An Exploration of the Relationships Between Personality, Eating Behaviour and Taste Preference

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Candidate's Statement

This is to certify that the research presented in this thesis is solely my own work.

Signed: ______________________________ Catherine Day

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Abstract

Taste is a fundamental determinant of food acceptance; it is the primary reinforcer in the complex process of food choice. The examination of individual difference factors in other complex behaviours have increased our understanding of other psychological processes and behaviours, despite this, these remain largely overlooked in the appetite and eating behaviour literature. This research explored individual differences in taste preference in non-clinical populations. The principle aim was to examine personality factors that predict taste preference for a number of taste dimensions, using a biological model of personality (Cloninger, 1987). In addition, the research examined the relationship between taste preference and cognitive characteristics of eating behaviour (using the Three Factor Eating Questionnaire; TFEQ), and also body mass (BMI). In study 1 the relationships between personality and self-rated usual taste preference were explored for tastes dimensions sweet, salty, umami, bitter, sour and spicy. The results indicated that small amounts of variance in taste preference could be explained by personality. Study 2, an exploratory study, sought to further examine relationships between personality and taste preference using real-food samples. This study also examined relationships between personality and characteristics of eating behaviour (TFEQ). Consistent relationships with study 1 were revealed, particularly related to sweet and sour tastes. Preference for the taste of high-calorie dense foods was examined in the final studies. Study 3 examined individual differences in preference for lemon-flavoured drinks with increasing intensities of glucose. Sweet tooth, usual sweet and sour and measures of eating behaviour were also explored. Associations between sweet tooth and personality factors, and also preferred drink choice and personality were related to the inhibition and maintenance system. The final study produced UK normative data for the Fat Preference Questionnaire© for both males and females. Furthermore this final study explored individual differences in fat preference. Preference for high fats was found to be associated with scores of Restraint and BMI, rather then personality. Overall, the conclusion drawn is that taste preference and characteristics of eating behaviour are associated with personality factors. Approach and avoidance behaviours characterised by constructs of Harm Avoidance and Reward Dependence are implicated in the process of explicit liking in terms of taste, rather than reward processes characterised by Novelty Seeking behaviour. Although the amount of variance may be small, personality factors are involved in the complex process of food choice, and therefore, future research examining food choice and eating behaviour should pay attention to these important individual differences.

List of Abstracts and Presentations

Abstracts

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Abbreviations

5-HT	Serotonin
BAS	Behavioural Activation System
BIS	Behavioural Inhibition System
BMI	Body Mass Index
BPS	British Psychological Society
BS	Boredom Susceptibility (subscale from the SSS)
CD36	Cluster of Differentiation 36 (taste receptor sensitive to fatty acids)
CHO	Carbohydrate
DA	Dopamine
DEBQ	Dutch Eating Behaviour Questionnaire
DIFF	dietary restraint for (high) dietary fats (subscale of the FPQ)
Dis	Disinhibition (subscale from the SSS)
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders, 4^{th} Edition
EPQ	Eysenck Personality Questionnaire
EPQ-R-S	Eysenck Personality Questionnaire-Revised Short Form
ES	Experience Seeking
FFM	Five Factor Model
FPQ©	Fat Preference Questionnaire
FPQ	Food Preference Questionnaire
FREQ	frequency of consumption of (high) dietary fats (subscale of the FPQ)
HA	Harm Avoidance (subscale of TPQ)
IC	The Information Centre, National Health Service
MAO	Monoamine oxidase
MSG	Monosodium glutamate
MSSP	Macronutrient Self-Selection Paradigm
NA	Noradrenalin
NEO-FFI	Neuroticism-Extroversion-Openness Five Factor Inventory
NS	Novelty Seeking (subscale of TPQ)
ONS	The Office of National Statistics
PER	Persistence (subscale of TPQ)
PROP	6-n-propylthiouracil
PTC	Phenylthiocarbamide
RD	Reward Dependence (subscale of TPQ)
RS	Restraint Scale

RST	Reward Sensitivity Theory
SS	Sensation Seeking
SSS	Sensation Seeking Scale
STR	Sensitivity to Reward
TAS	Thrill and Adventure Seeking
TASTE	taste preference for (high) dietary fats (subscale of FPQ)
TCI	Temperament and Character Inventory
TFEQ	Three Factor Eating Questionnaire
TPQ	Tridimensional Personality Questionnaire
UK	United Kingdom
US	United States
VAS	Visual analogue scale
ZKPQ	The Alternative Five

Chapter 1

General Introduction

1.1 Background to Research Programme

In recent years there has been considerable interest in food choice and eating behaviour. It is likely that this increased attention stems from the rise observed in health-problems associated with poor diet and over consumption. Rapid increases in health problems such as obesity, type II diabetes and coronary heart disease have been reported in developed countries, particularly the UK and the US. In 2006, 24% of UK adults were classified as obese; representing a 9% increase from 1993 (The Information Centre, IC; 2008). As a consequence food choice, eating behaviour and tackling the "obesity epidemic" are currently high on the British Government's agenda, with a number of plans and targets set which aim to combat and reduce the prevalence of obesity and improve poor diet (IC, 2008).

Despite considerable attempts to develop a comprehensive understanding of the process of food choice, this remains an area that is not fully understood (Furst, Connors, Bisogni, Sobal & Winter Falk, 1996). If individual eating behaviour is to be changed, further understanding of all the factors involved and how they interrelate is critical. This is particularly important if the prevalence of obesity and other health-related diet problems in developed countries are to be challenged.

The sensory properties of food (e.g. taste, appearance, texture) are thought to be primary reinforcers in the complex process of food choice; if the sensory properties are not perceived to be good the food will not be chosen (Aaron, Evans & Mela, 1995; Crystal & Teff, 2006). Foods perceived as highly palatable are often energy dense and easily over-consumed which can ultimately result in weight gain and obesity (Heatherington & Rolls, 2008). The physiological processes and transduction of taste are well researched and well established (see Gilbertson, Damak & Margolskee, 2000). Genetic individual variability in taste is also well observed (Kim, Breslin, Reed & Drayna, 2004). Psychological variables may also influence these individual differences observed in taste and liking, yet have not received much research interest.

The impact of individual differences on a number of psychological constructs has lead to fuller understandings of a number of behaviours. For example, individual differences have been found to effect attachment and personal relationships, implicit attitudes, job stress and health, to name a few (Kirkpatrick & Hazan, 1994; Greenwald, McGhee & Schwartz, 1998; Cooper, Kirkcaldy & Brown, 1994). Many of the influences that impact upon food choice have received, and continue to receive, a great deal of attention in the appetite literature. Despite this, research on individual differences related to food choice and preferences have been largely overlooked. This is particularly true in terms of personality. Given that the examination of individual differences has been applied to further understandings of other psychological concepts, taking an individual differences approach in the study of eating behaviour could produce useful insights into differences in food choice and selection.

Individual differences have been investigated in terms of general eating behaviour but have been restricted to disordered eating, dieting and restrained eating, neglecting normal populations. In order to combat diet-related health problems it is important that general populations, in addition to clinical populations, are examined. Many of the social and biological factors are well researched but it is clear that a "one-size-fits-all" model cannot adequately explain who is most susceptible to make particular food choices, or develop particular preferences. Furthermore, few studies take a biogenetic perspective which is unexpected given the evidence gathered from animal studies and other physiological literature which suggest that food consumption is heavily reliant on reward and incentive processing (Berridge, 1996; Rolls, 2000). The selection and consumption of food is complex; it is not merely about survival and striving for nutritional need (Berridge, 1996). If this was the case then health-related diet problems would be less prevalent particularly in developed countries.

The broad aim of the research programme was to investigate relationships between temperamental personality traits, and taste as the basis of food choice. Relationships between temperament and characteristics of eating were also explored. Due to the limited existing literature this research programme takes an exploratory approach.

The purpose of this chapter is to provide a general background to the existing literature directly relevant to the thesis. Firstly, food choice and models of food choice will be reviewed. The next section will focus of on the physiology of eating, introducing taste as a reinforcing mechanism for food selection. This will be followed by a review of the evidence indicative of individual differences in eating behaviour more generally. Following this, biological models of personality will be introduced. These are most relevant to the thesis and will be reviewed at this stage to provide a fuller understanding of the proceeding sections which will examine the existing, although limited, literature which examines relationships between taste and personality. The chapter will conclude with the overall aims of the thesis.

1.2 Food Choice and Preference

It is widely accepted that hunger and satiety are the key drivers in the regulation of eating. However with rapid increases in health problems associated with diet, particularly childhood and adult obesity, it is clear that food selection and consumption is not determined by nutritional needs alone; there are many influencing factors involved in the food choice process (Shepherd, 1989). These include food-related factors such as the nutritional content, sensory properties and physiological effects of the food, as well as economic, social, cognitive and environmental factors related to the individual. A number of different disciplines have focussed their attentions on the determinants of food choice (Rozin, 2006). Biological approaches to food choice focus on the physiological mechanisms involved in the brain and the body during the selection and consumption of food, biological predispositions and learning mechanisms. Psychological approaches have examined the cultural and social influences, as well as the acquisition of preferences (for example, Zajonc's (1968) theory of mere exposure), attitudes and changing dietary behaviour. Sociological approaches examine the demographic influences of food choice, the social organisation of the food industry and trends or "fashions" in food choice (for example, the growing popularity of organic foods and avoidance of genetically-modified foods). Cultural influences are also highly important in the examination of food choice; cultural and religious traditions vary across the world heavily impacting upon food and cuisine.

These different approaches offer important and valid explanations of the influences of human food choice. However there is a tendency for overlap between these explanations. In light of this other researchers sought to provide a broader explanation of the importance of these influences by developing more general models of food choice that seek to conceptually examine the determinants involved in the selection of foods and beverages.

1.2.1 Modelling Food Choice

Understanding the processes and factors involved in food choice has always been of the utmost importance to the food industry and various conceptual models of food choice and intake have been introduced. In the last twenty years or so the examination of the factors involved in the selection and consumption of foods and beverages has become vital in the understanding of more general eating behaviour and the promotion of healthy eating. Examination of food choice appear to fall into three general categories; those deductively developed (e.g. Shepherd & Sparks 1994; Lucas, 1984; Nestle et al., 1998); those relating to existing frameworks developed to explain other behaviours such as the theory of planned behaviour, the health belief model and the hedonic consumer model (e.g. Baranowski, Cullen & Baranowski, 1999; Connor & Armitage, 2002); and finally models of food choice which have been developed using qualitative techniques which aim to conceptualise how individuals think about and connect with the selection and consumption of food (e.g. Furst et al., 1996; Eertmans, Baeyens & Van den Bergh 2001).

Shepherd (1989) reviewed models of food choice and concluded that broadly speaking models of food choice are fairly similar, concentrating broadly on "the food", "the environment" and "the individual". The food category encompasses nutritional content, quality and quantity, and also the sensory characteristics. Liking (the affective response to the sensory properties of food) is often cited as the best predictor of food choice and therefore food intake (Clark, 1988). If foods are not positively evaluated, particularly in terms of the sensory properties (i.e. taste, smell, texture, and appearance) the food will not be accepted and therefore unlikely to be eaten and chosen again (Hetherington & Rolls 1996). Appetite, hunger and satiety are also included in this category; although these are thought to overlap with the "person" category as well (these physiological states are briefly introduced in section 1.3). Equally important are the environmental factors; food choice is heavily influenced by the social and cultural practices and influences on food consumption. Family, socioeconomic background and upbringing play a crucial part in individual food choice and consumption, as do political agendas which also shape attitudes towards food choice. For example, the recent 5-a-day campaign developed to improve intake of fruit and vegetables. The media further influences our food consumption, recently the change in opinion regarding the consumption of eggs has received much press coverage (BBC, 2009).

The food and environmental factors all influence *"the person";* food choice is influenced by the characteristics of the individual (i.e. age, sex, education, income, nutritional knowledge, cooking ability, attitudes to health). Personality variables are often overlooked in these models despite evidence to suggest that personality variables are linked to a number of eating behaviours (see section 1.3.4 for further discussion).

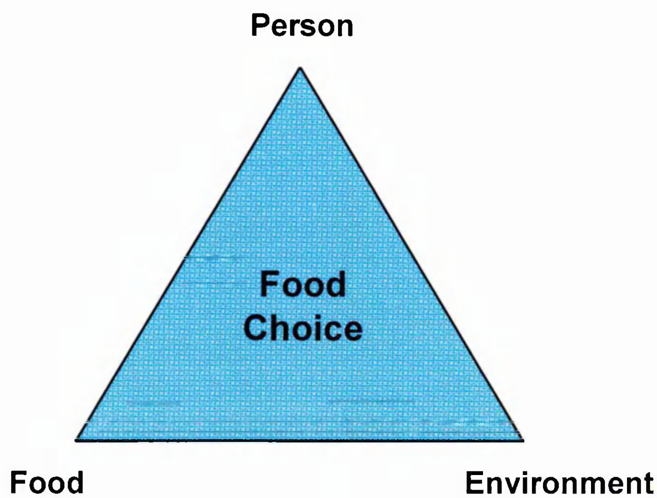

Figure 1.1: Simplified model of food choice

Each model may provide a different focus but these major themes are common to all (see figure 1.1). These models aim to categorise the likely influences of food choice and do not attempt to explain the mechanisms behind these processes or offer a framework for research and application (Shepherd & Sparks, 1994). Despite this they are useful as they provide a conceptualisation of the variety of variables involved in the process of food choice and a basis for research interest in this area. The number of variables observed in these models and involved in the food choice process highlights the complex nature of this behaviour. Due to this previous research interest has focused on isolated aspects of food choice aiming to build upon existing models of food choice. Ideally a multi-disciplinary approach would be the most appropriate method to examine the factors involved in food choice and how they interact but there is a lack of research combining different approaches to the study of food choice at present and an interdisciplinary approach is warranted, but this is extremely costly (Köster, 2009).

1.3 Physiology of Eating

1.3.1 Mechanisms of Eating

In this subsection a brief overview is provided outlining the key features and mechanisms involved in the regulation and control of eating in order to provide grounding for eating behaviour in general. The hypothalamus is often referred to as the brain's feeding centre; early studies found that damage or stimulation of this area resulted in overeating and weight gain or a failure to eat (see Rolls & Rolls, 1982). Imaging studies have shown that feeding behaviour results in a complex interplay between the cortex, the hypothalamus, the thalamus and the limbic system (Epstein, Leddy, Temple & Faith, 2007).

Despite variations in definitions of hunger it is commonly agreed to be “a sensation that promotes food seeking and ingestive behaviours” (McKiernan, Houchins & Mattes, 2008, pp. 700). A primary function of this mechanism is to ensure that energy levels are restored, although with increasing obesity rates it is clear that this is not always the case. Food deprivation motivates animals to seek out food. Taste and other orosensory components do this as well; the palatability of food is a strong motivator to continue to eat (taste is presented in more detail in section 1.3.3). Taste and other orosensory aspects of food such as texture and smell are also important in satiety, although these aspects are not thought to be exclusively motivating. Studies employing sham-feeding techniques, where everything eaten by-passes the stomach and intestines via an esophegeal fistula or other devices, suggest that the orosensory factors are not the only mechanisms involved (Young, Gibbs, Antin, Holt, & Smith, 1974). Studies using sham-feeding clearly demonstrate that satiety mechanisms are dependent on a reflex produced by ingested food in the stomach and intestines. The stomach conveys satiety messages to the brain's feeding centre via the vagus nerve (Deutsch, Young & Kalogeris, 1978).

If feeding was controlled by homeostatic mechanisms alone then individuals would not exceed their ideal body weight. Relationships between human hunger and feeding suggest that there are marked individual variations in self-reported hunger and food intake indicating that some individuals may be more prone to overeating than others (McKiernan et al., 2008).

1.3.1.1 Hedonic Hunger

Despite evolutionary and biological accounts of hunger as a mechanism for restoring energy after deprivation, human food consumption, particularly in wealthy, developed countries such as the UK and the US (where calorie-dense inexpensive foods are easily accessible) must, to some extent, be driven by pleasure and not caloric need alone (Lowe & Butryn, 2007). Sensations of hunger and the orosensory qualities of food are strong motivators (Levitsky, 2005; Lowe & Butryn, 2007). Highly palatable foods tend to be overeaten possibly because they are intrinsically rewarding, supporting the concept of hedonic hunger (Saper, Chou & Elmquist, 2002). Exposure to palatable foods can induce hunger but also satisfy hunger to a greater extent than less palatable foods; after the consumption of foods perceived as palatable, sensations of hunger appear to recover more quickly than after consumption of less palatable foods and self-rated appetite increases even after seeing palatable foods (Yeomans, Blundell & Lesham, 2004).

It has been reported that short-term caloric deprivation is related to increased taste sensitivity particularly to sweet and salty solutions but not bitter (Zverev, 2004). Although this has not been supported elsewhere (Pasquet, Monneuse, Simmen, Marez, & Hladik, 2006); taste thresholds in fasting students (hunger state) and after eating (full-satiated) were not significantly different. The palatability or liking of food, therefore, seems to be a strong indicator of food selection, desire to eat and overeat, and also sensations of hunger.

1.3.2 Food Reinforcement and Pleasure

"Eating is an action open to awareness by the individual" (Finlayson, King & Blundell, 2007, p987). In this way the behavioural action of eating can be seen as explicit but the processes controlling appetite, craving and the motivation to eat are not necessarily explicit (Finlayson et al., 2007). The goal of much animal behaviour is to gain biologically driven rewards such as sex, food or drink. A large and growing body of research implicates the involvement of specific brain regions in the process of reinforcing behaviour, particularly dopaminergic systems, the striatum, the orbitofrontal cortex and the amygdala (Everitt et al., 1999; Rolls, 2000; Schultz, Tremblay, & Hollerman, 2000).

Mechanisms of motivation and reward have received much research attention in relation to drug addiction (Wise, 1996; see Saper et al., 2002). Food reward and drug reward have been shown to have similar neural substrates, for example, opioid receptors which have been shown to be involved in both behaviours (Kelley et al., 2002). Food is one of the most important primary reinforcers and one the most powerful reinforcers (Epstein et al., 2007). Dopamine mediates the reward value of a stimulus (Wise, 1985). Berridge (1996) argues that the dopamine system is more likely to be involved in incentive motivation and perhaps plays a role in the anticipation of receiving a reward that the respondent is seeking. In this way Berridge and colleagues (1996, 1998) explain food reward in terms of separate psychological components, “wanting” and “liking”. Wanting corresponds to appetite and craving, whereas liking closely corresponds to the concept of palatability (taste preference) or sensory pleasure. Considering these definitions, the concept of liking is most relevant to this research programme, although explicit liking is more directly appropriate as this refers to the subjective feelings of orosensory pleasure (Finlayson et al., 2007).

Wanting and liking processes are mediated by different and separable neural substrates. Originally mesolimbic dopamine systems were thought to be largely involved with food reward particularly in terms of liking as Wise suggested (1985). Despite this, more recent findings from rat and mice studies have revealed that it is more likely the case that dopamine systems are necessary for “wanting” incentives but not for “liking” or for learning new “likes” and “dislikes” (Robinson, Sandstorm, Denenberg & Palmiter, 2005). In other words dopamine systems are not necessarily needed to mediate the hedonic pleasure of food reinforcers (Berridge & Robinson 1998). A great deal of research has been conducted in terms of “wanting” or hunger and satiety but it remains debatable as to the involvement of dopamine in reward mechanisms involved in "liking”.

Lesions to the orbitofrontal cortex and amygdala have been shown to result in altered food preferences in primates (Baylis & Gaffan, 1991), suggesting involvement in the food choice process. The amygdala is also implicated in taste reward; amygdala neurons respond to biological rewards such as taste or the sight of food (Scott et al., 1993). Neural responses also occur in anticipation of primary taste rewards as well as receipt of a food reward (O'Doherty, Deichmann, Critchley & Dolan, 2002).

As taste is a primary reinforcer of food intake perhaps the physiological process of pleasure is implicated. A recent study observed increased activation in the dopaminergic midbrain, posterior dorsal amygdala, striatum and orbitiofrontal cortex in response to a pleasant taste (O'Doherty et al., 2002). With the exception of the orbitofrontal cortex these regions were not activated by receipt of the reward but by the expectation of receiving the reward, confirming Berridge's assumption that the processes of wanting and liking are separate.

