.209	.662**	.693**	.759**	.586**	1
	Sig. (2-tailed)	.223	.260	.060	.080	.000	.000	.000	.000	
	N	71	71	71	71	71	71	71	71	71

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

		EIS	Socialactivity	CFQ	Gemeppositivefandsanger	Gemeppositivefandsjoy	Gemeppositivefandsamsusemnt	Gemeppositivefandspride	Gemeppositivefandssurprise	Gemeppositivefaceandsoundtotal
EIS	Pearson Correlation	1	.239*	.344**	.195	.171	-.021	.234*	-.071	.146
	Sig. (2-tailed)		.045	.003	.103	.155	.863	.050	.559	.223
	N	71	71	71	71	71	71	71	71	71
Socialactivity	Pearson Correlation	.239*	1	.246*	-.084	.231	.006	.129	.047	.136
	Sig. (2-tailed)	.045		.039	.487	.052	.960	.282	.695	.260
	N	71	71	71	71	71	71	71	71	71
CFQ	Pearson Correlation	.344**	.246*	1	.253*	.170	-.034	.207	.174	.225
	Sig. (2-tailed)	.003	.039		.033	.156	.778	.083	.146	.060
	N	71	71	71	71	71	71	71	71	71
Gemeppositivefandsanger	Pearson Correlation	.195	-.084	.253*	1	.100	-.051	.179	-.081	.209
	Sig. (2-tailed)	.103	.487	.033		.405	.675	.136	.501	.080
	N	71	71	71	71	71	71	71	71	71
Gemeppositivefandsjoy	Pearson Correlation	.171	.231	.170	.100	1	.217	.471**	.122	.662**
	Sig. (2-tailed)	.155	.052	.156	.405		.069	.000	.309	.000
	N	71	71	71	71	71	71	71	71	71
Gemeppositivefandsamsusemnt	Pearson Correlation	-.021	.006	-.034	-.051	.217	1	.346**	.397**	.693**
	Sig. (2-tailed)	.863	.960	.778	.675	.069		.003	.001	.000
	N	71	71	71	71	71	71	71	71	71
Gemeppositivefandspride	Pearson Correlation	.234*	.129	.207	.179	.471**	.346**	1	.184	.759**
	Sig. (2-tailed)	.050	.282	.083	.136	.000	.003		.124	.000
	N	71	71	71	71	71	71	71	71	71
Gemeppositivefandssurprise	Pearson Correlation	-.071	.047	.174	-.081	.122	.397**	.184	1	.586**
	Sig. (2-tailed)	.559	.695	.146	.501	.309	.001	.124		.000
	N	71	71	71	71	71	71	71	71	71
Gemeppositivefaceandsoundtotal	Pearson Correlation	.146	.136	.225	.209	.662**	.693**	.759**	.586**	1
	Sig. (2-tailed)	.223	.260	.060	.080	.000	.000	.000	.000	
	N	71	71	71	71	71	71	71	71	71