1.3.2.1 Dopamine and Food Reinforcement

Dopamine is believed to be a primary neurotransmitter in food reinforcement (Wise, 2006). Eating behaviour results in the release of brain dopamine and the possibility of a relationship between dopamine to the appetitive aspects of seeking out foods has been suggested (Berridge, 1996). This has been confirmed by positron emission tomography (PET) studies which have shown that brain dopamine release increases during ingestion and even in anticipation of food ingestion (Small, Jones-Gotman & Dagher, 2003). This adds strength to the existing evidence which implicates dopaminergic activity in food-seeking behaviour and food craving (Kiyatkin & Gratton, 1994; Berridge 1996). The transmission of dopamine has been shown to increase in response to novel stimuli (Salamone, Correa, Mingote & Weber, 2005). Motivation to seek out and consume new foods may be associated with increase dopamine activity which could help explain negative correlations between scores of food neophobia with novelty seeking and sensation seeking scores (Pliner & Hobden, 1992) on personality inventories.

1.3.2.2 Serotonin and Noradrenalin

Serotonin (5-HT) and Noradrenalin (NA) are also implicated in eating behaviour and the control of feeding behaviour (see Table 1.1 for some examples). A number of studies where serotonergic drugs have been injected peripherally and centrally show that this monoamine suppresses appetite, the desire to eat and also results in slower eating (Simansky, 1996; Saper, Chou & Elmquist, 2002). Enhancing post-synaptic serotonin activity also leads to a reduction in the amount of food eaten during a meal (Simansky, 1996; Saper, Chou & Elmquist, 2002). Decreases in the transmission of both serotonin and noradrenalin are also implicated in mood and depression (Hirschfield, 2000).

Depressive symptoms and mood changes are commonly associated with eating disorders, and depressed individuals often display diminished appetite (see, Kaye, 2008 for a review). Altered serotonin is thought to play a role in the dysregulation of appetite, mood and impulse control that is characteristic of bulimia and anorexia (Kaye, 2008). Individuals experiencing carbohydrate craving syndrome show improvements in dysphoric mood after carbohydrate self-administration (Corisa & Spring, 2008). Ingestion of carbohydrates is known to increase the plasma ratio of tryptophan; it has been suggested that excessive carbohydrate intake by patients with affective disorders (such as Seasonal Affective Disorder) reflects a self-medication that temporarily relieves symptoms of depression and low-mood reflected by increased central serotonergic activity (Wurtman & Wurtman, 1995). Although recent reports debate whether brain 5-HT has a general influence on overall intake of food, or whether is specifically influenced by carbohydrates (Asin, Davis & Bednarz, 1992; Pagoto et al., 2009). Wurtman's theory of carbohydrate-craving and serotonin hypothesis has also received criticism in terms of methodology and interpretation of findings (Corsica & Spring, 2008); there have also been failed attempts in the replication of his findings which further contribute towards the controversy of this construct (Gendall, Joyce & Abbott, 1999).

Human taste thresholds have also been linked to the transmission in serotonin and noradrenalin in affective disorders and in healthy adults after a stressor (Heath, Melichar, Nutt & Donaldson, 2006). Serotonin is used by the taste bud to modulate cellular responses to tastant stimulation before transmission to the primary gustatory neurons (Herness et al., 2005). Situations in which 5-HT and NA are lowered (i.e. altered mood states such as anxiety and depression) result in alterations in taste perception. Heath et al (2006) found that taste threshold and anxiety were positively related; anxious groups were found to have significantly higher bitter and salt recognition thresholds than non-anxious groups.

1.3.2.3 Personality and Eating Behaviour

The main biological models of personality are reviewed towards the end of this chapter (section 1.6).

Table 1.1: Personality and eating behaviour: biogenetic links and related brain systems

Personality Dimensions (related brain systems)	*Associated neurotransmitter*	*Link to Eating Behaviour*
Novelty Seeking – NS (Behavioural Activation)	Dopamine (DA)	Self administration behaviour (see Wise 1997) Role in food reward (see Berridge & Robinson, 1998) Increased hypothalamic DA turnover during feeding
Harm Avoidance – HA (Behavioural Inhibition)	Serotonin (5-HT)	Facilitates satiety (see Saper, Chou & Elmquist, 2002) BN and AN have a defect in satiety responses and evidence of serotonergic dysfunction (see Jimerson et al., 1990) Carbohydrate craving (see Wurtman & Wurtman, 1995)
Reward Dependence (RD) (Behavioural Maintenance)	Noradrenalin (NA)	Plays a role in regulating feeding behaviour within the PVN and the lateral hypothalamus (see Rowland. Morien & Li, 1996) Anorexic and bulimic patients show changes in both NA and 5-HT (see Jimerson et al., 1990) Taste thresholds modulated by NA and 5-HT (Heath et al., 2006)

Personality is highlighted here in light of the evidence to suggest the involvement of dopamine, serotonin and noradrenalin in eating behaviour and the control of feeding. These neurotransmitters are also implicated in the behavioural activation, inhibition and motivation systems associated with temperamental personality as outlined by Cloninger (1987; this is discussed in more detail later, in section 1.6). The table below provides a summary of the biogenetic links implicated in Cloninger's model of temperament (1987) and examples of how the same monoamines are involved in eating behaviour.

1.4 Taste

Models of food choice have shown that many biological and social aspects govern intake, although sensory and hedonic processes remain the most influential predictors of food choice. Above all other factors involved in the selection, choice and purchase of food, taste is the most important (Aaron et al., 1995; Crystal & Teff, 2006). In common language taste is often described in terms of interplay between taste, smell and irritation that is perceived both in the oral cavities and the nasal cavities (Mennella & Beauchamp, 1998). In this way taste is commonly confused with flavour; therefore it is important to clarify the terms that will be used in the present thesis (a more detailed discussion of problems relating to terminology is offered in Chapter 2 section 2.2). The thesis will concentrate on taste *per se*; that is taste perceived by the tongue and the process of preference resulting from the initial taste quality or judgement of a given food; taste perception or taste preference.

Taste is one of the most important primary reinforcers (Rolls, 2000). The energy obtained from food is essential to the survival of all animals, therefore if a food tastes good it will be consumed again (stimulus-reinforcement learning). Despite this, very little is known about the brain processes involved in human taste-related activity (Kringelbach, Araujo & Rolls, 2004). Evidence from primate studies suggest that the brain areas involved in primary taste processing include the anterior insula and the frontal opercular cortex, and the orbitofrontal cortex is part of the secondary taste cortex (Baylis et al., 1994; Rolls 1999). Neuroimaging studies in humans have also implicated the involvement of these two areas in taste processing, particularly the orbitofrontal cortex which is thought to be involved in the reward process of primary reinforcers such as taste (Rolls, 1999) and the pleasantness of taste (Rolls, 2004). This was further confirmed by Kringelbach and colleagues (2004) who discovered significant responses to a range of taste stimuli in the dorsolateral prefrontal cortex. The authors explained this novel finding, positing that cognitive processing may be involved in taste processing particularly in terms of taste perception.

The sense of taste is mediated by taste receptor proteins which live on the surface of taste receptor cells within the taste buds on the tongue (Kim et al., 2004). Chemical stimulation of the taste buds (clusters of taste receptors) result in the sensation of taste. The majority of taste buds can be found on the tongue, however a number are also found throughout the oral cavity including on the hard and soft palates, the larynx, the tonsils and the epiglottis (Cowart, 1981). The taste buds on the tongue consist of structures called taste papillae. Three types of taste papillae can be found on the human tongue (see B of figure 1.2 below), fungiform, the foliate, and the circumvallate papillae (Cowart, 1981).

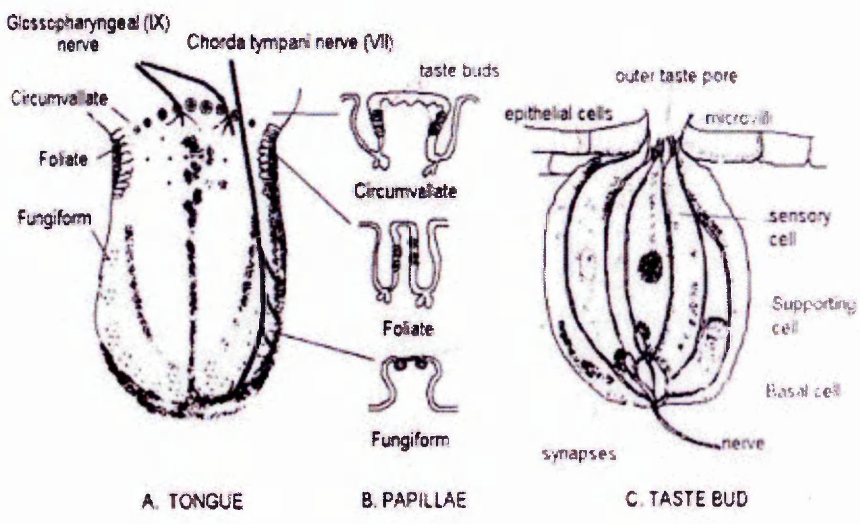

Figure 1.2: Surface of the tongue and taste receptors[1]

[1] Figure adapted from Guyton & Hall (1996)

Chemicals that interact with taste receptors have been grouped into 5 distinct categories or basic tastes. Traditionally it was thought that there were localised response areas on the tongue for each of these taste dimensions, recent evidence, however, has suggested that this is not the case and that taste receptors do not necessarily respond to a single taste quality (Boughter & Bachmanov 2007). The recent discovery of a taste receptor sensitive to fatty acids (CD36) suggests that the orosensory detection of dietary fats is involved in fat preference (Laugerette et al., 2005). This evidence confirms that taste receptors are not exclusively sensitive to the traditional basic tastes; the detection of fat taste suggests that fat can be considered a unique taste domain also.

Taste is thought to have a genetic basis (this is discussed later in the sections on individual taste dimensions, 1.3.5 and 1.3.6). The main determinants of taste thresholds are thought to be genetic; individual taste thresholds do not seem to vary on a day-to-day basis (Heath et al., 2006), although taste thresholds do vary across individuals and taste preference for different taste domains differ also (see sections 1.3.5 and 1.3.6).

1.4.1 Basic Tastes

Perhaps the most important sensory property relevant to this research is that of taste. Classically, the Basic Tastes theory described taste-dependent behaviour limited to 4 semantic descriptors of taste sensed by humans; sweet, sour, bitter and salty. Due to the evidence suggesting that taste receptors for the basic taste modalities can be found on all areas of the tongue, these classic models of the basic tastes as provided by the Basic Tastes theory and conceptualisations of the tongue map have since been refuted. More recently the concept of a fifth basic taste has become more prevalent in the literature as well. This fifth taste, Umami, comes from the Japanese meaning “savoury delicious”; it was first isolated by Ikeda in 1907 (Ikeda 1909). It is commonly associated with the flavour-enhancer monosodium glutamate and also described as “savoury” or "delicious".

It is argued that there are a greater number of perceived taste domains than originally thought (Lawless & Heymann, 1999). For example, the Chinese recognize a sixth taste "pungent" but this is not universally accepted and evidence for this taste quality is not well supported. It has also been argued that spicy is a unique taste construct although this remains a controversial issue; confusions lie between the concept of taste and flavour which involves olfaction as well as taste. As spice, particularly capsaicin, is an irritant, it is thought to be detected in terms of sensation rather than taste *per se*. It is clear from observation that individual differences in tolerance of spiciness vary tremendously; some individuals really enjoy the sensation of chilli-burn while others cannot tolerate it (Stevenson & Yeomans, 1995). Although is has been suggested that mere exposure can increase liking for tastes such as chilli (Stevenson & Yeomans, 1995), strengthening the concept of acquired taste preference. The discovery of taste receptors which respond to free-fatty acids provides evidence to suggest that fat should also be considered as a unique taste quality (Gilbertson, Fontenot, Liu. Zhang & Monroe, 1997; Laugerette et al., 2005).

The thesis will focus on the four originally defined basic tastes but extend this to examine umami, spicy and fat tastes as well. Since umami is now considered to be a unique taste domain with the discovery of taste receptors on the tongue uniquely responsive to umami taste modalities (see review by Bellisle, 1999) it is important to examine this within the current research programme. Spicy will also be examined due to observed individual differences in sensitivity to this (Stevenson & Yeomans, 1993). Finally, due to the recent findings that show that receptors on the tongue respond specifically to free fat acids (Gilbertson et al., 1997; Laugerette et al., 2005), fat taste is also defined as a unique taste domain and will be examined within the thesis.

1.4.2 Taste Preference and the Development of Taste Preference

The process of taste preference occurs in the brain; when taste cells sense a particular taste molecule, this information is translated chemically to the nearby cranial nerves, which in turn carry the information to the brain. When this information reaches the brain it is decoded and judged based on its hedonic value (Lindermann, 1996). Taste preference or explicit liking is central to the research programme. There are however definitional and measurement problems with taste preference, these issues will be discussed in detail on Chapter 2.

Studies of human infant reactions to taste suggest that even from an early age individuals react differently towards taste stimuli. Affective facial responses observed in human infants demonstrate the power taste stimulus can elicit, either in terms of positive or negative reactions (Steiner, Glaser, Hawilo & Berridge, 2001). Steiner (1973) found that when young babies were given a sweet solution they responded with facial acceptance, for example, large eyes and retraction of the mouth. In contrast response to bitter solutions are very different, elucidating negative responses such as tight closing eyes, gaping mouth and sudden turn of the head (Steiner, 1973; Steiner, 1979). Evidence such as this suggests innate liking for sweet tastes and dislike for bitter, consistent with evolutionary perspectives. These reactions are perhaps indicative of a basic survival instinct. Evolutionarily perspectives argue that the rejection of bitter taste stimuli served the purpose of avoiding possible harmful and poisonous substances (Steiner, 1974; Steiner, 1977; Cowart, 1981). This also suggests that preference for other tastes such as bitter, sour and spicy demonstrate a degree of acquired liking (Clark, 1998). For example, most adults develop a liking for bitter tastes such as coffee, lager and bitter vegetables; infants would instantly reject these.

Taste preference for salt is also thought to be innately liked although unlike the development of sweet taste preference which is thought to be universal, neonates do not easily detect salt. Individual differences in salt taste preference shortly develop, and can be evident from as young as 2 months (see review by Leshem, 2009). It is likely that taste preference for sour is learnt through long-term repeated exposure and conditioning (Liem & Mennella, 2003). Preference conditioning can be employed through flavour-flavour learning techniques; dislike for sour and bitter tastes can be reduced by pairing these with sweet tastes (Zellner, Rozin, Aron & Kulish, 1983; Capaldi & Privitera, 2008). Studies such as these demonstrate that a degree of acquired liking for certain tastes can develop through exposure and learning, adding support to the notion of acquired taste preference. Despite this, significant differences between individuals are observed in terms of their taste preferences and food selection (Shepherd & Sparks, 1994), suggesting that learning to like these acquired tastes such as bitter and sour, is not necessarily universally achieved. As the models of food choice show, there are a great deal of influences upon the foods and tastes individuals like, ranging from genetics to attitudes and beliefs, and person factors of which less is known.

1.5 Individual Differences in Eating

Individual differences in eating have been observed in clinical populations and particular eating habits and behaviours. This section briefly reviews disordered eating, restrained eating, eating specific traits, age and sex differences and also personality related to general eating behaviour. Although the thesis is interested specifically in individual differences in taste preference and eating behaviour this section is included in light of the limited research available specific to the aims of the thesis. The proceeding subsections examine how individual difference variables are important in developing further understanding of eating behaviour more generally.

1.5.1 Disordered eaters

Disorders of eating such as anorexia nervosa, bulimia and obesity are conditions which carry risks to health and in extreme cases life expectancy. This research area is vast with numerous annual conferences and publications showing the continued interest in this field. This section aims to use examples from the eating disorder literature to demonstrate individual differences in eating. This section does not intend to review eating disorders in great detail as this is beyond the scope of the thesis (see Cooper, 2005, and Kaye, 2008 for general reviews of this area). Since the literature on individual differences and non-clinical populations is somewhat limited, the clinical literature provides a useful starting point to explore personality and eating behaviour in normal eaters. Drawing upon this literature is also useful considering that eating behaviour can be seen as spanning a continuum from normal eating to disordered eating.

Eating disorders, much like food choice, are multi-factorial in origin; sociocultural, familial, psychological and biological factors all play a role making these extremely complicated disorders to study. Genetic evidence suggests that eating disorders and certain associated traits run in families (Strober, Lampert, Morrel, Burroughs & Jacobs 1990). The use of psychometric measures of personality as an assessment tool for eating disorders has become common-practice; obsessive and perfectionist traits often found in anorexic patients and are thought to run in families (Lilenfeld et al, 1998). Twin studies of anorexia nervosa and bulimia have concluded that levels of heritability are significantly high, providing further evidence of a genetic link to these disorders (Treasure & Holland 1989; Bulik, Sullivan & Kendler 1998). Other risk factors thought to influence eating disorders are character traits, particularly low self-esteem and perfectionism (Fairburn, Cooper, Doll & Welch 1999) suggestive of a personality link.

A number of studies have linked biological models of personality to disordered eating and have demonstrated differences in neurotransmitter functioning in patients with eating problems (Kleinfield, Sunday, Hurt, & Halmi, 1994; Waller et al., 1993). Bulimics tend to be high in the novelty seeking trait described by Cloninger (1987), whereas anorexics are highly persistent and both groups are high in harm avoidance (Cloninger, 1994; Waller et al., 1993). Harm avoidance is closely linked to serotonin transmission which has been shown to be increased when carbohydrate-rich foods are consumed. This was further confirmed in a study linking bulimia nervosa, harm avoidance and serotonin (Waller et al., 1993). A reduction of harm avoidance scores were observed during treatment with the serotonergic medication fluoxetine in bulimic patients; providing further support for Cloninger's theory linking serotonergic systems and harm avoidance (Waller et al., 1993). The Tridimensional Personality Questionnaire (TPQ; Cloninger, 1987), which measures these traits of Harm Avoidance, Reward Dependence and Novelty Seeking, has been found to be an internally consistent and valid instrument to use with disordered eaters (Kleifield et al., 1993).

During binges bulimic patients show an increased desire for carbohydrate-rich foods (especially those high in sugar). Carbohydrate craving is thought to be linked to changes in brain serotonin levels (Wurtman, 1984; Wurtman, 1986; Shaye 1989); high carbohydrate-containing foods increase tryptophan transport and serotonin turnover. In this way it is thought that bulimics consume carbohydrate-rich foods perhaps as a form of self-medication. Following this observation Shaye (1989) found that high impulsive bulimic participants exhibited a greater intake of food in general and sweet food preference during food binges. Low serotonin and dopamine metabolite concentrations in cerebrospinal fluid from bulimic patients who have frequent binge episodes have also been revealed (Jimerson, Lesem, Kaye & Brewerton, 1992).

Such evidence supports the notion that eating disorders have a biological basis and offers further support to the view that individuals with eating disorders often demonstrate extreme personality characteristics. With increasing levels of eating disorders and the very rapid rise in both adult and childhood obesity the role of personality assessment has been found to be an important factor in the evaluation of disordered eating (Fassiono et al., 2002). Despite this, little is currently known about individual differences in normal eaters and although the TPQ (Cloninger, 1987) has been used effectively in eating disordered groups it has been rarely utilised to examine links between eating and personality in normal eaters.

1.5.2 Dieters and Restrained Eaters

Dieting to lose weight is widespread in the Western world especially among women. Dieting is now so prevalent that it has become "normal", making definitions of what "normal eating" constitutes extremely problematic (Polivy & Herman, 1987; French & Jeffery, 1997). Yet identifying dieting associated behaviours has become increasingly important within the eating behaviour field due to increased promotion of healthy lifestyles as a result of increased levels of obesity in western societies. Dieting and levels of dietary restraint are largely prevalent in younger women, suggesting sex differences in eating behaviour (see section 1.5.5).

Restrained eating encompasses both past dieting history and current dieting (this is also discussed in Chapter 2, section 2.3.1). Dietary restraint can be defined as a conscious decision to limit food intake to achieve a desired body weight (McLean &

Barr, 2003). This eating behaviour is governed by cognitive processes rather than by physiological mechanisms (Gorman & Allison, 1995). Highly restrained eaters have been found to show greater emotional responsivity, greater neuroticism, greater depression, lower self esteem and poor psychological health compared to low restraint individuals (Herman & Polivy, 1975; Herman & Polivy, 1980; Appleton & McGowen, 2005).

According to French and Jeffery (1997) dieting consists of three distinct dimensions: current dieting; dieting history; and weight suppression. Dieting can have different associations in terms of eating and exercise behaviours depending on whether it is current or in the past (Lowe, 1993). For example, a history of unsuccessful dieting and weight "yo-yoing" may contribute to overeating, particularly sweet and high fat foods, whereas current dieting may be associated with low-fat food choices and avoidance of sweets (Lowe, 1993; French & Jeffery, 1997). Individuals associated with weight suppression behaviours are individuals who have successfully lost a significant amount of weight and have maintained that weight for a long duration. Success in terms of weight suppression is very low (Lowe, 1993). Interestingly if dieters attempting to reduce their weight are successful in changing their eating behaviours by reducing their food intake and eating lower-fat foods it is likely that a change in taste preferences will also occur (Lowe, 1993).

1.5.3 Personality

Personality factors and diet studies have been limited to selected samples (women, disordered eaters, dieters etc) and few studies examine personality factors in a general population. A recent study examined this relationship in a large population-based US sample; relationships were found between food choice and personality (van den Bree, Przybeck & Cloninger, 2006). More specifically this study reported associations between traits such as hostility and anxiety-proneness with greater likelihood to continue eating even when fully satiated and also sociability and low impulsivity correlated with greater monitoring and control of dietary intake. The strength of these relationships was thought to be influenced by a number of other factors as well as personality including demographic, lifestyle and sex differences.

Another of the few studies that examine personality within eating practices concentrated on the eating habits of a large community sample and found patterns of association between measures of health-related practices, vocational interests and personality traits (Goldberg & Strycker, 2002). Unlike previous studies in this area this study used a number of personality measures including Eysenck Personality Questionnaire (EPQ-R-S) and also a short form of Cloninger's TPQ. Despite this the only associations found were in relation to personality traits such as Openness to Experience and Conscientiousness and self-reported general healthy diet not specific food preferences.

Eysenck's personality dimensions have also been used to examine the relationship between personality and nutrient intake. It was found that a larger proportion variance was explained by personality factors (15-30%) than demographic factors (6-17%) including education and occupational status (Falconer, Baghurst & Rump, 1993). It was recommended that future research should consider personality factors when constructing nutrition health behaviour models and in the design of intervention strategies.

Logue and Smith (1986) found relationships between subscales of sensation seeking and preference for alcoholic beverages and ethnic foods. Such findings support the idea that individuals with high sensation seeking scores may be characterised as "food likers" and may purposely seek out stimulation not only in general but specifically in terms of food (Raudenbush, van der Klaauw & Frank, 1995). Cross-cultural individual differences have also been reported; taste preference differences were associated with personality traits measured by the Indian Personality Inventory (Venkatramaiah & Devaki, 1990).

The few studies that have examined links between personality and eating behaviour have concentrated on general eating habits, nutrient intake and health-related practices. Fewer still have explored these links in terms of taste preference or palatability and those that have largely focus on extraversion, sensation seeking and novelty seeking.

1.5.4 Other eating-specific traits

The examination of individual differences in general eating behaviour and eating patterns indicates that traits specific to eating may exist. Food neophobia is thought to be a personality trait related to reluctancy to try novel foods (Pliner & Hobden, 1992). From an evolutionarily perspective food neophobia makes a great deal of sense i.e. to protect the individual from the consumption of potentially toxic or harmful foods but perhaps not in today's society with unlimited availability and tight food standards. Martins and Pliner (2005) assert that this type of behaviour is maladaptive; it restricts the types of foods consumed which may in turn affect the nutritional quality of an individual's diet. Willingness to try novel foods decreases with manipulated fear and hunger (Pliner, Eng &, Krishnan, 1995). Further studies have linked arousal and food neophobia; by manipulating arousal Pliner and Melo (1997) found that low levels of arousal lead to the selection of more novel foods and high arousal resulted in fewer novel food selection compared to neutral arousal groups.

Food neophobia has also been linked to personality traits such as sensation seeking; it has found to be negatively correlated with experience seeking a subscale of Zuckerman's sensation seeking (Pliner & Hobden, 1992). Furthermore high sensation seekers tend to try more novel foods under low arousal conditions compared to low sensation seekers (Pliner & Melo, 1997).

The construct of food involvement is also thought to be an individual characteristic specifically associated with food selection and choice (Bell & Marshall, 2003). Bell and Marshall (2003) suggest that food involvement is a stable characteristic which varies between individuals; individuals who show high levels of food involvement can discriminate between food samples and make judgments about those food samples more effectively than those with lower levels of food involvement. More specifically individuals with high levels of food involvement show greater differences in hedonic ratings between food samples of sweet, salty, sour and fat

(Bell & Marshall, 2003). Relationships have been found between food involvement and food neophobia, sensation seeking (Zuckerman, 1979) and several other eating related characteristics and behaviours. Bell and Marshall (2003) propose that highly food-involved individuals might be that way because they are more sensation seeking compared to low food-involved individuals, and the array of sensory characteristics of food provide a means of increasing stimulation and sensation.

Evidence indicative of eating specific traits which appear to be more common in out-going personality types provide further support to suggest that individuals who tend to seek out stimulation are more willing to try novel foods compared to other types. This supports the evidence presented earlier which indicated that out-going traits were more likely to rate and prefer acquired tastes such as bitter and sour compared to less out-going individuals (see section 1.7.2).

1.5.5 Age and Sex differences

Age and gender have been well researched in relation to taste and general eating behaviour. Evidence suggests that, over time, preferences for sweet and salty foods decline (Desor, Greene & Maller, 1975). Age differences have been found within taste discrimination and sour and bitter perception (Hyde & Feller, 1981). There is biological evidence to suggest reasons for this; as people age the olfactory bulb in the brain responsible for processing smell becomes smaller. In addition, the receptors in the nose that sends information to the brain begins to thin and spread out, and may be less effective. In turn smells become more blunt and difficult to distinguish. As a result the ability to taste food diminishes. As these senses diminish, food tastes blander (Murphy, 1993).

Sex differences in taste and eating behaviour are also well observed. Men and women differ in their hedonic ratings of taste stimuli (Connor & Booth, 1988); their cravings for certain foods (Weingarten & Elston, 1991); their ratings of pleasantness and sweetness (Laeng, Berridge & Butter, 1993) and their rejections of food types along with their reasons for doing so (Mooney & Walbourn, 2001). Women are also more likely to comply with diet and health guidelines most likely due to body image factors (Turrell, 1997) and women are more likely to engage in calorie controlled dieting (see Ogden, 2003). Women are also reported to eat more fruit and vegetables compared to men (Kiefer, Rathmanner & Kunze, 2005). Clear sex differences are also observed in terms of the stress-eating relationship (see Stone & Brownell, 1994).

Individual differences are often treated as nuisance variables but can also be viewed as "providing useful evidence about the nature of mechanisms underlying sensory phenomena and thus are important in the generation of research hypotheses" (Stevens, 1996, pp.303).

1.6 Personality

The thesis draws upon biological models of personality; these will now be outlined. It is important to outline these models at this stage in order to provide grounding for the proceeding section which draws upon the existing literature outlining individual differences in taste preference.

1.6.1 Biological models of personality

A great number of personality models have been developed spanning across four traditional psychological paradigms. These are psychoanalytical, trait, behaviourist and humanistic paradigms (Flunder, 2001). These traditional paradigms have since expanded to include the social-cognitive approach, evolutionary psychology and the biological approach. The biological approach is heavily influenced by behaviourist and trait paradigms and places emphasis on the separate constructs of temperament and character.

Behavioural genetic research has provided sound evidence that personality is to some degree a consequence of genetic inheritance. Twin studies have confirmed this, finding that identical twins reared apart were found to possess similar traits and characteristics (Plomin, 2004). Further confirming a biological basis for personality associations between personality and brain anatomy have been shown; the frontal lobe has been found to be associated with foresight and anticipation (Damasio, 1994) and the amygdala has been implicated in aggressive traits and emotionality (Buck, 1999). It has been suggested that almost every psychological phenomenon can be linked to heritable influences (Turkheimer, 1998), although genetic variations do not always provide a complete understanding of how individual differences in behaviour develop (Paris, 2000).

It is commonly agreed that the processes involved with temperament are firmly rooted in biological mechanisms (Goldsmith et al., 1987). For the purposes of the current research this section of the thesis will draw on biological models of personality only, particularly those influenced by the trait approach which place an emphasis on temperament. The thesis draws on these models as the implication of motivational and reward systems implicated in temperament are also implicated in eating behaviour. The main biological models that take a brain-based approach will be discussed in turn in the proceeding sections.

1.6.2 Eysenck's Biological Basis of Personality

Eysenck defined personality as a more or less stable organisation of an individual's character, temperament, intellect, and physique. Eysenck provides a three-dimensional approach to personality based on a large amount of personality data gathered from a variety of populations all over the world.

Eysenck's psychoticism scale has received much criticism and has been widely questioned (Bishop, 1977; Block, 1977). It has been found to be genetically heterogeneous suggesting it is an unsatisfactory scale to measure this third dimension of biological personality traits (Heath & Martin, 1990). The lack of consistency with the psychoticism scale suggests that it is not a strong indicator of heritable personality, despite this two dimensions are thought to be far too few to provide a fully comprehensive model of personality (Cloninger, Przybeck, Svrakic & Wetzel, 1994). A comparison of the major factors of Eysenck's model, the Five Factor model and the Alternative Five found through factor analysis that psychoticism includes conscientiousness and impulsive sensation seeking factors (Zuckerman, Kuhlman, Joireman, Teta, & Kraft, 1993). Eysenck's other dimensions, extraversion and neuroticism, remain consistently valid and reliable scales of biological personality and these underlying concepts feature in a number of the following models in one form or another.

1.6.3 The Five Factor Model

The Five Factor Model (FFM) is largely based and influenced by the tradition of the lexical hypothesis. The lexical hypothesis describes basic individual differences in terms of trait descriptors or adjectives; individual differences are characterised by language (Digman, 1990; Goldberg, 1981; Goldberg, 1999). The FFM of personality (McCrae & Costa, 1990) consists of five broad higher-order factors or domains; extraversion, agreeableness, conscientiousness, emotional stability and openness to experience. These five factors were derived from a careful analysis of the personality literature (De Fruyt, Van De Wiele & Van Heeringen, 2000). In recent years a great deal of research has provided much support for a five-factor model of personality, some of this stems from behavioural genetic and animal personality studies which tend to conclude that the FFM is based on temperamental processes (McCrae, Costa, Ostendorf, Angleitner & Hrebickova, 2000).

Although widely used and accepted, the FFM is not without criticism. This model has been criticised for being derived from existing personality measures; it is data-driven, rather than derived from theory (Digman, 1990). The universality of the Big Five has also been brought to question; Saucier (2003) found that translations of the Big Five have resulted in substantial convergence of the factor structures. In addition the FFM was developed to measure and explain individual differences in adults in the general population and does not therefore provide measurement or explanation for maladaptive behaviour (De Fruyt et al., 2000). Despite these criticisms the FFM is widely applied in research examining individual differences in personality.

1.6.4 Reinforcement Sensitivity Theory (Gray, 1973)

Eysenck's model (1967) and the FFM have been criticised for taking an atheoretical approach whereby the trait descriptors are identified initially, and the underlying causes of individual differences and variation are then explored (Smillie, Pickering & Jackson, 2006). Unlike these, the Reinforcement Sensitivity Theory (RST) was developed to explain individual differences in motivated behaviour in terms of the sensitivity of behavioural reward and punishment systems (Gray 1973). Initially the RST was developed as a theory of motivation, emotion and learning based on animal learning models. Later the proposal that motivation and emotion may be involved in the processes underlying trait dimensions (Gray 1981), was viewed as a revolution in personality psychology (Depue & Collins, 1999).

The original model consisted of a punishment system, a reward system and a threat-response system. Behavioural Inhibition System (BIS) is an inhibitory system which is activated by conditioned stimuli related to punishment or cessation of reward. The Behavioural Activation System (BAS) is associated with goal-driven behaviour and is activated by conditioned stimuli related to reward and cessation of punishment. The Fight/Flight System (FFS) is activated by unconditioned aversive stimuli which either result in escape (flight) or defensive aggression (fight). This latter system has been removed from the model because it was not clearly linked to personality, and thought to overlap with the BIS (Gray, 1987). Therefore the RST explains individual differences in personality associated with variation in the BIS and the BAS systems. Mesolimbic and mesocortical pathways have been implicated in reward-driven behaviour; therefore the transmission of dopamine is strongly implicated in this model of individual differences in personality (Pickering & Gray, 1999).

The BAS is the most studied of the systems; associations between measures of behavioural activation and the activation of mesolimbic areas, including the ventral striatum, orbitofrontal cortex, and the amygdala, have been found (Carver & White, 1994). The RST is associated with individual differences in prefrontal asymmetry, where behavioural activation is related to left-sided prefrontal asymmetry and behavioural inhibition is related to right-sided asymmetry (Sutton & Davidson, 1997).

The application of the RST as an explanation for the underlying basis of individual differences in motivation and reward has been widely applied to subsequent models of personality such as Zuckerman's biosocial model (1984) and Cloniniger's neurobiological model (1987), these models have applied the RST to the development of instruments to measure personality.

1.6.5 Biosocial Basis of Sensation Seeking (Zuckerman, 1984; 1991; 1994)

Zuckerman (1984) describes a psychobiological model of personality rooted in monoamine neurotransmitter systems. This 3-factor model includes Sensation Seeking, a trait featuring the impulsive temperament (described in more detail in section 1.6.6). The theory was based on the assertion that there are consistent individual differences in optimal arousal and stimulation which could not be measured by any preceding measure. Genetic contributions of the trait Sensation Seeking (SS) have been investigated via twin studies, where around 58% of variance in SS was found to be heritable (Zuckerman, 1991). Zuckerman posits that personality traits are the result of inherited biological structures coded in DNA and as such, are not directly inherited. Monoamine oxidase (MAO) has been implicated as a biological trait marker for SS. High scores of SS tend to reflect low levels of MAO compared to low scores of SS (see Zuckerman, 1991 for a review).

High correlations have been observed between Zuckerman's impulsive sensation seeking scale (from the Alternative Five; ZKPQ) and Cloninger's Novelty Seeking scale confirming the similarity between these constructs. Both authors define novelty and sensation seeking as major dimensions in their models of temperamental personality, demonstrated by the biological basis of this dimension and the high heritability (Zuckerman & Cloninger, 1996). In comparison, Eysenck's model and the 5 factor model describe sensation seeking as a lower facet of extraversion and impulsivity as a lower facet of neuroticism.

Although the Sensation Seeking trait is now widely accepted as having an influence on risk taking behaviour and implicated in individual differences in arousal, it broadly describes a unitary trait. This led Zuckerman to develop a measure that assessed a broader range of personality dimensions, the Alternative Five (ZKPQ; Zuckerman, Kuhlman, Joireman, Teta, & Kraft, 1993). Despite disagreement across the huge array of personality models Zuckerman maintained that three-factor and five-factor models are equally valid and robust (Zuckerman, Kuhlman, Thornquist & Kiers, 1991).

1.6.6 Psychobiological Theory (Cloninger, 1987)

Cloninger (1987) also developed a psychobiological model of personality based upon sampling individuals with extreme personality profiles or disorders and using information obtained from family studies, studies of longitudinal development and studies of personality structure. Cloninger's model was developed to be a general model that could be applied to both normal and abnormal personalities. This theory places great emphasis on the interaction between temperament and character, relating these to the dissociation of major brain systems (Cloninger, 1994). Cloninger describes temperament as unconscious, or the heritable part of personality, explaining individual differences in terms of percept-based habits and skills. According to Cloninger, as a result of associative conditioning individuals possess 4 main habits; passive avoidance, novelty seeking, reward dependence and persistence. Based on neurobiological based operant learning, the model was developed to explain temperament systems in the brain as independent varying systems for the behavioural activation (Novelty Seeking), maintenance (Reward Dependence), and inhibition (Harm Avoidance) towards specific classes of stimuli.

Behavioural activation is a reward-driven system associated with behavioural response to novelty and signals of reward, and relief from punishment, similar to the BAS. This system is thought to be underpinned by dopamine activity. Studies of sites of reward suggest that dopaminergic cell bodies in the ventral tegmentum, project to the striatrum, nucleus accumbens, and frontal and limbic cortex (Cloninger, 1986). In this way the exploratory activity and intense responses to novel stimuli are thought to be related to low basal dopaminergic activity (Cloninger et al., 1994).

Behavioural inhibition is very similar in nature to the BIS (described above). This system is activated in response to signals of punishment or non-reward. This system is related to the temperament Harm Avoidance (HA) outlined by Cloninger (1987). Harm avoidance has been found to be positively associated with turnover of serotonin (5-HT) along with metabolites in the brain and cerebrospinal fluid (Cloninger, 1986). Individuals high in HA learn to passively avoidant behaviour and consequently are found to have high basal level serotonin activity in the behavioural inhibition system (Cloninger et al., 1994). The maintenance system is associated with behaviour that was previously rewarded which is maintained for sometime without reinforcement. Noradrenergic neurons in the dorsal bundle are thought to be involved in the maintenance of behaviour. These arise from the locus coerulus and projects to limbic structures such as the amygdala, septum, hippocampus and cerebral cortex (Cloninger, 1986).

The Tridimensional Personality Questionnaire (TPQ; Cloninger, 1987) was developed to measure the major dimensions of temperament. Each major dimension is multifaceted consisting of a number of lower order components. In total 12 subscales which were developed to reflect temperament descriptions, these are summarised in more detail in chapter 2, section 2.3.2 (a summary of the descriptions of each lower order subscale can be viewed in appendix 8).

1.6.6.1 Novelty seeking and dopamine

Cloninger's personality model highlights a link between personality and biological mechanisms. Novelty seeking, one of the three temperament dimensions defined within this model, has been linked with increased mesolimbic dopamine activity within the brain (Cloninger, 1994). Similarities have also been observed within the neurobiology of personality in extraverts (Depue & Collins, 1999). Recent research has explored individual differences in brain dopamine functioning in relation to extraversion, and concluded that differences in D2 receptor responsivity may represent a neurobiological structure for extraversion (Rammsayer, 1998; Depue & Collins, 1999). These findings are explained in terms of positive incentive motivation. Novelty seeking and sensation seeking (described by Zuckerman, 1979) highly correlate with extraversion suggesting that these traits are fairly similar, so it follows that these links between dopamine and extraversion can also be applied to novelty and sensation seeking.

Dopamine transmission is also thought to be involved in the psychostimulant properties of drugs of abuse. For example, dopamine agonists such as cocaine and amphetamines facilitate dopaminergic transmission and are positively reinforcing. This may explain why these personality types may be more prone to drug use than other types; they may "seek out" dopamine due to the activation of the brain's reward system (Le Grange, Jones, Erb & Reyes, 1995). Cloninger (1987) maintains that the novelty-seeking traits reflect variation in the brain's "incentive" system associated with novel environmental stimuli, the pursuit of potential rewards and escape from punishment, underpinned by dopamine.

1.6.7 Impulsivity

A key theme of many personality models including those mentioned above is that of impulsivity. Impulsivity features in every major model of personality and temperament (Whiteside & Lynam, 2001). The concept of impulsivity also plays an important role in the comprehension and the diagnosis of a number of forms of psychopathology varying from impulsive control disorder and mania to bulimia nervosa. It is perhaps the most common diagnostic criteria that feature in the DSM-IV (American Psychiatric Association, 1994; Whiteside & Lynam, 2001).

1.6.8 Temperament and Personality

Temperament is thought to have a genetic, heritable basis (Rothbart, Ahadi, & Evans, 2000). Temperament has been defined as individual differences in reactivity of the behavioural and physiological systems and self-regulation (Rothbart & Derryberry, 1981). In this way is it assumed to have a constitutional or biological basis strongly influenced by heredity. The predispositions for behaviour that form the substrate on which environment and experience form the traits that later emerge as personality. Temperament, traits and personality are closely linked and are therefore difficult to distinguish from each other particularly within the individual differences literature. Cloninger distinguishes temperament from character as being connected to the procedural learning systems embedded within the brain, whereas character results from propositional learning and memory (Cloninger, 1994). Cloninger suggests that character and temperament combine to form personality.