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

		EIS	Socialactivity	CFQ	Gemeppositivesoundanger	Gemeppositivesoundjoy	Gemeppositivesoundamusement	Gemeppositivesoundpride	Gemeppositivesoundsurprise	Gemeppositivesoundtotal
EIS	Pearson Correlation	1	.239*	.344**	.083	.025	-.011	.038	.049	.067
	Sig. (2-tailed)		.045	.003	.490	.835	.926	.752	.683	.579
	N	71	71	71	71	71	71	71	71	71
Socialactivity	Pearson Correlation	.239*	1	.246*	-.086	-.069	.107	.031	.018	.004
	Sig. (2-tailed)	.045		.039	.476	.569	.376	.797	.882	.975
	N	71	71	71	71	71	71	71	71	71
CFQ	Pearson Correlation	.344**	.246*	1	.039	.182	-.038	.155	.152	.176
	Sig. (2-tailed)	.003	.039		.745	.128	.755	.196	.207	.143
	N	71	71	71	71	71	71	71	71	71
Gemeppositivesoundanger	Pearson Correlation	.083	-.086	.039	1	.100	.107	-.017	.121	.493**
	Sig. (2-tailed)	.490	.476	.745		.409	.374	.890	.316	.000
	N	71	71	71	71	71	71	71	71	71
Gemeppositivesoundjoy	Pearson Correlation	.025	-.069	.182	.100	1	.020	.309**	.039	.538**
	Sig. (2-tailed)	.835	.569	.128	.409		.867	.009	.745	.000
	N	71	71	71	71	71	71	71	71	71
Gemeppositivesoundamusement	Pearson Correlation	-.011	.107	-.038	.107	.020	1	.174	.077	.550**
	Sig. (2-tailed)	.926	.376	.755	.374	.867		.146	.526	.000
	N	71	71	71	71	71	71	71	71	71
Gemeppositivesoundpride	Pearson Correlation	.038	.031	.155	-.017	.309**	.174	1	.160	.578**
	Sig. (2-tailed)	.752	.797	.196	.890	.009	.146		.183	.000
	N	71	71	71	71	71	71	71	71	71
Gemeppositivesoundsurprise	Pearson Correlation	.049	.018	.152	.121	.039	.077	.160	1	.516**
	Sig. (2-tailed)	.683	.882	.207	.316	.745	.526	.183		.000
	N	71	71	71	71	71	71	71	71	71
Gemeppositivesoundtotal	Pearson Correlation	.067	.004	.176	.493**	.538**	.550**	.578**	.516**	1
	Sig. (2-tailed)	.579	.975	.143	.000	.000	.000	.000	.000	
	N	71	71	71	71	71	71	71	71	71

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

		SofP	Positiveaffect	negativeaffect	FluidIntel	CrystalIntel	Gemeppositivefandsanger	Gemeppositivefandsjoy	Gemeppositivefandsamusemnt	Gemeppositivefandspride	Gemeppositivefandssurprise	Gemeppositivefaceandsoundtotal	Gemeppositivefaceanger
SofP	Pearson Correlation	1	-.316**	-.021	.154	-.447**	.102	-.159	-.007	.162	-.042	.005	.106
	Sig. (2-tailed)		.007	.861	.200	.000	.397	.186	.952	.177	.729	.966	.380
	N	71	71	71	71	71	71	71	71	71	71	71	71
Positiveaffect	Pearson Correlation	-.316**	1	.148	-.105	.211	-.048	.051	-.046	.051	.014	.018	-.205
	Sig. (2-tailed)	.007		.218	.382	.077	.693	.672	.702	.675	.906	.880	.086
	N	71	71	71	71	71	71	71	71	71	71	71	71
negativeaffect	Pearson Correlation	-.021	.148	1	-.272*	-.086	-.023	.036	-.152	.148	-.105	-.025	.046
	Sig. (2-tailed)	.861	.218		.022	.476	.852	.765	.207	.219	.381	.837	.701
	N	71	71	71	71	71	71	71	71	71	71	71	71
FluidIntel	Pearson Correlation	.154	-.105	-.272*	1	.189	-.042	-.155	.147	-.007	.047	.005	-.002
	Sig. (2-tailed)	.200	.382	.022		.115	.731	.197	.223	.953	.699	.965	.990
	N	71	71	71	71	71	71	71	71	71	71	71	71
CrystalIntel	Pearson Correlation	-.447**	.211	-.086	.189	1	-.133	.006	.088	-.095	.152	.029	-.170
	Sig. (2-tailed)	.000	.077	.476	.115		.268	.961	.465	.429	.207	.811	.156
	N	71	71	71	71	71	71	71	71	71	71	71	71
Gemeppositivefandsanger	Pearson Correlation	.102	-.048	-.023	-.042	-.133	1	.100	-.051	.179	-.081	.209	.115
	Sig. (2-tailed)	.397	.693	.852	.731	.268		.405	.675	.136	.501	.080	.338
	N	71	71	71	71	71	71	71	71	71	71	71	71
Gemeppositivefandsjoy	Pearson Correlation	-.159	.051	.036	-.155	.006	.100	1	.217	.471**	.122	.662**	-.013
	Sig. (2-tailed)	.186	.672	.765	.197	.961	.405		.069	.000	.309	.000	.914
	N	71	71	71	71	71	71	71	71	71	71	71	71
Gemeppositivefandsamsusemnt	Pearson Correlation	-.007	-.046	-.152	.147	.088	-.051	.217	1	.346**	.397**	.693**	-.151
	Sig. (2-tailed)	.952	.702	.207	.223	.465	.675	.069		.003	.001	.000	.210
	N	71	71	71	71	71	71	71	71	71	71	71	71
Gemeppositivefandspride	Pearson Correlation	.162	.051	.148	-.007	-.095	.179	.471**	.346**	1	.184	.759**	-.035
	Sig. (2-tailed)	.177	.675	.219	.953	.429	.136	.000	.003		.124	.000	.772
	N	71	71	71	71	71	71	71	71	71	71	71	71
Gemeppositivefandssurprise	Pearson Correlation	-.042	.014	-.105	.047	.152	-.081	.122	.397**	.184	1	.586**	-.132
	Sig. (2-tailed)	.729	.906	.381	.699	.207	.501	.309	.001	.124		.000	.273
	N	71	71	71	71	71	71	71	71	71	71	71	71
Gemeppositivefaceandsoundtotal	Pearson Correlation	.005	.018	-.025	.005	.029	.209	.662**	.693**	.759**	.586**	1	-.099
	Sig. (2-tailed)	.966	.880	.837	.965	.811	.080	.000	.000	.000	.000		.409
	N	71	71	71	71	71	71	71	71	71	71	71	71
Gemeppositivefaceanger	Pearson Correlation	.106	-.205	.046	-.002	-.170	.115	-.013	-.151	-.035	-.132	-.099	1
	Sig. (2-tailed)	.380	.086	.701	.990	.156	.338	.914	.210	.772	.273	.409	
	N	71	71	71	71	71	71	71	71	71	71	71	71

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations

		EIS	Socialactivity	CFQ	Gemepnegativefaceandsoundjoy	Gemepnegativefaceandsoundsad	Gemepnegativefaceandsoundfear	Gemepnegativefaceandsoundanger	Gemepnegativefaceandsounddisgust	Gemepnegativefandsoundtotal
EIS	Pearson Correlation	1	.239*	.344**	.006	.026	.185	.167	-.123	.054
	Sig. (2-tailed)		.045	.003	.959	.828	.123	.164	.305	.652
	N	71	71	71	71	71	71	71	71	71
Socialactivity	Pearson Correlation	.239*	1	.246*	-.094	.114	-.079	-.173	-.024	-.070
	Sig. (2-tailed)	.045		.039	.434	.344	.511	.150	.842	.560
	N	71	71	71	71	71	71	71	71	71
CFQ	Pearson Correlation	.344**	.246*	1	.020	.071	.102	.084	-.051	.066
	Sig. (2-tailed)	.003	.039		.867	.554	.397	.486	.670	.587
	N	71	71	71	71	71	71	71	71	71
Gemepnegativefaceandsoundjoy	Pearson Correlation	.006	-.094	.020	1	-.118	-.033	-.124	.060	.198
	Sig. (2-tailed)	.959	.434	.867		.326	.786	.304	.618	.098
	N	71	71	71	71	71	71	71	71	71
Gemepnegativefaceandsoundsad	Pearson Correlation	.026	.114	.071	-.118	1	.366**	.051	-.025	.514**
	Sig. (2-tailed)	.828	.344	.554	.326		.002	.670	.836	.000
	N	71	71	71	71	71	71	71	71	71
Gemepnegativefaceandsoundfear	Pearson Correlation	.185	-.079	.102	-.033	.366**	1	.059	.060	.536**
	Sig. (2-tailed)	.123	.511	.397	.786	.002		.628	.622	.000
	N	71	71	71	71	71	71	71	71	71
Gemepnegativefaceandsoundanger	Pearson Correlation	.167	-.173	.084	-.124	.051	.059	1	.282*	.479**
	Sig. (2-tailed)	.164	.150	.486	.304	.670	.628		.017	.000
	N	71	71	71	71	71	71	71	71	71
Gemepnegativefaceandsounddisgust	Pearson Correlation	-.123	-.024	-.051	.060	-.025	.060	.282*	1	.694**
	Sig. (2-tailed)	.305	.842	.670	.618	.836	.622	.017		.000
	N	71	71	71	71	71	71	71	71	71
Gemepnegativefandsoundtotal	Pearson Correlation	.054	-.070	.066	.198	.514**	.536**	.479**	.694**	1
	Sig. (2-tailed)	.652	.560	.587	.098	.000	.000	.000	.000	
	N	71	71	71	71	71	71	71	71	71