1.7 Individual Differences and Taste Preference

1.7.1 Individual Differences and Innate Taste Preferences

1.7.1.1 Sweet

As outlined in section 1.4.2 evidence from neonate studies indicates that humans have an innate liking for sweet tastes (Desor, Maller & Turner, 1973; Steiner, 1974). Individual differences in sweet food consumption have been observed both in humans and animals. When sugars are freely available, individual variability in the amount of consumed sugar varies widely across individual rats (Brennan, Roberts, Anisman & Merali, 2001). It is suggested that these individual differences in sweet consumption may be attributable to a complex interplay between differential motivational behaviours (Brennan et al., 2001). The rewarding aspect of sweet foods is highly influenced by the dopaminergic system which has been found to influence motivation toward sugar consumption (Hoebel, Avena & Rada, 2007; Sills & Vaccarino, 1996). This is thought to be related to the reinforcing effects (particularly in terms of the hedonic value) of sugars (Brennan et al., 2001; Sills & Vaccarino, 1996) and also linked to self-administrative and addictive behaviours both in animals and humans (Perl, Shufman, Vas, Luger & Steiner, 1997; Kampov-Polevoy, Garbutt, & Janowsky, 1998).

In addition previous research has suggested that variation in sweet liking varies across individuals further suggestive of an individual differences and underlying genetic component to sweet liking (Keskiatelo et al., 2007). Sweet taste preference related traits have been found to be inherited; it is reported that approximately 50% of the variation in sweet liking can be explained by genetic factors and 50% can be explained by psychological and environmental factors unique to the individual (Kestitalo et al., 2007). This suggests that personality variables may play a role in sweet preference.

Individual differences in 'sweet tooth' have been repeatedly demonstrated (Conner & Booth., 1988a; Conner et al., 1988b). Generally sweet-liking has found to correlate with out-going traits such as novelty seeking and extraversion. In terms of personality there is strong evidence to suggest that outgoing traits, particularly those related to dopamine, predict a high sweet preference and liking. Preference for highly sweetened solutions have been found to negatively correlate with Exploratory Excitability (a lower facet of novelty seeking which highly correlates with sensation seeking and extraversion) and positively correlate with Extravagance (also a lower facet of novelty seeking) (McHale, Hunt & Evans, 2002). Similarly Stone and Pangborn (1990) found that sweet food and sweet drink preference could be linked to individuals with outgoing traits. In alcoholic subgroups high scores in Novelty Seeking have been found to correlate with sweet liking and alcoholic status (Kampov-Polevoy, Garbutt & Janowsky, 1997; Kampov-Polevoy, Garbutt & Janowsky, 1998; Kampov-Poelvoy et al., 2004).

1.7.1.2 Salty

Individual differences in salt intake have been examined but previous research has not examined salt liking and personality. Stone and Pangborn (1990) explored locus of control traits in relation to individual self-control over healthy eating. They found that high internal locus of control was associated with preference for lower salt levels, conversely high external locus of control (in relation to healthy eating motives) correlated with preference for higher salt levels. Shepherd and colleagues (1985; 1986a; 1986b) carried out a number of investigations on salt intake and their relation to personality traits concluding that neuroticism was negatively related to salt intake; individuals with high scores for neuroticism showed low salt intake, whereas individuals with high scores for extraversion showed high total salt intake. Stone and Pangborn (1990) found that participants who felt they had self-control over their health (internal locus of control) preferred lower levels of salt in a beef broth, whereas individuals with a high external locus of control preferred higher levels of salt. They also found that a combination of the general locus of control, non-assertiveness and enthusiasm traits best predicted salt taste preference.

Further evidence to support individual differences in salt preference is provided in a series of studies by Shepherd and colleagues (1985; 1986). Across these studies it was consistently shown that high score on the extraversion scale positively correlated with higher non-discretionary intake (salt content in foods as opposed to table salt use) of salt. Despite this the findings in terms of neuroticism were contradictory although relationships were found.

In a Japanese study high scores on agreeableness (determined by a modified version of the NEO-FFI test) was associated with dislike for salty tastes, this was also true of high conscientiousness scorers who also implied dislike for fatty foods (Kikuchi & Watanabe, 1999).

1.7.1.3 Umami

There is growing evidence to suggest that Umami should be considered a unique taste dimension. Glutamate receptors have been found in rat taste buds; these receptors respond specifically to Umami compounds (Chaudhari, Landin & Roper, 2000). In addition neonates show positive hedonic responses to Umami tastes even prior to food experience (Steiner et al., 2001). In a review of the literature surrounding the Umami taste and glutamate a number of studies were described which indicated that in many cases MSG and NaCL were found to be very similar in taste (Bellisle, 1999) and adding MSG increased the saltiness of foods (Prescott, 2004). Infants show preference for Umami over plain water, and soup with Umami over plain soup, suggesting that it is highly palatable even at a very young age (Beauchamp & Pearson, 1991). Umami has also been found to increase the palatability of novel foods in adult participants and condition liking for new flavours (Bellisle et al., 1991; Prescott, 2004).

There is a gap in the literature in terms of umami preference and personality associations, possibly due to the fairly recent discovery of this as a unique taste dimension, therefore the examination of individual differences in personality specific to umami taste preference has not been previously examined.

1.7.2 Individual Differences and Acquired Taste Preferences

1.7.2.1 Bitter

Genetic variation in bitter taste preference has been well documented. Fox (1931; 1932) first discovered that some individuals could detect the bitter taste of phenylthiocarbamide (PTC, tasters), and others could not (non-tasters). Family studies confirmed that the ability to taste PTC is a dominant genetic trait; the location of the gene is now thought to be found on chromosome 5 (Reed et al., 1999). Variation in perceived bitterness concentrations of both PTC and 6-n-propylthiouracil (PROP) is wide-ranging across tasters; tasters are subdivided into medium tasters, where PROP is rated as moderately bitter, and supertasters, where PROP is rated as exceptionally bitter (Duffy & Bartoshuk, 2000).

There is a paucity of research examining personality and liking for bitter tastes and foods. Although Mattes (1994) found that bitter taste preference positively correlated with sensation seeking (SS) and negatively correlated with scores of food neophobia. This suggests that there is a relationship between approach behaviour characterised by high scores of SS, and liking for bitter tastes. Conversely, a deficiency in willingness to try novel foods is related to low preference ratings for bitter tastes.

1.7.2.2 Sour

Individuals often find it hard to distinguish between sour and bitter tastes (Halpern, 1997); the main problem is likely to be due to individual difficulty in distinguishing between bitter and sour descriptions. Due to these difficulties and lack of a full understanding of the taste transduction of sour (see Brand, 1997), little research has examined sour taste preference directly (Liem, Westerbeek, Wolterink, Kok & Graaf, 2004). Like bitter, sour is thought to be an acquired taste (discussed in section 1.4.2 with regards to the development of taste preference), preference for sour tastes have been shown to increase and develop through exposure and pairing with sweet tastes, as found in studies using preference conditioning (Capaldi, 1996; Capaldi, Hunter & Lyn, 1997; Capaldi & Privitera, 2008). Few studies have examined individual difference variables as possible predictors for sour taste preference. From the few reported studies that have sought to investigate these relationships, patterns of findings suggest that taste dimensions defined as acquired such as preference for bitter and sour tastes have found to positively correlate with sensation seeking and negatively correlate with food neophobia (Mattes, 1994). A heightened salivary response to lemon juice has been observed in introverts, thought to be suggestive of an attempt to dilute the taste, indicative of a dislike for sour tastes in these individuals (Eysenck & Eysenck, 1967; Howarth & Skinner, 1969). It has been suggested that preference for sour tastes in children are related to desires to try unknown foods and desire to engage in thrill and adventure (Urbrick, 2000; Liem et al., 2004).

1.7.2.3 Spicy

Spicy tastes are defined in terms of burn sensation. The burn sensation of chilli pepper is produced by capsaicin. Similarly to the other tastes reviewed in this section humans can develop a liking for chilli; preference for chilli in not innate (Rozin & Schiller, 1980; Rozin, 1990). Individual differences have been observed in relation to chilli liking, where repeated exposure to chilli solutions increasing in intensity were reported as increasingly pleasant in some participants yet increasingly unpleasant in others (Rozin, Ebert & Schull, 1982). These findings were supported by Stevenson and Yeomans (1993) who further noticed that female participants rated the burn sensation as more intense than males.

There may also be a genetic component to the burn sensation produced by capsaicin; PROP tasters sensed greater burn perceptions than non-tasters after tasting capsaicin solutions. (Karrer & Bartoshuk, 1990). From the evidence presented above it is clear that there is individual variability relating to spicy taste preference and chilli burn, despite this individual difference variables such as personality have rarely been investigated. Kish and Donnenwerth (1972) found that sensation seekers rated spicy, sour and crunchy foods higher than bland, sweet and soft foods. Terasaki and Imada (1988) later supported this findings by observing that individuals who scored high on the sensation seeking scale showed strong preference for spice and spicy foods. In particular they found that those who achieved high score on the Thrill and Adventure Seeking (TAS) subscale and the Experience Seeking (ES) subscale positively correlated with preference ratings for spicy foods.

1.7.3 Calorie Dense Food

In the current "obesiogenic environment" it is believed that the huge variety and availability of energy-dense foods is a major contributory factor to increasing rates of obesity (Raynor & Epstein, 2001). Previous research has found positive associations linking the consumption and preference for a variety of high energy density foods (particularly highly sweet and highly fattening foods) with body mass index (BMI); conversely negative relationships were found between consumption of vegetables and BMI (McCrory et al., 1999).

Self-control or self-regulation, something that is lacking in certain individuals when it comes to food consumption and food craving (Wurtman & Wurtman, 1995), has been found to lead to a decrease in glucose below optimal levels (Gailliot et al., 2007). Therefore the act of resisting the temptation to eat (and much other behaviour) uses up vital energy resources. This is perhaps unsurprising since the brain consumes approximately 20% of the body's calories despite making up as little as 2% of the body's mass (Dunbar, 1998). As well as the adaptive influence of taste, taste also influences how much food is consumed and caloric intake (Haase, Cerf-Ducaste & Murphy, 2009). Calorie-dense foods may also be over-consumed due to different orosensory qualities compared to low-calorie dense foods. For example, high fats tend to chosen over low-fat because they are perceived as tasting better (Mattes, 1993), and due to other physical properties that convey sensations of fat, such as texture, thickness, and viscosity (Drewnowski & Greenwood, 1983).

1.7.3.1 Fat

Until fairly recently it was assumed that responses to, and the over consumption of dietary fat were a product of the textural properties of fat (Aaron et al., 1995) and not of taste (Verhagen, Rolls & Kadohisa, 2003; Rolls, Critchley, Browning, Hernadi & Lenard, 1999). Few studies have tested the affect of fat on the taste system, particularly the taste receptors (Gilbertson, 1998). Gilbertson and colleagues identified that free fatty acids contained in fat were used by taste receptor cells to detect fat (Gilbertson et al., 1997). This was further confirmed by Fukuwatari and colleagues (1997) who discovered fatty-acid transporters used in the taste system of rats. These discoveries have important implications for the taste of fat in humans; Mattes (1996) found that oral exposure to fat resulted in changes in postprandial lipid metabolism, indicative of a sensory mechanism for the detection of fat in humans.

Dietary fats are high calorie-dense foods and due to their pleasant orosensory characteristics are often over eaten. Dietary fat is a fundamental contributor to the selection of food; not only does it influence the taste of food but also the texture (Aaron et al., 1995) and the palatability (Crystal & Teff, 2006). Mattes (2005) asserts that the inherent difficulties in determining whether there is a taste mechanism for the detection of fat result from individual variability. Different strains of rats have been found to have different sensitivities and preferences towards dietary fat (Gilbertson, Liu, York & Bray, 1998). In humans individual differences in fat have been found to be linked with the detection of PROP (Tepper & Nurse, 1997). PROP tasters have a higher density of taste papillae which the authors believed resulted in a greater sensitivity to the orosensory characteristics of fat compared to non-tasters; tasters could easily distinguish between fat contents of salad dressings compared to non-tasters (Tepper & Nurse, 1997). The examination of individual differences in preference for dietary fat is extremely limited. This may be, in part, due to the complex nature of the taste system in the detection of fat and also due to the difficulties in measurement of fat preference (problems with the measurement of preference for dietary fat is discussed in Chapter 2, section 2.4.4).

It is perhaps unsurprising that preference for high-fat foods has been found to be positively associated with higher levels of the consumption of highly-fattening foods compared to individuals who show a preference for low-fat foods (Drewnowski & Hann, 1999). The examination of individual differences specific to personality in fat preference has been limited to 2 studies only (at the time of writing). Davis and colleagues (2006) found that Sensitivity to Reward (STR) was positively related to preference for sweet and fatty foods and also related to overeating. They concluded that personality traits such as STR can influence body weight indirectly by the way it co-varies with eating behaviours and food preferences that contribute directly to variation in the outcome variable. Elfhag and Erlanson-Albertsson (2006) found that while a strong preference for sweet tastes was associated with more neurotic personality traits, fat preference was better explained by eating behaviour, particularly dietary restraint, rather than personality traits directly. These studies focussed on an obese population (Elfhag & Erlanson-Albertsson, 2006) and a sample of pre-menopausal women (Davis et al., 2006); previous to this no studies have examined personality and fat preference in a non-clinical sample.

Research specific to personality and fat preference is sparse, however a number of studies have found strong links between eating characteristics and preference for dietary fat. Restrained eaters typically avoid or reduce their consumption of high fat foods compared to unrestrained eaters (Tushl, 1990; Alexander & Tepper, 1995). Previous research indicates that the avoidance of high-fat is not due to taste or palatability as restrained eaters tend to give similar hedonic values to high-fat foods and low-fat foods (Chapelot, Pasquet, Apefelbaum & Fricker, 1995; Roefs, Herman, MacLeod, Smulders, & Jansen, 2005). This suggests that restrained and unrestrained eaters may like high-fat foods to the same extent, but may differ in their craving and perception of these foods as "forbidden". This was further confirmed by Rideout and colleagues (2004), who also found that women with high scores of cognitive dietary restraint choose foods lower in fat and energy than those with low dietary restraint, but did not necessarily prefer the low-fat options in terms of taste.

1.8 Conclusion

There is an evidence-base to suggest that individual difference variables are an important aspect of human eating behaviour. Personality variables have been found to explain some of the variance in disordered eating, dieting and general eating behaviour. They have also been implicated in particular eating traits, for example, neophobic eaters and restricted eaters. Although the complexity of the food choice process is well established, there is little understanding of the role of personality variables in this process in non-clinical populations. Taste is a primary reinforcer influencing subsequent food selection, yet individual differences in personality have rarely been examined in terms of taste preference. The examination of individual differences in other health-related behaviours has successfully demonstrated that personality variables can be useful in developing understanding of these behaviours. In light of this the thesis will examine individual differences in personality, taking a biological approach, for taste preference for sweet, salty, bitter, sour, umami, spicy and fat tastes with a view to add to existing models of food choice. It is expected that individual differences specific to temperamental personality in preference for the taste of foods as in important reinforcer of food selection will map individual differences in general eating behaviour and highlight the importance of the inclusion of individual differences in the taste process.

Chapter 2

Methods and Measures

2.1 Overview

This chapter aims to review and outline the selection and employment of the methods used within this research programme. The studies employed a variety of methods and measures, both experimental and psychometric, these are discussed in detail. This chapter also examines issues relating to terminology, the recruitment and selection of participants, and the ethical considerations.

2.2 Terminology

2.1 Palatability

Within the appetite and eating behaviour literature the meaning of the word palatability and related words has not been consistently applied (Ramirez, 1990). Due to these inconsistencies in definition it is important to outline the meaning of these in relation to the current research programme. Palatability is often used interchangeably with taste preference. These terms are used widely in the eating behaviour literature; the word palatable is thought to be the most frequently used description of the properties of foods (Yeomans & Symes 1999).

The Concise Oxford English Dictionary (1999) provides a simple definition suggesting that palatable is pleasant to taste, this is in agreement with the everyday use of the term. Despite this, within the scientific literature there is disagreement in terms of what is meant by the term palatable or palatability. The meaning behind palatability has been described in a number of ways; it is often used to denote a number of meanings relating to the hedonic response of an organism to a food, the orosensory action of the food that determines its acceptance, the hunger-dependent and sensory-specific stimulation to eat, or the interaction between the orosensory stimulation and internal factors that together determine acceptability of a food (Bellisle, 1989). In this way palatability may be seen as a broad continuum (Bellisle, 1989).

Kissileff (1990) suggests asking participants to rate how much they dislike or like a food item could be termed "intrinsic palatability". He suggests that this term may be useful to distinguish between the response to a property of a food rather than a response based on prior associations between a food and the post-ingestional effects of that food. Kissileff (1990) refers to this latter form of palatability as "learned palatability". Intrinsic palatability may be defined as the rating of liking or disliking an individual gives to an item when tested under standardised conditions. This is a useful distinction which may be practical within the scientific literature but would probably mean very little to the lay person.

The literature does tend to agree that a common factor of palatability is "the acceptability of a food under constant physiological conditions" (Perez, Dalix, Guy-Grand & Bellisle, 1994, pp.165). It is also generally agreed to be the sensory qualities of foods on intake (Yeomans, 1996). Palatability has been further described as “liking”; suggesting that it is an important factor of food that affects everyone (Roefs, Herman, MacLeod, Smulders & Jansen 2005). This is in line with the dictionary definition and perhaps the common use of the word in everyday English. However, Rogers (1990) refers to “liking” as conditioned food preferences, recommending that future research should clearly distinguish between the pleasantness of the taste of the food (influenced by palatability) and the pleasantness of ingesting the food (influenced by satiety and hunger). In terms of the interpretation of human ratings of pleasantness this is fundamental; “are they rating how good the food tastes, or how good it is to eat?” (Rogers, 1990, pp.168). Booth (1990) describes palatability, satiety, hunger and thirst as cognitive processes or aspects of dispositions to eat and drink. These immediate cause effects are “abstracted features of the organisation of ingestive behaviour” (pp.172). In this respect the palatability process is dependent on the perception of the eater at the time of eating and dependent on the context (e.g. in a state of hunger or satiety) in which the food is eaten. Booth (1990) further asserts the manipulation of ingestive processes, such as satiety, can alter palatability and subsequent ingestive behaviour.

Berridge and colleagues differentiate between 'liking' and 'wanting' (Berridge, 1996; Berridge & Robinson 1998, see Chapter 1 section 1.3.2). Wanting corresponds to appetite and craving, whereas liking closely corresponds to the concept of palatability outlined above. In this way the concept of liking as defined by Berridge, also reflects that of taste preference and sensory pleasure. Finlayson et al (2007) expand upon this, suggesting that there are explicit and implicit components to wanting and liking in terms of level of processing. The implicit components describe motivational expression of reward attribution and unconscious affect, whereas the explicit component relates to a conscious desire or subjective feelings of intent or desire, and subjective feelings of orosensory pleasure (Finlayson et al., 2007).

Considering these definitions, the concept of explicit liking is most relevant to this research programme; of interest is the subjective feelings or orosensory pleasure specific to taste. Taking from this literature, the word palatability is used within the thesis chapters interchangeably with taste preference as both these terms refer to the acceptability or liking of the sensory properties of food, of which the thesis is concerned.

Yeomans and Symes (1999) recommend that future studies evaluating the hedonic properties of food should take great care when using the term palatability. They further recommend that researchers should clearly define what is meant by the word i.e. state how the word is defined from the onset of the research or avoid direct questions which include the word entirely by seeking an alternative.

Due to these definitional problems and in light of Yeomans and Syme's (1999) recommendations a small pilot study was run. The aim of the pilot was to gain a fuller understanding of the common meaning of the term palatability, informing the terminology to be used in the study procedures of the research programme. In total, 64 1st year undergraduate students at the beginning of their course were asked to write down a definition or what they understood by the term palatability. Using content analysis the frequency of term occurrences were assessed (see table 2.1).

Table 2.1 – Frequency of term occurrences used by participants to define palatability

Terms used to define palatability	*Frequency of term occurrences*
Pleasant /pleasurable	4
Taste/tasty/tasteful	34
Easy/willing to eat	7
Preference/likes and dislikes	14
Taste buds	4
Edible	3
Palate/palatable	4
Looks appealing/appetising	2
Texture	1
Amount/how much someone can manage to eat	2
Satisfaction from food	1
Unsure/don't know	12

The most frequent terms used referred to the hedonic properties of foods and drinks, particularly to taste, for example "the ability to distinguish tastes" or "how something tastes, whether or not it tastes good". Followed by references to likes and dislikes or preferences in terms of food and tastes, for example "your likes and dislikes in regards to taste" or "likes and dislikes of individuals". The pilot revealed that common understandings of the term palatable or palatability closely reflected the dictionary definition and referred to the hedonic value of food or the taste of food; taste-related words were most frequently used to describe palatability. This is also in agreement with a number of researchers in the field (e.g. Roefs et al., 2005; Yeomans, 1996), although it is also thought to be more complex than these definitions would suggest. A number of participants stated that they were unsure or did not know what the term meant (although the majority of these did attempt to define it) in light of this it may be useful to define the term at the onset of subsequent studies as recommended by Yeomans and Symes (1999) or as this brief pilot indicates using a derivative of the term "taste" may be more meaningful to participants. In light of this, during the research programme this stance was adopted; studies reported in the thesis employ terms relating to taste and liking in study procedures (i.e. when asking participants to rate the taste of the test foods) as these terms appear to be elicit more meaning compared to the term palatability.