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

		EIS	Socialactivity	CFQ	Gemepnegativefacejoy	Gemepnegativefacesad	Gemepnegativefacefear	Gemepnegativefaceanger	Gemepnegativefacedisgust	Gemepnegativefacetotal
EIS	Pearson Correlation	1	.239*	.344**	-.066	-.096	.329**	.106	.103	.154
	Sig. (2-tailed)		.045	.003	.586	.428	.005	.379	.394	.199
	N	71	71	71	71	71	71	71	71	71
Socialactivity	Pearson Correlation	.239*	1	.246*	-.087	-.003	-.031	.097	.034	.012
	Sig. (2-tailed)	.045		.039	.472	.978	.800	.421	.776	.919
	N	71	71	71	71	71	71	71	71	71
CFQ	Pearson Correlation	.344**	.246*	1	-.079	-.053	.208	-.002	.049	.064
	Sig. (2-tailed)	.003	.039		.511	.660	.081	.989	.685	.593
	N	71	71	71	71	71	71	71	71	71
Gemepnegativefacejoy	Pearson Correlation	-.066	-.087	-.079	1	-.125	.106	-.101	.037	.205
	Sig. (2-tailed)	.586	.472	.511		.298	.378	.401	.761	.086
	N	71	71	71	71	71	71	71	71	71
Gemepnegativefacesad	Pearson Correlation	-.096	-.003	-.053	-.125	1	-.183	-.031	.147	.444**
	Sig. (2-tailed)	.428	.978	.660	.298		.127	.797	.221	.000
	N	71	71	71	71	71	71	71	71	71
Gemepnegativefacefear	Pearson Correlation	.329**	-.031	.208	.106	-.183	1	.150	.241*	.503**
	Sig. (2-tailed)	.005	.800	.081	.378	.127		.210	.043	.000
	N	71	71	71	71	71	71	71	71	71
Gemepnegativefaceanger	Pearson Correlation	.106	.097	-.002	-.101	-.031	.150	1	.223	.422**
	Sig. (2-tailed)	.379	.421	.989	.401	.797	.210		.062	.000
	N	71	71	71	71	71	71	71	71	71
Gemepnegativefacedisgust	Pearson Correlation	.103	.034	.049	.037	.147	.241*	.223	1	.783**
	Sig. (2-tailed)	.394	.776	.685	.761	.221	.043	.062		.000
	N	71	71	71	71	71	71	71	71	71
Gemepnegativefacetotal	Pearson Correlation	.154	.012	.064	.205	.444**	.503**	.422**	.783**	1
	Sig. (2-tailed)	.199	.919	.593	.086	.000	.000	.000	.000	
	N	71	71	71	71	71	71	71	71	71

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

		EIS	Socialactivity	CFQ	Gemepnegativesoundjoy	Gemepnegativesoundsad	Gemepnegativesoundfear	Gemepnegativesoundanger	Gemepnegativesounddisgust	Gemepnegativesoundtotal
EIS	Pearson Correlation	1	.239*	.344**	.157	-.051	.194	.036	.029	.125
	Sig. (2-tailed)		.045	.003	.192	.670	.105	.763	.808	.299
	N	71	71	71	71	71	71	71	71	71
Socialactivity	Pearson Correlation	.239*	1	.246*	-.153	-.249*	-.012	.064	.056	-.092
	Sig. (2-tailed)	.045		.039	.204	.036	.921	.594	.645	.447
	N	71	71	71	71	71	71	71	71	71
CFQ	Pearson Correlation	.344**	.246*	1	.182	-.017	.162	-.027	.060	.129
	Sig. (2-tailed)	.003	.039		.130	.885	.177	.820	.617	.282
	N	71	71	71	71	71	71	71	71	71
Gemepnegativesoundjoy	Pearson Correlation	.157	-.153	.182	1	.035	.406**	.168	.314**	.685**
	Sig. (2-tailed)	.192	.204	.130		.772	.000	.162	.008	.000
	N	71	71	71	71	71	71	71	71	71
Gemepnegativesoundsad	Pearson Correlation	-.051	-.249*	-.017	.035	1	.204	.009	.120	.393**
	Sig. (2-tailed)	.670	.036	.885	.772		.089	.938	.319	.001
	N	71	71	71	71	71	71	71	71	71
Gemepnegativesoundfear	Pearson Correlation	.194	-.012	.162	.406**	.204	1	.280*	.293*	.695**
	Sig. (2-tailed)	.105	.921	.177	.000	.089		.018	.013	.000
	N	71	71	71	71	71	71	71	71	71
Gemepnegativesoundanger	Pearson Correlation	.036	.064	-.027	.168	.009	.280*	1	.317**	.542**
	Sig. (2-tailed)	.763	.594	.820	.162	.938	.018		.007	.000
	N	71	71	71	71	71	71	71	71	71
Gemepnegativesounddisgust	Pearson Correlation	.029	.056	.060	.314**	.120	.293*	.317**	1	.714**
	Sig. (2-tailed)	.808	.645	.617	.008	.319	.013	.007		.000
	N	71	71	71	71	71	71	71	71	71
Gemepnegativesoundtotal	Pearson Correlation	.125	-.092	.129	.685**	.393**	.695**	.542**	.714**	1
	Sig. (2-tailed)	.299	.447	.282	.000	.001	.000	.000	.000	
	N	71	71	71	71	71	71	71	71	71

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

		EIS	Socialactivity	CFQ	Pellfaceandsoundhappy	Pellfaceandsoundsad	Pellfaceandsoundsuprise	Pellfaceandsoundanger	Pellfaceandsounddisgust	Pellfaceandsoundtotal
EIS	Pearson Correlation	1	.239*	.344**	.094	.040	.022	.118	.140	.174
	Sig. (2-tailed)		.045	.003	.434	.743	.857	.328	.243	.147
	N	71	71	71	71	71	71	71	71	71
Socialactivity	Pearson Correlation	.239*	1	.246*	-.251*	-.179	-.015	.254*	-.091	-.159
	Sig. (2-tailed)	.045		.039	.035	.134	.902	.032	.448	.185
	N	71	71	71	71	71	71	71	71	71
CFQ	Pearson Correlation	.344**	.246*	1	.084	.131	.296*	.109	.008	.268*
	Sig. (2-tailed)	.003	.039		.486	.275	.012	.364	.948	.024
	N	71	71	71	71	71	71	71	71	71
Pellfaceandsoundhappy	Pearson Correlation	.094	-.251*	.084	1	.072	.017	-.238*	.139	.498**
	Sig. (2-tailed)	.434	.035	.486		.553	.889	.045	.247	.000
	N	71	71	71	71	71	71	71	71	71
Pellfaceandsoundsad	Pearson Correlation	.040	-.179	.131	.072	1	.084	.078	-.004	.466**
	Sig. (2-tailed)	.743	.134	.275	.553		.484	.519	.972	.000
	N	71	71	71	71	71	71	71	71	71
Pellfaceandsoundsuprise	Pearson Correlation	.022	-.015	.296*	.017	.084	1	-.135	.099	.531**
	Sig. (2-tailed)	.857	.902	.012	.889	.484		.263	.411	.000
	N	71	71	71	71	71	71	71	71	71
Pellfaceandsoundanger	Pearson Correlation	.118	.254*	.109	-.238*	.078	-.135	1	-.022	.143
	Sig. (2-tailed)	.328	.032	.364	.045	.519	.263		.853	.234
	N	71	71	71	71	71	71	71	71	71
Pellfaceandsounddisgust	Pearson Correlation	.140	-.091	.008	.139	-.004	.099	-.022	1	.598**
	Sig. (2-tailed)	.243	.448	.948	.247	.972	.411	.853		.000
	N	71	71	71	71	71	71	71	71	71
Pellfaceandsoundtotal	Pearson Correlation	.174	-.159	.268*	.498**	.466**	.531**	.143	.598**	1
	Sig. (2-tailed)	.147	.185	.024	.000	.000	.000	.234	.000	
	N	71	71	71	71	71	71	71	71	71