Despite this within the written thesis the terms palatability and taste preference are used in relation to the acceptability or liking of the sensory properties of food.

2.3 Psychometric measures

2.3.1 Characteristics of Eating Behaviour

Previous research has found individual variability in eating behaviour (see Chapter 1, section 1.5) and links between eating behaviour and personality (see section 1.5.3). Research exploring relationships between eating behaviour and personality often employ either the Three Factor Eating Questionnaire (TFEQ; Stunkard & Messick, 1985) or the Dutch Eating Behaviour Questionnaire (DEBQ; Van Strien, Frijiters, Bergers, & Defares, 1986). These measures are largely influenced by the development of the Restraint Scale (Herman & Polivy, 1975, 1980). As the research programme is interested in relationships between characteristics of eating behaviour and personality, as well as taste, a measure to assess eating behaviour was required.

Perhaps the most well-known construct of eating behaviour is dietary restraint, a psychological determinant towards over-eating. This construct of dietary restraint features as a subscale in both the TFEQ and the DEBQ. The original Restraint Scale (RS) first devised by Herman and Mack (1975) and later revised by Herman and Polivy (1975, 1980), was developed to measure the cognitive processes involved in the restraint of eating in order to suppress body weight. The theory of restraint highlighted the importance of cognitive processes associated with attempts to reduce body weight rather than actual success in terms of weight loss and suppression. The RS was developed to measure this and although extensively used, the RS has been criticised with the validity of this scale brought to question.

The RS has been criticised for not distinguishing differences between restriction of food intake and disinhibition of control over eating (Stunkard & Messick, 1985). It is limited to measuring the short-term regulation of eating and not extended to assess longer-term energy imbalances which may also have physiological effects (Lowe, 1993). Originally developed to be a uni-dimensional construct, studies employing factor analysis have found that the RS has a multifactorial structure (van Strien et al, 1986; Wardle, 1986; Wardle, 1987), and others found it to contain 2 subscales, concern for dieting and weight fluctuations (Gorman & Allison, 1995).

The RS is a measure of the attempt to control eating rather than eating *per se*. Restraint may be seen as a subcomponent of eating behaviour and a characteristic of eating style. The TFEQ and DEBQ were both developed to measure Restraint and other subcomponents, or characteristics of eating behaviour. The attempts of the TFEQ and DEBQ were to differentiate between food restriction and the tendency to over-eat, and hunger levels or levels of intake. In doing this it is believed that these alternative measures assess different constructs of restricted eating compared to the original RS; the RS measures dieting and over eating, while the TFEQ and DEBQ measure intention to diet and successful dieting (Heatherton, Herman, Polivy, King & McGree, 1988; Laessle et al., 1989). These instruments also measure external and emotional eating (DEBQ), disinhibition and hunger (TFEQ).

The counter-regulatory behaviour observed in restrained eaters as measured by the RS has been found to relate to disinhibition (tendency to overeat) instead of restraint in isolation; the scale does not seem to be unidimensional as it sets out to be (Van Strien et al., 1986). In light of this Van Strien and colleagues (1986) developed the DEBQ which measures 3 subscales of eating behaviour: restrained eating; emotional eating; and external eating. The aim of this scale was to offer an improved measurement of dietary restraint but taking into account individuals who may have latent obese eating patterns and weight fluctuations. In the process of development of this measure, 20% of the variance in scores on the DEBQ were explained by various measures of food intake; concluding that the measure had moderate to good validity (Van Strien et al., 1986).

Wardle (1987) found that the DEBQ was successful in measuring and evaluating restraint, emotional eating and external eating in non-clinical and clinical groups. Wardle (1987) suggests that the DEBQ effectively measures the relationship between restraint and loss of control of eating (disinhibition). Despite this the External and Emotional subscales are thought to measure a single construct, and are often combined to provide a measure of disinhibited eating (Van Strien, 1997). A further comparison of the psychometric properties of the 3 measures of restraint found that the DEBQ (van Strien, Frijiters, Bergers & Defares, 1986) was the most homogeneous restraint scale when examined as a single factor structure, and was also found to be the most stable factor across different populations (Allison, Kalinsky & Gorman, 1992).

Mixed findings have been revealed in terms of the restraint subscale of the TFEQ. Differences between this and the original RS suggest that these scales measure different constructs (Ridgway & Jeffrey, 1998). Lowe (1993) suggests that this may be due to differences in the assessment of restraint; the RS measuring actual dieting (caloric restriction) and the TFEQ measuring restraint as the intent to diet or restrict caloric intake. Further observations have concluded that the restraint scale of the TFEQ is a weak measure of caloric intake (Stice, Fisher & Lowe, 2004; Stice, Copper, Schoeller, Tappe, & Lowe, 2007).

However, Stice and colleagues (2004) findings have also been challenged; they base their conclusions on a 'snapshot' view; assessing dietary intake on a single eating episode opposed to assessing overall dietary restriction (van Strein, Engles, van Stavern & Herman, 2006). In addition Stice and colleagues (2004) compared their findings with results where restrained eaters self-reported their dietary intake; underreporting has been observed among highly restrained eaters in terms of caloric intake and body weight (Cash, Grant, Shovlin & Lewis, 1992; McCrabe, McFarlane, Polivy & Olsted, 2001). In addition, Stice and colleagues fail to consider that the restraint scale of the TFEQ was developed to measure intent to diet and not calorie intake (Stunkard & Messick, 1985). Further assessment of the restraint subscale of the TFEQ has found this to be the most valid measure of both intent to diet and caloric restriction (Williamson et al., 2007), compared to the DEBQ and the RS (revised version).

The TFEQ was found to have the greatest discriminant validity in terms of social desirability; participants completing the scale tend to respond truthfully and responses made and thought to be true representations of their actual eating style

(Allison et al., 1992). In addition the authors of this paper indicate that of the 3 measures the TFEQ is the only measure containing both negativity and positively worded items. This may account for the observations that the scale performs better in terms of truthful responding and shows high levels of validity in relation to socially desirable responding.

All 3 subscales of the TFEQ have been assessed independently against other psychometric predictors of restrained eating (Collins, Lapp, Helder & Saltzberg, 1992). The intercorrelations between the subscales revealed similar findings to Stunkard and Messick (1985); a significant correlation between disinhibition and hunger and no correlations were revealed between the restraint scale and other scales suggesting that this is a unique construct. The TFEQ was found to contain 2 higher order factors which seemed to be highly independent, relating to Cognitive Restraint and Impulsive eating (defined in this case as excessive eating). This paper suggests that the TFEQ is an internally reliable and consistent measure of cognitive restraint and disinhibition of eating. Although 2 higher-order factors were found the authors conclude that the three subscales are equally valid measures of eating behaviour and that the TFEQ provides a good assessment of underlying constructs involved in dietary restraint (Collins et al., 1992).

The DEBQ and the TFEQ offer valid and reliable assessments of constructs of eating behaviour, which can be quickly and easily assessed. Previous research has shown that these show predictive power, both in and outside, the laboratory. As highlighted above, the three scales measure slightly different constructs of eating behaviour and dietary restraint, yet all equally valid (Hill, 1996). An overall aim of this thesis was to measure characteristics eating behaviour and taste preference in relation to personality variables. Examining the past literature has highlighted relationships between the subscales of the TFEQ and personality variables, particularly in terms of biologically based measures of personality (McLean & Barr, 2003; van den Bree et al., 2006). The DEBQ is only thought to reliably measure 2 constructs, restraint and disinhibition by summing external and emotional eating subscales (Allison et al., 1992). In light of this and the evidence presented above which suggests that the TFEQ is a reliable, valid and useful measure of constructs of eating behaviour this was the chosen measure for the reported studies within the thesis.

2.3.2 Temperamental Personality

Temperament is multidimensional and biologically-influenced (Zuckerman, 1991; Cloninger, 1987). Previously research examining personality and eating have often employed biological models of personality. Temperament traits have been shown to be a risk-factor in the development of disordered eating behaviour (Kleifield et al, 1993; Brewerton, Hand & Bishop, 1993; Waller et al, 1993; Jimerson, Wolfe, Brotman & Metzger, 1996; Ringham, Levine, Kalarchian & Marcus, 2008); they are also related to characteristics of eating behaviour in the obese (Elfhag & Morey, 2008) and normal eaters (Van den Bree et al., 2006); relationships have been found between temperament and craving (Gendall, Sullivan, Joyce, Fear, & Bulik, 1997); and in terms of taste preference (e.g. Kampov-Polevoy et al., 1997, 1999).

The previous chapter (see section 1.7 of Chapter 1) discussed the research suggesting links between taste and personality. Generally these studies have examined out-going traits in isolation (e.g. extraversion, sensation seeking, novelty seeking and reward sensitivity). In theoretical terms temperamental personality traits are seen to span a continuum, that is, individuals will achieve scores on all sub-traits and these sub-traits appear to interact. For example, an individual low in harm avoidance and high in novelty seeking will tend to seek thrills and danger, displaying behaviour that is impulsive-aggressive, whereas an individual high in harm avoidance and low in novelty seeking will seek security and conform to social conventions (Svrakic, Przybeck & Cloninger, 1992; Giancola, Zeichner, Newbolt & Stennett, 1994). Personality traits such as harm avoidance, neuroticism and introversion have been examined in clinical populations; high scores of these traits have been found to be good predictors of eating disorders (Kleifield et al., 1993; Brewerton et al., 1993; Waller et al., 1993). Despite this, links between temperament and taste preference have been rarely examined among all the temperamental traits particularly in non-clinical populations; this is a principle objective of the research programme.

A biological approach is warranted in this type of research due to the genetic influence in the development of taste preference in humans. In addition due to the links with reward and motivational systems implicated in eating behaviour, drawing on a biological model of personality, which also examines these mechanisms may be beneficial. In terms of measures of biologically-based temperament a number of measures have been developed to assess these individual difference traits. Perhaps the most well-known on the biological models is Eysenck's biological model (1967). Eysenck developed a personality measure to assess 3 dimensions of biological personality and had a huge impact on the study of personality. In recent years the Eysenck Personality Questionnaire (EPQ) has received much criticism. Much like the 5 factor model of personality, the EPQ is data-driven, derived from factor analysis. Eysenck's dimensions neuroticism and extraversion are specified on the basis of factor analysis of the phenotypic structure of personality and thought to be the product of both genetic and environmental factors. Eysenck assumed that phenotypic and genotypic structures were the same, suggesting that the genetic and environmental factors influence behaviour in much the same way. This assertion has been brought to question by Cloninger and colleagues (Cloninger et al., 1994) and Zuckerman (1991). Factor analysis can determine the number of personality dimensions used within a model but not the theoretical causal structure (Cloninger, 1987). This has been further observed by Gray (1982). Gray (1982) showed that scores of both neuroticism and introversion were lowered as a result of anti-anxiety drugs, suggesting that these dimensions share biologic influences despite Eysenck's assertion that they these processes are independent.

Both Zuckerman and Cloninger focus on the monoamine neurotransmitter systems as a basis for temperamental personality traits, although they differ in the relationships between particular monoamine transmitter systems and personality dimensions (Zuckerman, 1995). Both models describe novelty seeking, or sensation seeking, as higher-order traits; previously Eysenck's model and the development of the FFM had placed less emphasis on these impulsivity-based traits, placing it as a lower-order trait.

Zuckerman describes sensation seeking as having a biosocial basis (Zuckerman, 1994). The theory was based on the assertion that there are consistent individual differences in optimal arousal and stimulation which could not be measured by any preceding measure. The Sensation Seeking Scale (SSS) was developed in order to test this (Zuckerman, Kolin, Price, & Zoob, 1964). The scale was later revised from the General Scale, whereby factor analysis revealed 4 dimensions of sensation seeking (Zuckerman, 1971): Thrill and Adventure Seeking (TAS); Experience Seeking (ES); Disinhibition (Dis); and Boredom Susceptibility (BS). The 4 subscales have shown to have good reliability both cross-culturally and among males and females (Zuckerman, 1994). Although the Sensation Seeking trait is now widely accepted as having an influence on risk taking behaviour and implicated in individual differences in arousal, it broadly describes a unitary trait. This led Zuckerman to develop a measure that assessed a broader range of personality dimensions, the Alternative Five (abbreviated to ZKPQ, Zuckerman, Kuhlman, Joireman, Teta, & Kraft, 1993).

High correlations have been observed between Zuckerman's impulsive sensation seeking scale (from the ZKPQ) and Cloninger's Novelty Seeking scale confirming the similarity between these dimensions. Both authors define novelty and sensation seeking as major dimensions in their models of temperamental personality, demonstrated by the biological basis of this dimension and the high heritability (Zuckerman & Cloninger, 1996). Yet Eysenck's model and the 5 factor model describe sensation seeking as a lower facet of extraversion and impulsivity as a lower facet of neuroticism.

Cloninger developed his own personality questionnaire, the TPQ, to measure his 3 dimensions of temperamental personality (TPQ, Cloninger 1987). He later extended this to include measures of character; the Temperament and Character Inventory (TCI; Cloninger, 1994). The TPQ was developed to operationalise and measure behaviours associated with three dimensions of temperamental personality; Novelty Seeking (NS), Harm Avoidance (HA) and Reward Dependence (RD). Cloninger (1987) asserts that these dimensions are genetically independent, stable and heritable, but also have predictive patterns of interaction in their adaptive responses to specific stimuli. Harm avoidance relates to the tendency towards intense avoidance of aversive stimuli and reward dependence relates to the tendency towards intense response to rewards. Novelty seeking relates to the tendency towards exhilaration and excitement; this is the most dominantly researched of Cloninger's personality dimensions (see table 2.2 for a summary of the dimensions of temperament and the related stimuli-response characteristics). After the theoretical development of the TPQ the proposed factor structure was subjected to factor analysis (Cloninger, 1991; Waller at el., 1991). This resulted in a 4th dimension, Persistence, originally a subscale of Reward Dependence.

Table 2.2: Major brain systems influencing stimulus-response characteristics observed in Cloninger's original temperament dimensions[2]

Temperamental personality dimension	*Brain system*	*Monoamine neurotransmitter system*	*Activating stimuli*	*Behavioural response*
Novelty Seeking	Behavioural activation	Dopamine	Novelty	Exploratory pursuit
			Potential reward	Appetitive approach
			Relief of punishment	Active avoidance
Harm Avoidance	Behavioural inhibition	Serotonin	Conditioned signals for punishment and non-reward	Passive avoidance
Reward Dependence	Behavioural maintenance	Noradrenalin	Conditioned signals for reward or relief of punishment	Resistance to extinction

Unlike other measures of personality the TPQ was developed to be used in both normal and abnormal populations where the dimensions have been found to be stable and consistently reliable despite mood (Cloninger, 1987; Cloninger, 1991; Cloninger et al., 1994). The structure and stability of the TPQ have also been observed cross-culturally; the measure has been translated into many languages

[2] Table adapted from Cloninger (1987) A systematic method for clinical description and classification of personality variants, pp.575

including Japanese, Italian, Spanish (see Cloninger et al., 1994), and also Finnish (Miettunen et al., 2004). A recent meta-analysis of 16 studies across a number of countries found support for the factor structure of Cloninger's 4 temperament dimensions (Miettunen, Lauronen, Kantojarvi, Veijola & Joukamaa, 2008).

The TPQ has also been examined in British samples (Otter, Huber & Bonner, 1995; Stewart, Ebmeier & Deary, 2004). The factor structure and the internal consistency of Harm Avoidance were consistency strong. Reward Dependence was found to be less consistent and sex differences emerged in the factor structure suggesting that Cloninger's original 3-factor solution may be more appropriate in British females particularly (Otter et al., 1995). Novelty seeking was found to be consistently higher in the British samples compared to the US normative data provided by Cloninger and colleagues (1994). Otter and colleagues paper is useful as it provides the only UK based normative data (Otter et al. 1995), which is useful for comparison purposes.

2.4 Taste Measures

2.4.1 Measuring Taste

The eating behaviour literature has drawn upon a variety of measures to record palatability and taste preference in humans. These can generally be split into two distinguishable measures, that of taste acuity and taste sensitivity. Taste acuity measures taste detection and recognition of taste whereas taste sensitivity measures are based on intensity scaling of more taste concentrated stimuli (Drewnowski, 1997). Studies that measure taste preference generally use hedonic response ratings which aim to measure the acceptability or pleasantness of a given taste stimuli. As a rule, studies of this type ask participants to rate the taste and flavour, the colour and texture of the food product; these are generally used when testing food products for marketability purposes.

In terms of asking participants how much they like the taste of food, studies have asked participants to rate their ideal preference, for example, salt levels in a taste stimuli using graphic scales (Shepherd & Farleigh, 1986); or used forced choice discrimination (Hyde & Feller, 1981); or used preloads to measure appetizer effects

(Yeomans, 1996). Changes in pleasantness and palatability ratings have also been observed between the start and end of a meal (Yeomans & Symes, 1999), finding that 'fullness' or satiety affect individuals' ratings of pleasantness. Few studies actually ask participants to rate their subjective taste preference which seems surprising given the basic assumption that individuals are aware of their likes and dislikes in terms of taste. In addition few studies have set out to compare subjective ratings of taste preference with ratings of actual taste samples in order to test the reliability of participants' self-reported taste preference. Weaver and Britten (2001) found that self-reported general food preferences were related to sensory evaluation measures of some foods, but did not examine taste directly.

Taste preference is often assessed using sensory evaluation and acceptance testing (Meiselman, 1994). In the food industry panelists are employed and trained to assess the palatability of foods. Such tests are often criticised; it is often questioned if such short exposure to a specific food during a taste test can realistically predict future consumption (Lucas & Bellisle, 1987). Despite this alternative methods do not offer effective solutions.

Taste is thought to be a primary influence in food choice, therefore understanding the influences of taste preference is important to gain a fuller understanding of the food choice process. In light of this it was decided the examination of taste preference should relate to real life, therefore use real food. Previously studies examining individual differences in taste preference have taken different approaches; taste perception and hedonic preference. Studies examining taste perception have concentrated on the detection, recognition and intensity of taste thresholds. These studies tend to use aqueous solutions. In this way the taste stimuli can be controlled and tested rigorously in laboratory settings. Studies examining hedonic preference employ sensory evaluation measures in the form of acceptability and preference ratings of food-based stimuli.

2.4.2 Rating Scales

In both industrial and academic research, sensory testing and acceptance testing involves the selection of appropriate measures or scales. Most studies employ category scales, line scales, relative-to-ideal scales or magnitude of estimation measures (see figure 2.1 for examples). Sometimes 7-point category scales are used but 9-point scales are argued to be more sensitive (Peryam & Pilgrim, 1957).

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1. Category scaling

(Example taken from Drewnowski, Ahlstorm Henderson, Levine & Hann, 1999)

Dislike extremely				Neither like nor dislike				Like extremely
1	2	3	4	**5**	6	7	8	**9**

2. Line scaling -100 mm visual analogue scale (VAS)

(Example taken from Yeomans, 1996)

Not at all |——————————————| Very much

3. Relative-to-ideal scaling

(Example taken from Shepherd & Farleigh, 1986)

Not nearly enough *Just right* *Much too salty*

Figure 2.1: Examples of the most frequently used sensory rating scales

Lawless and Malone (1986a) tested the efficiency and comparability of a number of these rating scales in distinguishing among different consumer stimuli. They found that category (9-point labelled scales) and 100 millimetre line scales were equally effective. This was further confirmed by Pangborn and colleagues who also compared different taste intensity and liking scales, finding that category and line scales performed similarly and were more effective than magnitude estimation to measure liking (Pangborn, Guinard & Meiselman, 1989). Studies asking participants about the use of these different rating scales reported that category and line scales scored higher on most criteria compared to magnitude estimation, indicating that category and line scaling are easier to use by participants (Lawless & Malone, 1986b; Shand, Hawrysh, Hardin & Jeremiah, 1985). Meiselman (1994) concludes that when measuring food preferences it is important to use an existing scale of measurement unless the researcher rigorously tests and develops a new method beforehand. Meiselman further suggests that category and line scaling are advantageous in terms of discrimination and these are user-friendly.