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

		EIS	Socialactivity	CFQ	Pellfacehappy	Pellfacesad	Pellfacesurprise	Pellfaceanger	Pellfacedisgust	Pellfacetotal
EIS	Pearson Correlation	1	.239*	.344**	-.020	.070	.111	.097	.299*	.264*
	Sig. (2-tailed)		.045	.003	.868	.562	.356	.421	.011	.026
	N	71	71	71	71	71	71	71	71	71
Socialactivity	Pearson Correlation	.239*	1	.246*	-.167	.064	.234*	.143	-.240*	-.016
	Sig. (2-tailed)	.045		.039	.165	.593	.049	.234	.044	.895
	N	71	71	71	71	71	71	71	71	71
CFQ	Pearson Correlation	.344**	.246*	1	.145	.056	.132	-.080	.058	.144
	Sig. (2-tailed)	.003	.039		.229	.646	.273	.506	.633	.232
	N	71	71	71	71	71	71	71	71	71
Pellfacehappy	Pearson Correlation	-.020	-.167	.145	1	-.146	.180	-.221	-.062	.307**
	Sig. (2-tailed)	.868	.165	.229		.225	.132	.064	.610	.009
	N	71	71	71	71	71	71	71	71	71
Pellfacesad	Pearson Correlation	.070	.064	.056	-.146	1	.135	.074	.155	.519**
	Sig. (2-tailed)	.562	.593	.646	.225		.261	.542	.197	.000
	N	71	71	71	71	71	71	71	71	71
Pellfacesurprise	Pearson Correlation	.111	.234*	.132	.180	.135	1	.070	.050	.628**
	Sig. (2-tailed)	.356	.049	.273	.132	.261		.560	.681	.000
	N	71	71	71	71	71	71	71	71	71
Pellfaceanger	Pearson Correlation	.097	.143	-.080	-.221	.074	.070	1	-.107	.242*
	Sig. (2-tailed)	.421	.234	.506	.064	.542	.560		.373	.042
	N	71	71	71	71	71	71	71	71	71
Pellfacedisgust	Pearson Correlation	.299*	-.240*	.058	-.062	.155	.050	-.107	1	.567**
	Sig. (2-tailed)	.011	.044	.633	.610	.197	.681	.373		.000
	N	71	71	71	71	71	71	71	71	71
Pellfacetotal	Pearson Correlation	.264*	-.016	.144	.307**	.519**	.628**	.242*	.567**	1
	Sig. (2-tailed)	.026	.895	.232	.009	.000	.000	.042	.000	
	N	71	71	71	71	71	71	71	71	71

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Correlations

		EIS	Socialactivity	CFQ	Pellsoundhappy	Pellsoundsad	Pellsoundsurprise	Pellsoundanger	Pellsounddisgust	Pellsoundtotal
EIS	Pearson Correlation	1	.239*	.344**	.176	.247*	-.113	-.104	.009	.090
	Sig. (2-tailed)		.045	.003	.143	.038	.349	.388	.941	.455
	N	71	71	71	71	71	71	71	71	71
Socialactivity	Pearson Correlation	.239*	1	.246*	-.015	.070	.288*	-.103	-.175	.079
	Sig. (2-tailed)	.045		.039	.903	.564	.015	.393	.145	.511
	N	71	71	71	71	71	71	71	71	71
CFQ	Pearson Correlation	.344**	.246*	1	.035	.148	.197	-.009	.104	.244*
	Sig. (2-tailed)	.003	.039		.775	.216	.099	.940	.388	.040
	N	71	71	71	71	71	71	71	71	71
Pellsoundhappy	Pearson Correlation	.176	-.015	.035	1	.027	-.175	-.041	.015	.388**
	Sig. (2-tailed)	.143	.903	.775		.822	.145	.735	.900	.001
	N	71	71	71	71	71	71	71	71	71
Pellsoundsad	Pearson Correlation	.247*	.070	.148	.027	1	-.060	-.019	.023	.397**
	Sig. (2-tailed)	.038	.564	.216	.822		.618	.874	.850	.001
	N	71	71	71	71	71	71	71	71	71
Pellsoundsurprise	Pearson Correlation	-.113	.288*	.197	-.175	-.060	1	.074	.037	.536**
	Sig. (2-tailed)	.349	.015	.099	.145	.618		.539	.762	.000
	N	71	71	71	71	71	71	71	71	71
Pellsoundanger	Pearson Correlation	-.104	-.103	-.009	-.041	-.019	.074	1	-.110	.296*
	Sig. (2-tailed)	.388	.393	.940	.735	.874	.539		.360	.012
	N	71	71	71	71	71	71	71	71	71
Pellsounddisgust	Pearson Correlation	.009	-.175	.104	.015	.023	.037	-.110	1	.474**
	Sig. (2-tailed)	.941	.145	.388	.900	.850	.762	.360		.000
	N	71	71	71	71	71	71	71	71	71
Pellsoundtotal	Pearson Correlation	.090	.079	.244*	.388**	.397**	.536**	.296*	.474**	1
	Sig. (2-tailed)	.455	.511	.040	.001	.001	.000	.012	.000	
	N	71	71	71	71	71	71	71	71	71