Given the frequent use of line scaling in the eating behaviour and the sensory science literature, this type of scaling was selected to measure liking of taste samples, self-reported liking, hunger, and fullness across the studies reported in the thesis. Chapter 4 reports a large-scale self-report study concerned with perceived taste preference and temperamental traits as predictors. Self-report taste and food preference have also been found to be good predictors of sensory evaluation of food preference and food intake (Weaver & Britten, 2001; Drewnowski et al., 1999). One objective of the study presented in Chapter 5 was to examine if self-reported perceived liking followed similar patterns of liking after sensory evaluation of taste samples. Previous comparisons of these methods have found that self-reported preferences and sensory evaluation yielded similar results for some foods, although sensory evaluation methods generally produced lower preference ratings for most foods (Weaver & Britten, 2001). The anchors are very important because they define the frame of reference for the participant, Anderson (1974) describes them as “additional stimuli that are more extreme than the experimental stimuli to be studied” (Cited in Lawless & Heymann, 1998, p219). As the studies are specifically interested in taste and liking the VAS were labelled with extreme reference points specific to the taste stimuli. For example, when asked about the taste of a stimulus participants were asked to make a judgement about their liking on a scale anchored with descriptors “not at all” to “very much so”.

2.4.3 Taste samples

Chapter 5 of the thesis examines individual differences in taste preference for 6 taste domains; sweet, salty, bitter, sour, umami and spicy. The study was interested in relationships between personality and the acceptability or liking of these different taste domains. Studies previous to this have described the problems with using taste samples using the raw substances to examine taste preference. These are generally found to be unpalatable, for example, monosodium glutamate to examine umami preference (Yamaguchi & Takashai, 1984; Beauchamp & Pearson, 1991). Following this it was fundamental that the taste stimuli were developed to be palatable and representative of real food. It was also essential that the taste samples were visually and texturally identical in order to control for other sensory properties as much as possible. The development of the taste samples used in study 2 is described in more detail in Chapter 5 (section 5.3.2.1).

Chapter 6 describes the following study which aimed to further examine individual differences in sweet and sour taste preference. The development of the taste samples in study 2 was challenging; finding a food sample to test explicit liking of each taste dimension across the same food sample proved difficult. It was suspected that the pasta and sauce food sample did not appropriately reflect taste preference, particularly bitter, due to expectancy effects relating to the expectation of the taste of pasta and sauce based on prior experience of this food. To overcome this study 3 (chapter 6) employed a range of intensity of aqueous taste samples (lemon-flavoured drinks). The frequent use of aqueous taste samples in the sensory science and eating behaviour literature is attributed to observations of strict control compared to solid taste samples. Using a range of concentrations can be effective in showing preference for sweet tastes; Perez and colleagues found that hedonic ratings of a range of sucrose samples reflected actual intake (Perez et al., 1994).

It is recommended that studies employing taste stimuli employ specific techniques to maximise control and rigour. In order to avoid interaction and the possible influence of other foods and tastes, sensory studies usually ask that participants to either fast or refrain from eating and drinking (with the exception of water) for 2 hours prior to tasting (Lawless & Heymann, 1999). In addition it is common practice that studies involving the sensory evaluation of food employ the 'sip and spit' technique (Moskowitz, 1986). In most sensory studies, swallowing of taste samples is avoided in order to minimise carryover effects from the taste of one sample to the next, instead samples are expectorated (Lawless & Heymann, 1999). Despite this there are sensory advantages to swallowing the sample; taste receptors have been found at the back of the mouth on the tonsils and epiglottis and also in the throat. In this way swallowing is advantageous when examining the effects of chilli-burn and pepper (Lawless & Heymann, 1999). In light of this participants were not asked to expectorate the taste samples in study 2 (Chapter 5)[3] as one of these contained chilli-pepper. These taste stimuli were given in small portions (approximately 15g per sample) so it was unlikely that consumption of all 6 would lead to satiety, which is known to influence like and acceptability scores (Lawless & Heymann, 1999). Since study 3 (Chapter 6) employed aqueous solutions involving very small quantities of a lemon flavoured glucose solution the sip and spit technique was employed.

As taste sensitivity varies depending on the individuals' composition of saliva (Christensen, 1986), rinsing the mouth between taste samples is usually recommended in order to control for this type of variability (see Shepherd & Farleigh, 1986). It was ensured that participants rinsed their mouths between taste samples in both studies (see Chapter 4 and 5). Taste sensitivity and taste bud density also varies across individuals which can result in variation in hedonic ratings to sucrose and PROP depending on the number of fungiform papillae (Miller & Reedy, 1990), unfortunately this is difficult to control for. To ensure further control the presentation of the taste samples was randomised in order to minimise order effects which are particularly problematic in sensory evaluation studies (Lawless & Heymann, 1999).[4]

2.4.4 Measuring Preference for Dietary Fat

The final study of the research programme aimed to investigate individual differences in taste preference for dietary fats. Previously the measurement for fat preference and fat intake has generally been examined via experimental studies. Despite this, experimental studies in particular sensory tests often prove problematic due to the complex nature fat plays in the human diet and their function in foods (Mela, 1990), and the difficulty finding appropriate test foods (Mela & Marshall, 1992; Mela & Sacchetti, 1991). Fat is rarely, if ever, consumed in a pure state. Generally attempts to test fat preference using solutions of fat have

[3] Participants were provided with appropriate receptacles for expectoration in the event that they needed to expectorate the taste sample
[4] Study 2 (Chapter 5) employed a Latin square design. This was later revised for study 3 (Chapter 6); a computer-based random number generator was employed in order to increase randomisation

been perceived as unpalatable (Mela, 1990). In addition, fat content of a food can dramatically change the properties of a food and since fat content varies across the food groups it is difficult to draw general conclusions about fat preference based on one test food.

Few studies have sought to examine hedonic preference of the taste of fat (Drewnowski & Greenwood, 1983). As discussed above (in section 2.4.3) studies examining taste preference in humans have traditionally used water-based solutions adding different taste dimensions. As texture is a fundamental attribute to the pleasantness of fat, studies examining fat preference have used both liquid and solid based test foods (Drewnowski, Shrager, Lipsky, Stellar & Greenwood, 1989). Common methods include adding thickeners, which generally increase the perceived intensity of fat in foods (Drewnowski & Schwartz, 1990). Another method involves adding substances which reduce the viscosity; these result in perceptions of lower-fat content (Mela, 1993). Despite this pleasant ratings for fat mixtures tend not to reflect accurate assessments of the fat content. Drewnowski and Schwartz (1990) found that adding sugar to fat mixtures increased the palatability of the test food but resulted in lower ratings of fat content in solid taste samples compared to liquids.

Studies that examine fat preference and intake tend to restrict the test foods to a single food and manipulate the fat content, for example milk is often used (Drewnowski, Brunzell, Sande, Iverius & Greenwood, 1985; Drewnowski & Greenwood, 1983; Drewnowski et al., 1989). Consequently it is problematic to generalise results from these studies to overall fat preference. Mela and colleagues attempted to overcome these difficulties by using a number of foods representative of a number of food groups, including milk, scrambled egg and mashed potatoes (Mela & Marshall, 1992; Mela & Sacchetti, 1991). In total they used 10 different real foods prepared with 2 levels of fat content. Despite this preferred fat levels varied across the foods with no consistent associations found in preferred fat levels. Furthermore, there are practical and logistical problems with this type of method; as a consequence studies employing these methods are most suited to small sample sizes (Lediwke et al., 2007). These issues draw attention to the methodological difficulties often encountered by researchers examining fat preference.

Progress understanding the influence of dietary fat on food choice and preference has been restricted due to this lack of reliable and valid measures which assess preference for dietary fat across a range of food groups. In light of these difficulties 2 research groups have each developed a self-rated instrument aimed to specifically assess preference for dietary fats across a range of foods and overcome limitations observed in studies employing sensory and hedonic ratings of food samples (Geiselman et al., 1998; Ledikwe et al., 2007). Geiselman et al (1998) developed a Macronutrient Self-Selection Paradigm (MSSP) and used this to develop a Food Preference Questionnaire (FPQ). The MSSP was developed to vary fat content systematically with sugar, complex carbohydrates, and protein content in a battery of foods. This informed the FPQ which has a similar design; 2 Fat (high and low) x 3 Carbohydrate (CHO: high simple sugar, high complex CHO and low CHO/high protein). The measure contains 72 foods which respondents must rate on a 9-point hedonic scale. The questionnaire has strong test-retest reliability and validity. The instrument has significantly demonstrated marked individual differences in fat intake and fat preference (Geiselman et al., 1998). Despite this the questionnaire does not measure how frequently foods are consumed; high fat foods may be preferred but may not consumed regularly. For example, individuals may prefer the taste of full-fat milk but choose to purchase and consume semi-skimmed milk as a means to restrict fat intake. The FPQ (Geiselman et al., 1998) is also lengthy and fairly complex.

Ledikwe et al. (2007) also developed a Fat Preference Questionnaire© (also abbreviated to FPQ©). This measure had a lower cognitive demand than the FPQ developed by Geiselman and colleagues, containing only 19 food sets. Each food set includes foods varying in fat content, for example, the set *salad dressing* includes a full-fat option, a low (reduced) fat option and no dressing option. Respondents must select the food that tastes better (TASTE score) and the food that is eaten more often (FREQ score). These scores can then be used to calculate a dietary fat restraint score (DIFF score) which reflects foods chosen as tasting better but consumed infrequently. The DIFF subscale has shown to strongly relate to the dietary restraint subscale of the TFEQ (Stunkard & Messick, 1985). This instrument is stable with high test-retest correlations among the subscales and is valid across a number of research settings, including laboratory based, longitudinal studies and clinical weight loss studies (Ledikwe et al., 2007). The instrument is easy to administer and score (Ledikwe at al., 2007).

In the development of the fat study (Chapter 7) pilot studies were conducted in order to select an appropriate test food to assess taste preference for dietary fat. A number of solid and liquid foods were piloted ranging in fat content, including fromage frais, crème fraiche and milk. Participants found these unpalatable and subsequently scores of liking were very low across the foods particularly the lower-fat containing foods (see appendix 1 for pilot scores). In light of this and the problems observed with sensory testing of fat it was decided that a self-rated measure would be employed in the fat study (Chapter 7). In this way taste preference for dietary fat could be assessed across a number of foods. Both self-rated measures outlined above were developed in the US and are based on foods consumed more frequently in the US rather than the UK. It was decided that the FPQ developed by Ledikwe and colleagues was the most suitable for this research programme (Chapter 7). This instrument is easy to administer and score, and straightforward to complete. The FPQ© is available in the public domain with permission from the authors; the authors were contacted and subsequently gave their permission to amend some of the food sets to reflect UK consumption. Furthermore, the FPQ© seemed suitable for the study because of the relationships found with the TFEQ (Ledikwe et al., 2007); another instrument that would be included in the study.

2.5 Other measures

Background measures were developed in order to gain a detailed account of participants' characteristics and general eating behaviour. These included questions relating to health, medication, alcohol consumption and other issues affecting taste. Fullness and hunger visual analogue measures were taken in line with other studies employing taste samples (Lowe & Butryn, 2007). These were included and measured before testing in order to examine hunger and satiety levels at the time of tasting.

The fat study (Chapter 7) included a measure of body mass. Participants were asked to indicate their height and weight in order for body mass index (BMI) to be calculated. Obesity is commonly defined in terms of body mass (The Health Committee, 2004); obesity is defined as a BMI score of 30 or more (see table 2.3). This definition is the most frequent and widely used. Despite this using BMI as a measure of obesity is highly criticised for failing to take body composition into account (Ogden, 2003).

Table 2.3: Body Mass Index classifications[5]

Classification	*BMI*
Underweight	<18.5
Normal range	18.5-24.9
Overweight	25.0-29.9
Obese	>30.0
Class I	30.0-34.9
Class II	35.0-39.9
Class III severe (or morbid obesity)	>40.0

Other measures are available such as waist circumference (Lean, Han & Morrison, 1995) which has found to be related to obesity and the development of type II diabetes (Chan, Rimm, Colditz, Stampfer & Willet, 1994; Han, Richmond, Avenell, & Lean, 1997). Other measures include measuring the percentage of body fat directly, using bio-electrical impedance scales or callipers. However, BMI remains to be the most frequently used measure within the eating behaviour literature, in light of this it was decided that BMI would be the best measure in order to draw comparisons with previous research.

[5] Adapted from: *Obesity: Third Report of the session 2003-2004 Volume 1* (The Health Committee, 2004)

2.6 Sample Selection

Previously the majority of studies investigating individual differences in eating behaviour have often restricted their samples to clinical populations (i.e. obese populations), women and students. The research programme was interested in "normal" eating or everyday eating including taste preference and eating behaviour in males. Eating may be seen as a continuum; with overeating at one end of the spectrum (i.e. obese) and limited or restrictive eating patterns at the other (anorexia). Whilst every attempt was made to ensure the samples selected for the studies within the thesis would be drawn for a wide population (parents from a local school, office workers, local professionals and students), the majority were undergraduate students.

2.7 Ethical Considerations

Ethical approval was obtained for all studies reported in the thesis by the Development and Society Research Ethics Committee at Sheffield Hallam University in line with the British Psychological Society's Code of Ethics and Conduct (BPS, 2006). Consent forms were developed for all studies to inform participants of their ethical rights in terms of confidentiality and the right to withdraw, based on the Code of Ethics and Conduct (BPS, 2006). Confidentiality was also ensured in terms of data storage; all raw data collected was kept in locked filing cabinets only accessible by the researcher. Appropriate ethical conduct was essential, particularly for studies involving sensory testing (Chapters 5 and 6). All nutritional information and ingredients were provided to participants before tasting. In addition screening questionnaires were developed and administered prior to tasting in order to check for allergies and food intolerances and/or health-problems affecting diet. Any individual reporting food allergies or intolerances were not permitted to take part in the studies for their own safety. This was also the case for health-related problems such as diabetes and hypoglycaemia; participants were not permitted to take part if they disclosed health-related problems specific to diet.

2.8 Outliers

The broad aim of thesis was to examine the impact of individual difference variables on taste preference and eating behaviour. Unfortunately individual differences variables are often treated as nuisance variables (Stevens 1996). During statistical analysis some outliers were observed particularly relating to the personality subscales and BMI. Different authors recommend different methods for the treatment of outliers. For example, some recommend using transformations (Osborne & Overbay, 2004), recoding extreme scores to the highest reasonable score within the data set, or removing them entirely (Clark-Carter, 2002). On the other hand some authors argue that the removal of extreme scores can produce undesirable outcomes. When the data points are found to be legitimate, others argue that data are more likely to be representative of the population as a whole if outliers are not removed (Orr, Sackett & Dubois 1991). As this research programme was specifically interested in individual differences it was not deemed appropriate to remove or adjust extreme scores, particularly when these were considered to be legitimate scores. For example, an outlier was observed in study 4a (Chapter 7) on the BMI variable, as this reflected a true score within the range of BMI, it was retained.

Chapter 3

Aims and Objectives

3.1 Aims of the Research Programme

The principle aim of this thesis is to extend and to further develop understandings of individual differences in taste preference. The sensory properties of food (e.g. taste, appearance, texture) are thought to be primary reinforcers in the complex process of food choice; if the sensory properties are not perceived to be good the food will not be chosen (Aaron, Evans & Mela, 1995; Crystal & Teff, 2006). Individual genetic variability in taste is well established, and there is some evidence to suggest that other individual difference variables may be involved in liking and taste preference yet these explorations have been limited to specific personality traits such as extraversion, sensation seeking and novelty seeking.

Despite previous attempts to develop a comprehensive understanding of the process of food choice, this process is still not fully understood (Furst et al., 1996). If individual eating behaviour is to be changed a fuller understanding of all the factors involved in food choice is essential. As taste is a primary reinforcer in the selection of food, further investigation of the influences on taste may add to existing models of food choice.

Temperament refers to individual differences in reactivity of the behavioural and physiological systems, and self-regulation (Rothbart & Derryberry, 1981). Temperament has been found to influence eating behaviour in clinical and non-clinical populations (see Chapter 1). Since temperament is assumed to have a biological basis strongly influenced by heredity it is likely that the motivational, incentive and rewarding aspects of liking (food) may also be influenced by temperament. Previously temperament has been associated with general eating behaviour and taste preference, although limited research has examined these latter relationships. One of the major objectives of this research programme was to examine relationships between temperamental personality variables and dimensions of taste and eating behaviour. Due to the limited previous research within the appetite and eating behaviour literature the personality variables were used in an exploratory manner to assess the variation in taste preference and eating behaviour processes.

3.2 Structure of the Research Programme

Figure 3.1 provides a schematic representation of the structure of the thesis. The initial study (Chapter 4) explored relationships between taste preference for 6 taste dimensions; sweet, salty, umami, bitter, sour, and spicy. This first study sought to examine self-rated reflective measures of taste. Self-rated food preferences have been shown to provide fairly accurate indications of intake (Weaver & Britten, 2001). Therefore it was expected that self-rated taste preferences should also reflect 'real' taste preference. Study 2 (Chapter 5) extended this to examine taste preference for taste stimuli developed to reflect the taste dimensions tested in study 1. Relationships were explored between temperamental personality variables, eating behaviour (as measured by the TFEQ) and taste preference for the real-food samples. Measures of usual taste preference were also taken to compare self-rated 'usual' taste preference with actual taste preference toward the real-food samples.

Prior to this, relationships have been found between preference for sweet tastes and personality, particularly out-going and stimulus-seeking traits such as extraversion, novelty seeking and sensation seeking. Study 3 (Chapter 6) explored these further by examining individual differences in temperamental personality and characteristics of eating behaviour, and preference for a range of intensities of lemon-flavoured glucose drinks. Individual differences in preference for the taste of high-calorie dense foods were further examined in Chapter 7 (see fat study B, section 7.4). Individual variability in fat taste perception has been observed and attributed to the discovery of fat taste receptors on the tongue which specifically respond to free-fats. With growing rates of obesity in developed countries such as the UK, examining individual differences in fat taste preference will led to fuller understandings of the factors involved in the over consumption of high fat and high-calorie dense foods.

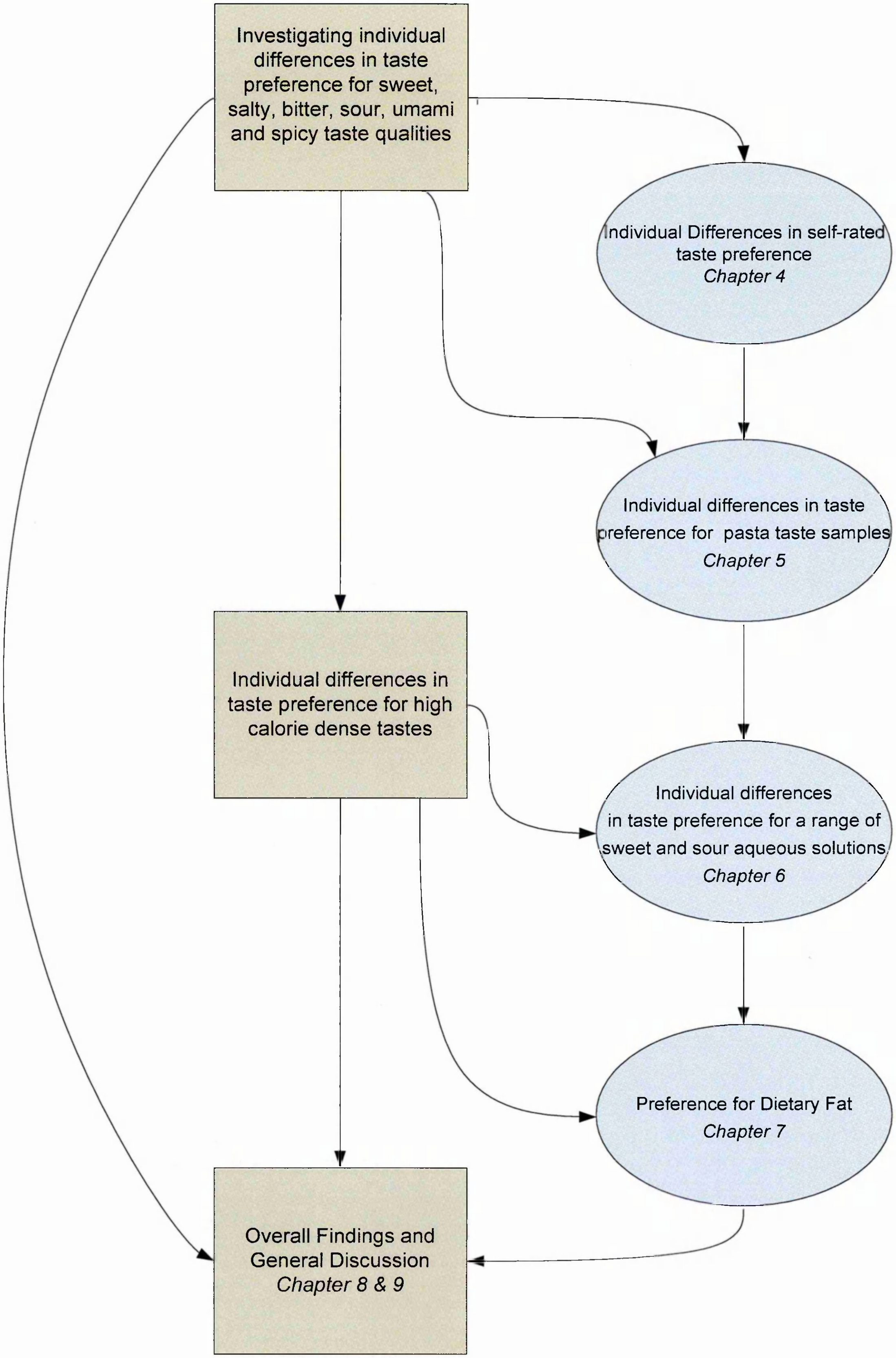

Figure 3.1 Schematic representation of the research programme

3.3 Overall Objectives

- To assess the extent to which temperament (personality) and characteristics of eating behaviour can explain taste preference for the traditionally defined "basic tastes" (sweet, salty, bitter and sour), and also umami and spicy (chilli-burn)
    - using self-reported preference measures (Chapter 4)
    - using preference measures for taste samples (Chapter 5)

- To assess the extent to which temperamental personality and characteristics of eating behaviour can explain variation in preference for a range of calorie dense drinks, considering how sweet and sour tastes interact (Chapter 6)
- To produce UK normative data for the Fat Preference Questionnaire© for both females and males (fat study A - Chapter 7)
- To assess how much variation in preference for dietary fat can be explained by temperamental personality, characteristics of eating behaviour, and body mass index (fat study B - Chapter 7)

Chapter 4

Individual Differences in self-rated taste preference for sweet, salty, bitter, sour, umami and spicy tastes: A questionnaire study

4.1 Overview

The aim of this questionnaire study was to investigate relationships between self-rated "usual" taste preferences for sweet, sour, bitter, salty, spicy and umami tastes with temperamental personality variables.

4.2 Introduction

The process of food selection is influenced by a range of factors as various models of food choice have demonstrated (see Chapter 1 section 1.2.1 for a review of models of food choice). A large and growing body of research has investigated many of these factors including cultural, social, religious, developmental and cognitive. Despite this with the increasing rates of both adult and child obesity in Western societies it is clear that individuals do not always select food based on these factors and awareness of healthy eating. Shepherd's (1989) review of models of food choice identified 3 major themes common to most models, that of "the food", "the environment" and "the individual". When asked why individuals choose particular foods the overarching influence generally relates to the sensory pleasure, especially that of taste (Rappaport, Peters, Huff-Corzine & Downey, 1992; Pliner & Martin, 2005); taste is fundamental to food selection and subsequent consumption.

In terms of "the food", the sensory properties particularly the taste and odour are thought to be the most important determinants leading to food choice and food selection (Clark 1998; Shepherd & Farleigh 1989). Traditionally 4 basic tastes have been described; salty, sweet, bitter and sour. With the discovery that umami receptors in rat taste buds respond specifically to glutamate compounds (Chaudhari et al., 2000), umami has been accepted as a 5th taste dimension.

Opposing traditional ideas of the tongue map and localised areas for these basic taste domains it is now thought that taste receptors do not necessarily respond to a single taste dimension (Boughter & Bachmanov 2007).

Evolutionally perspectives argue that there are biological predispositions to taste. Extreme reactions observed in infants and neonates are well documented, showing innate preference for sweet tastes and disgust for bitter tastes (Steiner 1974; Steiner 1977; Cowart 1981). Innate aversions have also been observed to very strong tastes (Bartoshuk 1990). These reactions to the sensory properties of foods are thought to be adaptive by influencing the careful selection of "safe" foods and avoidance of foods that could cause potential harm. In this way the development of liking for tastes such as sour, spicy and bitter, are thought to be acquired through exposure and learning (Rozin & Fallon 1987).

Theoretically preference for these tastes (bitter, spicy, sour) can be acquired through exposure and learning, although development of these preferences is not necessarily universal. The construct of food neophobia explains the lack of willingness to try novel foods and tastes (Pliner & Hobden 1992). Sensation seeking scores have shown to negatively correlate with food neophobia; generally high scores of sensation seeking are associated with low food neophobia (Pliner & Hobden 1992; Pliner & Melo 1997). In other words sensation seekers like unusual, novel foods and tastes which may be attributable to a tendency for these individuals to seek out stimulation (Cloninger 1994). Conversely less out-going personality types tend to score high on the food neophobia measure, suggesting a lack of willingness to try and like more unusual foods and flavours (Pliner & Melo 1997). These individuals also tend to achieve low scores on the Food Involvement scale indicating that they avoid novel, unusual or different food stuffs (Van Trijp, Hoyer & Inman 1996). This evidence further strengthens the argument for individual differences, specific to personality, in food selection and food choice. In light of this, individual differences in terms of personality may offer an alternative explanation as to why some individuals like unusual/novel tastes and others do not.

Individual differences have been observed in terms of food selection and taste preference within specific populations: age differences (e.g. Murphy 1993); sex differences (e.g. Laeng et al., 1993) and differences in clinical groups (e.g. Sunday & Halmi 1991; Elfhag & Morey 2007) are well documented. Associations between personality variables and general eating behaviour and eating patterns have also elicited much research interest particularly with regards to adherence to dieting (van den Bree et al., 2006) and attitudes towards eating (Pumariega & LaBarbera, 1986). There is limited research that has specifically examined relationships between taste and personality which is surprising given the evidence that psycho-biological personality traits are thought to be rooted in the neurotransmission of dopamine, serotonin and noradrenalin (Cloninger, 1987, 1994) and simultaneously these neurotransmitters have also been linked to various aspects of eating behaviour (see section 1.3.2.3, Chapter 1).

The majority of the research exploring taste and personality associations was conducted between the late 1970s and mid 1990s, and produced mixed findings. Few studies examine salt preference and personality relationships; instead research has focused on salt intake. Stone and Pangborn (1990) explored locus of control traits in relation to individual self-control over healthy eating. They found that high internal locus of control was associated with preference for lower salt levels, conversely high external locus of control (in relation to healthy eating motives) correlated with preference for higher salt levels. Shepherd and colleagues (1985; 1986a; 1986b) carried out a number of investigations on salt intake and their relation to personality traits concluding that neuroticism[6] was negatively related to salt intake; individuals with high scores for neuroticism showed low salt intake, whereas individuals with high scores for extraversion[7] showed high total salt intake.

There is a gap in the literature in terms of umami preference and personality associations, possibly due to the fairly recent discovery of this as a unique taste

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[6] Neuroticism correlates with HA1 (Worry and Pessimism), a lower facet of Cloninger's (1987) Harm Avoidance (Goldberg et al 2006)
[7] Extraversion, sensation seeking and novelty seeking have found to highly intercorrelate, suggesting that they measure similar constructs of personality (Zuckerman & Cloninger 1996)

dimension. However adding glutamate to food has been shown to increase the perceived saltiness of the food (Prescott 2004), indicating that similar patterns of results may emerge between salty and umami taste preference.

Taste dimensions where liking is acquired, such as bitter and sour tastes, have found to positively correlate with sensation seeking and negatively correlate with food neophobia (Mattes, 1994). In addition a strong body of evidence indicates that sensitivity to bitter taste detection has a genetic basis (Blakeslee, & Fox 1932; Fox, 1932; Fischer & Griffen, 1964; Bartoshuk, 1979). Terasaki and Imada (1988) found that individuals who scored high on the sensation seeking scale showed strong preference for spice and spicy foods. A similar pattern of findings were produced by Kish and Donnenwerth (1972); sensation seekers tended to prefer spicy, sour foods rather than bland, sweet foods.

Individual differences in 'sweet tooth' have been repeatedly demonstrated (Conner & Booth 1988a; Conner et al 1988b). Generally, sweet-liking has found to correlate with out-going traits such as novelty seeking and extraversion. Strong preference for highly sweetened solutions have been found to negatively correlate with Exploratory Excitability (a lower facet of novelty seeking which highly correlates with sensation seeking and extraversion) and positively correlate with Extravagance (also a lower facet of novelty seeking) (McHale et al., 2002). Similarly Stone and Pangborn (1990) found that sweet food and sweet drink preference could be linked to individuals with outgoing traits. In alcoholic subgroups high scores in Novelty Seeking have been found to correlate with sweet liking and alcoholic status (Kampov-Polevoy et al., 1997; Kampov-Polevoy et al., 1998; Kampov-Poelvoy et al 2004).

The aforementioned literature confirms links between taste and personality, although there is insufficient research in this area to draw firm conclusions. Tentatively the pattern of findings do suggest that acquired tastes (bitter, spicy and sour) are generally preferred by individuals with more out-going traits observed in high scores of novelty/sensation seeking and extraversion, and disliked by individuals with high scores of neuroticism and food neophobia. Limited research on umami and salty taste preference has been conducted instead studies have examined salt intake. In terms of sweet taste preference most research has focused solely on more outgoing traits showing clear correlations between these variables.

As discussed in Chapter 2 the measurement of palatability or taste preference cannot be directly achieved, instead participant ratings of these hedonic properties of food samples are used as indirect measures. Commonly studies which aim to evaluate palatability or taste preference rely on participant ratings of explicit liking or pleasure ratings of a particular food in a laboratory setting (Finlayson et al., 2008; Yeomans 1998). The rating scales vary across studies, some employing labelled Likert scales (e.g. Peryam & Pliner 1957 first employed a 9-point scale) while others use anchored visual analogue scales (see review by Drewnowski 1997).

Evidence suggests that the tastes are distinct from one another (Beauchamp & Pearson, 1991). Preference for sweet, sour, bitter and salty tastes development at different time points supports evidence that the tastes exist as separate and distinct entities. Consequently most studies examine a single taste dimension and frequently employ aqueous solutions of sugars to measure sweet, sodium chloride to measure salty, critic acid to measure sour, and either caffeine or quinine to measure bitter (see review by Drewnowski 1997). Although widely used these aqueous solutions do not reflect typical food intake; reliable, consistent measures of taste preference are vital. Other studies employ a checklist procedure where food names are presented and rated and so measures here reflect introspective measurements of food preference (Frank & van der Klaauw 1994). These procedures aim to overcome the problems associated with the distribution of aqueous solutions which do not reflect typical food; preference for sweet and salty solutions do not necessarily predict actual sweet and salty preference (Bellisle 1987; Pangborn & Pecore 1982). Studies using food as taste samples also tend to employ small sample sizes due to the time and expense factors of running such experiments, resulting in problems of statistical power and therefore generalisability. As a result there is an absence of a consistently reliable measure of taste preference. This is further complicated by the confused and overlapping definitions of taste perception, taste preference, and palatability (see chapter 2 for a discussion of the problems with terminology, section 2.2).

In light of the literature relating to taste preference and personality and the evidence suggesting innate and acquired tastes, the aim of this study was to investigate taste and personality relationships on a larger scale, by examining simplified taste dimensions. As a result of the difficulties accompanying taste preference measures this initial study asked participants to reflectively rate their "usual" preference for the 5 basic taste dimensions: sweet, salty, bitter, sour, and umami. Additionally preference for spicy tastes was included, in light of the previous findings confirming differences in preference for spicy foods (Kish & Donnenwerth, 1972; Terasaki & Imada, 1988). Links between food choice and personality have been rarely examined in "normal" eaters, despite evidence from clinical populations which link personality style with eating behaviour. This study examined heritable personality factors that make up the individual and preference for the fundamental taste domains (see figure 4.1). Since preference for the sensory properties of food determine food selection and purchase, these data will add to the existing models of food choice.

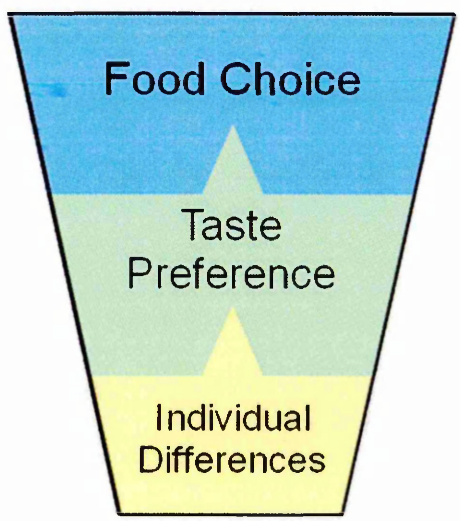

Figure 4.1: Simplified conceptual model

Due to the genetic and biological evidence presented in Chapter 1 particularly in relation to disordered eating Cloninger's Tri-dimensional Personality Questionnaire (TPQ, Cloninger 1987) was employed to measure biological heritable personality traits (see Chapter 2 for discussion of personality models). Visual analogue scales were used to measure individual explicit liking for the simplified taste domains; sweet, salty, sour, bitter, umami and spicy.

Despite the paucity of existing literature, and the exploratory nature of this study, there are a number of predictions:

- A strong preference for tastes defined as acquired (i.e. bitter, sour and spicy) will be related to scores of Novelty Seeking
- Low preference ratings for tastes where liking is acquired will be related to scores of Harm Avoidance and Reward Dependence
- Preference for tastes that are thought to be innately preferred (i.e. sweet, salty and umami) will be associated with scores of both Harm Avoidance and Reward Dependence
- There will be a positive relationship between preference ratings for sweet tastes and Novelty Seeking scores

4.3. Method

4.3.1 Participants

4.3.1.1 Recruitment

One thousand questionnaires were distributed to office workers, parents from local schools and undergraduate students at Sheffield Hallam University in Research Methods laboratory sessions and lectures. First year undergraduate students studying Psychology could receive research participation credits upon completion of the questionnaire. Permission was granted from 2 Primary schools to send questionnaires home with each pupil for parents and carers to complete. A covering letter was also provided explaining the background to the study and details of completion and how to return the questionnaire. In addition local professionals were requested to distribute questionnaires among their work colleagues; this was accompanied with a covering letter. In this way data collection and the recruitment of participants employed some degree of snowballing.

Permission was granted in advance to distribute the questionnaires and ethical approval was achieved via the Faculty Ethics Committee. Questionnaires were either returned to the researcher via free-post envelopes or collected up at the work place or school in a secure "return box" and then later collected by the researcher. A total of 358 questionnaires were returned although 6 of these were not completed appropriately (a return rate of 35.8%), therefore 352 completed questionnaires were used in the analysis of this study.

4.3.1.2 Sample Characteristics

The respondents age ranged between 18 and 81 years with a mean age 32.4 years (SD=11.77). The study included 248 females (mean age 31.9 years, SD=11.57) and 103 males (mean age 33.4 years, SD=12.24). Students made up the majority of the sample (30.9%), followed by professionals (21%) and associate professionals (see figure 4.2 below).

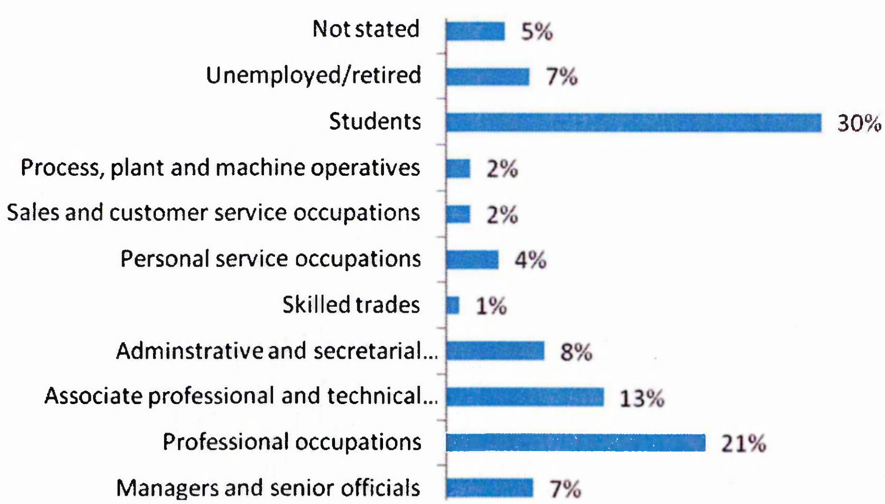

Figure 4.2: Bar chart to show the breakdown of occupations (percentages) of the sample (using the ONS Standard Occupation Classification, 2000)

The sample characteristics are summarised below. The majority of respondents reported being non-smokers, in good health and not currently on medication. A few respondents reported food allergies or intolerances; those reporting allergies were in relation to dairy products (particularly milk), wheat, acidic fruits and fish (particularly prawns and other shell fish). In terms of alcohol consumption, on an average week respondents reported consumption of 17 units (mean, SD=15.70); mean alcohol units for men was 23.81 (SD=22.27) and mean alcohol units for women was 14.96 (SD=12.35). According to the Department of Health "safe" consumption of alcohol is defined as 3-4 units per day for men and 2-3 units per day for females; no more than 28 units for men per week and no more than 21 units per week for women (Department of Health, 2007). Therefore the alcohol consumption of this sample can be defined as within safe limits, although the large standard deviations suggest that alcohol consumption was very variable across the sample.

Table 4.1: Sample Characteristics

Characteristics	*Percentage of sample*
Smokers	22.4%
Reporting good health	95.2%
Currently on medication	21.3%
Suffer food allergies/intolerances	6.8%
Suffer health problems that affect diet	3%

4.3.2 Design

The study aimed to explore relationships between taste preference and personality traits therefore employing a correlational, questionnaire-based design. In this way there were no independent and dependent variable as such. Two sets of latent variables were measured relating to 1) taste dimensions and 2) the subscales of the Tri-dimensional Personality Questionnaire (TPQ; Cloninger 1987). Participants were asked to complete a 10 page questionnaire relating to their general health and diet, taste preferences and personality.

4.3.3 Measures

The questionnaires were presented in a set order in a 10 page booklet, laid out in sequence with the following subsections. Instructions were clearly presented on the front page describing how to complete the questionnaires and details of how to complete the personal code. Participants were instructed to give a personal code, and were given an example of what it could include (e.g. the first 2 initials of their mother's maiden name followed by their house number). Contact details of the researcher were also provided.

4.3.3.1 Background Measures

Along with typical demographic information (age, sex, occupation etc) respondents were also asked how much alcohol they consumed on an average week, whether they smoked and about their health and diet (i.e. any medication or treatment that had affected their diet or sense of taste). See appendix 2.

4.3.3.2 Personality

Personality temperament was measured via the Tridimensional Personality Questionnaire (TPQ; Cloninger, 1987); a personality measure containing 100 short items relating to the temperamental personality. The questionnaire covers the 4 domains; Harm Avoidance, Reward Dependence, Novelty Seeking and Persistence (originally a subscale of Reward Dependence). Reward dependence (24 items) has 3 subscales, novelty seeking (34 items) and harm avoidance (34 items) both have 4 subscales. Persistence (originally RD2 - see table 4.2) is made up of 8 items and is represented by a single subscale. The table below shows a summary of the main domains and their related subscales.

Each item requires a "true" or "false" response. The responses were scored as instructed by Cloninger (1987), giving participants a score for all 12 facets and 4 total scores for the main domains.

Table 4.2: Summary of the major domains and related subscales measured by the TPQ (from Cloninger, Przybeck, Svrackic & Wetzel 1994)

Main Domains	*Facets/Subscales*
Harm Avoidance (HA)	Anticipatory Worry and Pessimism *vs.* Uninhibited Optimism (HA1)
	Fear of Uncertainty (HA2)
	Shyness with Strangers (HA3)
	Fatigability *vs.* Vigour (HA4)
Novelty Seeking (NS)	Exploratory Excitability *vs.* Stoic Rigidity (NS1)
	Impulsiveness *vs.* Reflection (NS2)
	Extravagance *vs.* Reverse (NS3)
	Disorderliness *vs.* Regimentation (NS4)
Reward Dependence (RD)	Sentimentality (RD1)
	Attachment *vs.* Detachment (RD3)
	Dependence vs. Independence (RD4)
Persistence (P)	Persistence (RD2)

4.3.3.3 Taste Measures

Usual taste preference was measured via 100mm visual analogue scales. Respondents were asked to consider each taste and place a vertical mark at the point which best described their usual taste preference (see figure 4.2).