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Appendix 8

Agreements for Use of Datasets

Max-Planck-Institut für Bildungsforschung Max Planck Institute for Human Development

FACES Database Release Agreement (in parts)

Center for Lifespan Psychology

The undersigning researcher agrees to the following restrictions on the FACES database:

1. TheFACESdatabasemustonlybeusedforresearchpurposes.

2. TheFACESdatabasemustonlybeusedforthespecificstudyoutlinedinthisrelease form and only by the researcher signing this release form. If the study is a collaborative project, all researchers involved need to submit a Release Agreement. Conducting multiple

studies using the FACES database requires the submission of multiple release forms, one for each study.

3. AllrequestsforaccesstotheFACESdatabasemustbeforwardedtotheFACES Technical Agent.

4. TheFACESdatabasemustnotbedistributed,published,copied,orfurther disseminated in any way or form whatsoever, whether for profit or not. This also includes further distributing, copying or disseminating to a facility or organization unit within the requesting university, organization, or company.

5. PhotographsoftheFACESdatabasemustonlybeusedintheformtheyaredelivered. As a rule, the images must not be modified or processed in any way. Exceptions may be possible in certain cases, but require prior agreement by the FACES Technical Agent and adherence to additional conditions. Please contact the FACES Technical Agent If you wish to modify the FACES for your study.

6. PhotographsoftheFACESdatabaseareneitherpermittedforpublicationinanytype of report, paper, and other document nor permitted for display in any type of presentation or exhibition.

7. ExemptfromRule6arethepicturesofthefollowingpersons: 004,066,079,116,140, and 168. Research-related publication and display of these photographs are permitted for the purpose of illustrating research methodology. These photographs must not be published or displayed for any other purpose. All other rules fully apply to this subset of pictures as well.

8. AlldocumentsandpapersthatreportonresearchthatusestheFACESdatabaseare requested to acknowledge the use of the FACES database by citing the reference below. The FACES Technical Agent will communicate

updates to this reference. □ Ebner, N. C., Riediger, M., & Lindenberger, U. (2010). FACES—A database of facial expressions in young, middle-aged, and older women and men: Development and validation. Behavior Research Methods, 42, 351-362. doi:10.3758/BRM.42.1.351

9. AcopyofallreportsandpapersthatusetheFACESdatabas eandthatareforpublic or general release must be forwarded to the FACES Technical Agent after release or publication for documentation.

MOUNT SINAI HOSPITAL
Joseph and Wolf Lebovic Health Complex

August 19, 2013

Nicola Dimelow
PhD student and demonstrator
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Dear Ms. Nicola Dimelow:

This letter is to confirm that you have paid the copyright fee and have my permission to use t
Twenty-item Toronto Alexithymia Scale (TAS-20) in a research study.

Sincerely,

Graeme J. Taylor, M.D., FRCPC
Professor of Psychiatry
University of Toronto

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