1) I usually like **sweet** tastes

Figure 4.3 Example of a taste measure used within this study

Six taste dimensions were presented in total, relating to sweet tastes, spicy tastes, salty tastes, sour tastes, bitter tastes and "artificially enhanced tastes" (to measure Umami taste preference).

4.3.4 Procedure

Upon receiving permission and ethical approval, the questionnaire booklets were distributed to the establishments and participants who agreed to take part in the study. Each questionnaire was accompanied by a consent form which also acted as an information sheet about the study (this also included contact details). Pre-arrangements were made to collect data during Psychology undergraduate lecture and laboratory sessions. After explaining the study aims and what was involved in terms of participation, students whom agreed to take part were handed a questionnaire, consent form and freepost envelope. Students were asked to bring the completed questionnaire back to the following teaching session (generally a week later), or post it back to the researcher. First year Psychology undergraduates were offered 20 Research Participation credits in exchange for participation, although it was emphasised that the questionnaire should be returned in person in order to collect these.

Other questionnaires were sent to a number of local professionals who had previously agreed to distribute these to their work colleagues. Free-post envelopes were provided and respondents were instructed to return these using these envelopes, alternatively "return" boxes were also provided in order for respondents to place their completed questionnaire. Questionnaires were then returned in bulk to the researcher. A similar process was implemented at the schools; questionnaires were distributed to the parents via the pupils who were asked to take them home by their teachers at the end of a school day. A briefing letter was included in order to introduce the researcher and explain the aim of the study. Freepost return envelopes were also distributed with the questionnaire boxes and a "Returns Box" was placed outside the school office in order to collect any questionnaires sent back to school, the researcher collected these every few days.

4.3.5 Statistical Analysis

Descriptive data was analysed for the taste measures, personality subscales and main domains. Comparisons were made with other British data (Otter, Huber & Bonner 1995; Stewart, Ebmeier & Deary 2004); between the sexes on all personality variables. Pearson's Product-Moment Correlation Coefficient was performed initially and results were further analysed using stepwise regression using the backward function conducted as an exploratory technique (Wright, 1997) to examine relationships between measures of taste preference and personality variables. Models of "best fit" were developed for each taste therefore the 6 taste dimensions were entered separately as the dependent variables and the 12 subscales of the TPQ were entered as the predictor variables. In light of the sex differences in the personality variables found and taste preferences (descriptive data), sex was added to the model to see if this explained any additional variance in taste over and above that explained by personality. The probability level for significance used for the interpretation of all analyses was set at an alpha level of $p<0.05$. Selection of the most parsimonious models was decided *a priori* by selecting the model which retained the significant predictors. All analyses were performed using SPSS for Windows.

4.4 Results

4.4.1. Descriptive Data and Checking Assumptions

The means and standard deviations for all personality subscales and major dimensions, and for self-rated taste measures are presented in table 4.3. This information is presented separately for males and females in order to draw comparisons with previous studies. No sex differences were shown in terms of Novelty seeking, in line with other UK data (Otter et al., 1995; Stewart et al., 2004), and contrasting with Cloninger's US normative data (Cloninger et al., 1994). Women showed higher scores on all subscales of Harm avoidance (with the exception of HA3) and Reward Dependence but not Persistence. The mean scores and standard deviations for all subscales were in line with other UK data (Otter et al., 1995).

In terms of taste preference women gave significantly higher preference ratings for sweet tastes compared to men, whereas men rated spicy, sour and bitter tastes significantly higher than female participants. No sex differences were found in terms of salty and artificially-enhanced taste preference.

Table 4.3 Means, standard deviations and *p*-values associated with sex differences, for personality subscales and major dimensions, and taste measures

	Men			*Women*			*Sex Difference*
	n	Mean	SD	*n*	Mean	SD	*P*
NS1	103	4.96	1.77	248	5.17	1.96	0.36
NS2	103	3.08	2.11	248	3.28	2.05	0.41
NS3	103	3.83	1.98	248	4.22	1.70	0.06
NS4	103	5.21	2.07	248	4.91	2.16	0.22
Total Novelty Seeking	103	17.08	5.52	248	17.57	5.46	0.45
HA1	103	3.31	2.54	248	4.28	2.64	0.002**
HA2	103	3.30	2.02	248	4.12	1.89	<.01**
HA3	103	2.87	2.03	248	2.75	1.98	0.60
HA4	103	2.81	2.44	248	3.44	2.52	0.03*
Total Harm Avoidance	103	12.29	6.59	248	14.59	6.92	0.004**
RD1	103	3.15	1.34	248	3.90	1.14	<.01**
RD3	103	5.84	2.94	248	7.74	2.30	<.01**
RD4	103	2.90	1.45	248	3.64	1.31	<.01**
Total Reward Dependence	103	11.88	4.43	248	15.28	3.32	<.01**
Persistence	103	4.80	2.15	248	5.16	2.04	0.13
Sweet taste	103	61.78	26.07	248	70.80	23.34	0.002**
Spicy taste	103	70.31	24.58	248	60.24	27.26	0.001**
Salty taste	103	45.88	24.0	248	42.46	27.60	0.27
Sour taste	103	43.76	23.55	248	35.46	22.87	0.002**
Bitter taste	103	38.04	23.12	248	27.80	20.09	<.01**
Artificially enhanced taste	103	29.59	26.21	248	31.56	27.70	0.54

The standard deviations for all measures of taste preference showed huge variation from the mean scores, indicative of individual variation in preferences. Overall mean scores for bitter, sour and umami were very low; below 50.

Inspection of histograms and boxplots indicated that all taste preference and personality variables were normally distributed. The skewness statistic for all variables lay between the guideline of ±2.58 set by Clark-Carter (2004). Z scores were calculated and inspected for all taste preference and personality variables; one outlier was detected on NS4. This was not adjusted as it was considered a "true" score (Orr, Sackett & Dubois, 1991). All other scores were within the guideline of ±3 for the detection of outliers (Clark-Carter, 2004).

Multiple correlations were conducted between all predictor variables (the TPQ subscales) to check the assumption of multicollinearity. Since all correlations were below +/-0.8 this assumption was not violated. The sample size was large enough to run multiple regression, based on the guidelines set by Tabachnick and Fidell (1996). Furthermore correlational analysis found that the variables were linearly related to the criterion variables.

4.4.2. Regression Analysis

Due to sex differences in personality scores and taste scores 2 step hierarchical regression was performed to examine the interaction between sex and personality in patterns of taste preference. Z scores for sex and personality scores were created and new interaction variables were formed to combine sex and personality. The interaction variables were calculated by multiplying z scores for each personality subscale scores by z values for sex (previously dummy coded). Despite this relationships between taste and the new interaction variable (sex and personality) revealed that sex did not add to the amount of variance explained in taste, with the exception of sweet taste preference. Therefore the hierarchical regression analyses are only presented for sweet taste preference here (the 2 step hierarchical regression outputs for all tastes can be viewed in appendix 3). Due to the exploratory nature of this study stepwise regression using the backward method was performed on each taste dimension (with the exception of sweet) in order to discover the most parsimonious model consisting of the best predictor variables. All predictors are presented in the tables summarising the regression model for each taste, although only the best predictors are described in detail (i.e. the significant predictors and those with the highest beta values).

4.4.2.1 Sweet Taste Preference

The correlations between the subscales of the TPQ and usual sweet taste preference measures are presented figure 4.4. Correlation coefficients above 0.11 were generally significant at p=0.05. Attachment vs. Detachment (RD3) was significantly and positively associated with sweet taste preference, suggesting that strongly attached individuals rated sweet tastes preferably (r=0.12, p=0.03). Total harm avoidance was found to significantly correlate with sweet taste preference despite the individual subscales failing to reach significance (r=0.11, p=0.05). Exploratory excitability (NS1) and sweet taste preference were found to be negatively related, just falling short of significance (r=-0.10, p=0.051).

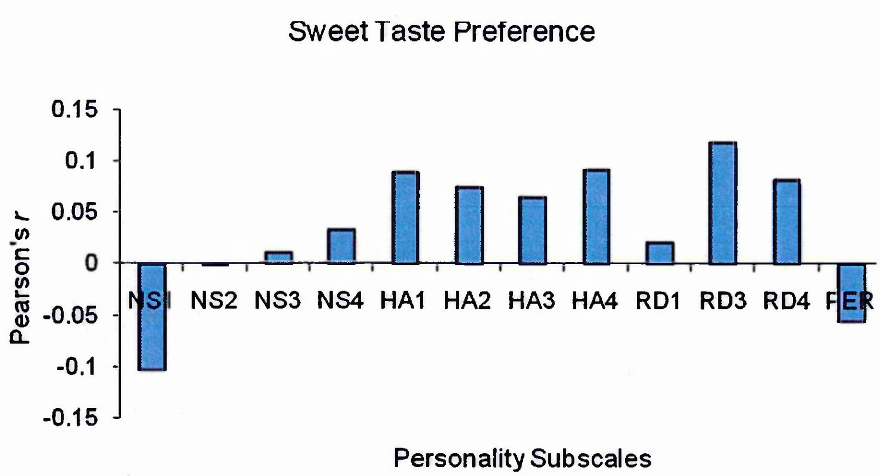

Figure 4.4 Correlation coefficients between subscales of the TPQ and sweet taste preference scores

Regression analysis was conducted to further examine these relationships and to see if sweet taste preference could be explained by subscales on the TPQ (Cloninger 1987). Due to observed sex differences in scores of sweet taste preference and personality subscale scores, sex and personality scores were combined to form interaction variables which were also entered into a hierarchical regression model at step 2. In step 1 of the analysis personality and sex were entered as the predictors whilst sweet taste preference was entered as the criterion. The association between the criterion and predictor variables was moderate (Multiple R=0.25). Together the predictor variables accounted for 2.7% of the variance in sweet taste preference (adjusted R^2). The analysis showed that the amount of variance in sweet taste preference explained by personality and sex approached significance ($F(13,337)=1.74$, $p=0.052$).

The additional contribution of the interaction variables (personality scores x sex) on the model was assessed at step 2. The association between the criterion and predictor variables at this stage was moderate (Multiple R=0.36), explaining 6% of the variance in sweet taste preference (adjusted R^2). The analysis showed that the amount of variance explained by personality scores, sex and the interaction variables combined was significant ($F(25,325)=1.88$, $p=0.007$). The R Square Change statistic indicated that the interaction variables significantly contributed to the model (R^2 Change =1.97, $p=0.026$). The significant coefficients at step 1 and step 2 are presented in table 4.4 (see appendix 4 for the full models).

Table 4.4 Hierarchical regression coefficients for sweet taste preference at step 1 and 2

Predictors	B	SE B	β
Step 1			
(Constant)	68.15	1.29	
Sex	3.89	1.44	0.16**
Step 2			
(Constant)	67.80	1.40	
Sex	3.98	1.46	0.16**
HA3xSex[8]	3.37	1.59	0.14*
RD4xSex[9]	4.34	1.51	0.18**

p<.05 ***p<.01*

[8] HA3xSex is the a interaction variable created by multiplying the z-scores for HA3 (relating to Shyness - a subscale of Harm Avoidance) by the z-scores for Sex

[9] RD4xSex is the interaction variable created by multiplying the z-scores for RD4 (relating to Dependence - a subscale of Reward Dependence) by the z-scores for Sex

Step 1 is the equivalent of examining the main effect of the variables. In this instance only sex accounted for variance in sweet taste preference ($t=2.70$, $p=0.007$). At step 2 HA3xSex contributed an additive effect to the model ($t=2.12$, $p=0.03$), however RD4xSex was found to be the best predictor of sweet taste preference ($t=2.87$, $p=0.004$).

In order to examine the different patterns of sweet taste preference across the sex groups taking into account scores in HA3 and RD4 the unstandardised beta values were placed into a regression formula[10]:

$$y=m_1x_1+m_2x_2+m_3x_1x_2+c$$

In terms of HA3 the formula was:

$$\text{Sweet} = 0.796\text{HA3} + 3.998\text{Sex} + 3.369\ (\text{HA3xSex}) + 67.80$$

This formula became simplified for males (-1.55) to:

$$\text{Sweet} = -4.424\text{HA3} + 61.605$$

For HA3 the formula became simplified for females (0.64) to:

$$\text{Sweet} = 2.964 + 70.37$$

These formulae were plotted on a scatter graph to show these differing patterns of scores for sweet taste preference for the sex groups taking into account scores of HA3. Figure 4.5 provides a graphical representation of these findings (the scatter graph produced by SPSS can be seen in appendix 4). The graph indicates that for males as scores in HA3 (Shyness with strangers) increased by 1 unit, preference for sweet tastes decreased by 4.42. For females, as HA3 scores increased by 1

[10] Where m = the unstandardised beta value of the variable of interest
x = the variable of interest
c = the constant/intercept

unit, preference for sweet tastes increased by 2.96; suggesting that the more shy females rated themselves the more they liked sweet tastes.

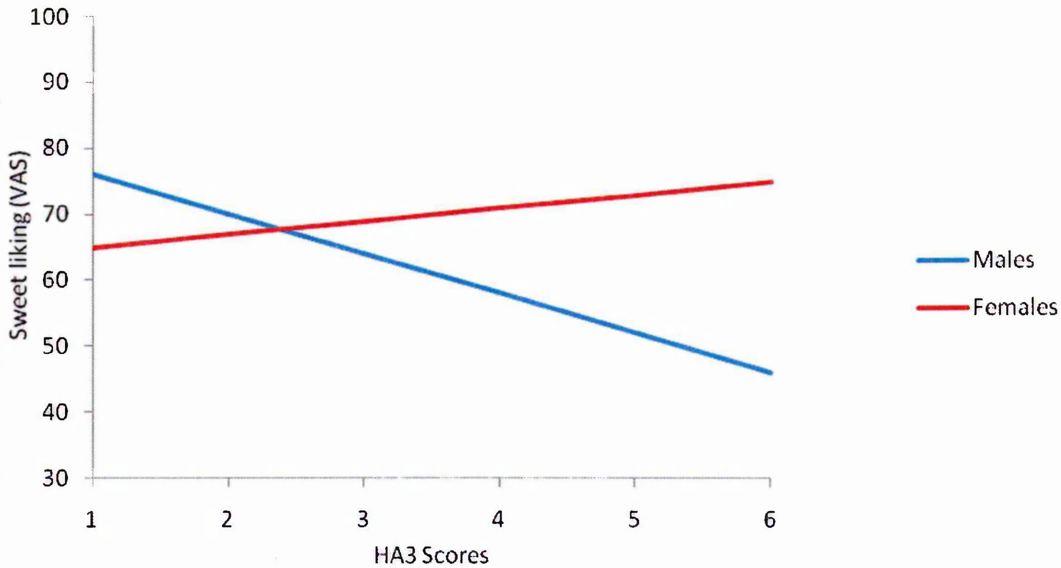

Figure 4.5: A graphical representation of sweet liking by scores of HA3 (Shyness with strangers vs. Gregariousness), showing the line of best fit for males and females

The regression formula was applied to examine patterns of scores in sweet taste preference between males and females taking RD4 (Dependence) into account to become:

$$Sweet = 0.940RD4 + 3.998Sex + 4.342\ (RD4xSex) + 67.80$$

For males (-1.55) this became simplified to:

$$Sweet = -5.788 +61.614$$

For females (0.64) the formula became simplified to:

$$Sweet = 3.734 + 70.377$$

These formulae were plotted onto a scatter graph to illustrate the different patterns in sweet taste preference scores for males and females taking RD4 into account. Figure 4.6 provides a graphical representation of these findings (the scatter graph produced by SPSS can be seen in appendix 4). The graph illustrates that for male respondents as scores of RD4 increased by 1 unit, ratings of sweet taste preference decreased by 5.79, suggesting that the an increase in Dependence lead to a decrease in preference for sweet tastes. For female respondents as scores of RD4 increased by 1 unit scores for sweet taste preference also increased by 3.73, suggesting that females with high scores of dependency show a strong preference for sweet tastes.

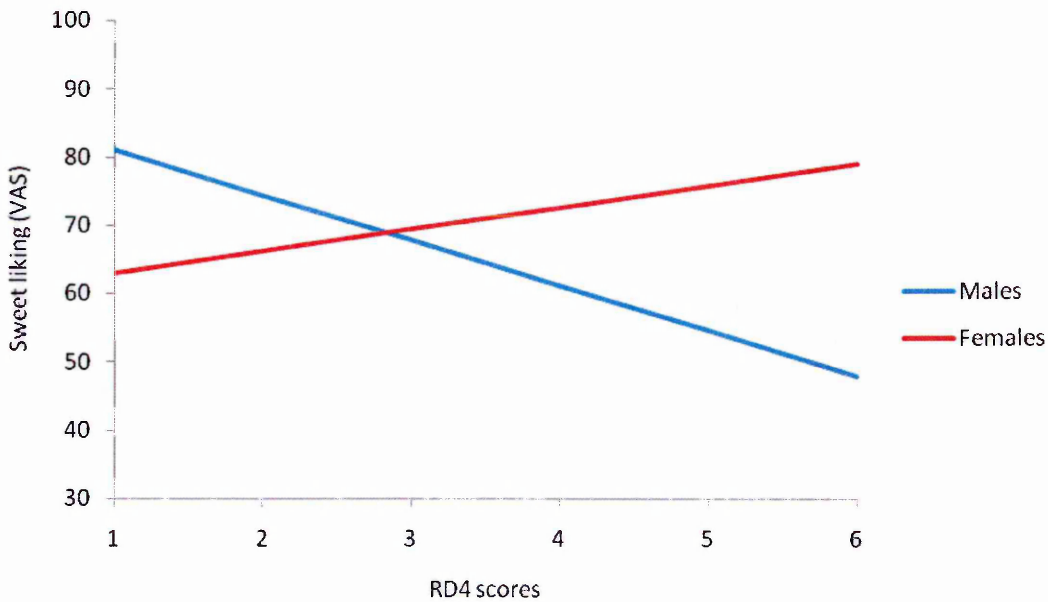

Figure 4.6: A graphical representation of sweet liking by scores of RD4 (Dependence vs. Independence), showing the line of best fit for males and females

4.4.2.2 Salty Taste Preference

The correlation coefficients (see figure 4.7) show that Fatigability & Asthenia vs. Vigor (HA4) was negatively correlated with salt preference (r=-0.14, p=0.009), suggesting that individuals who have low energy levels and appear to be asthenic tend to show low preference for salty tastes. No other correlations reached significance.

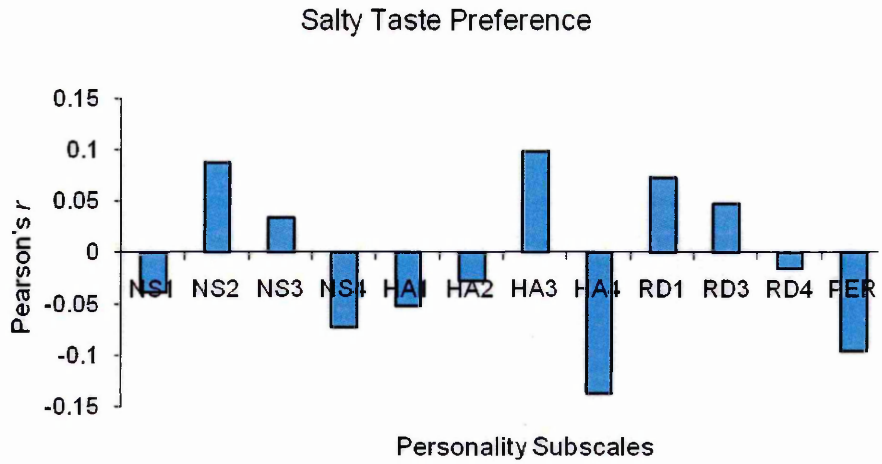

Figure 4.7: Correlation coefficients between subscales of the TPQ and salty taste preference scores

Backward regression was conducted to examine the amount of variance in usual salty taste preference explained by personality; the 12 subscales of the TPQ were entered at the predictor variables and usual salt preference as measured by VAS was input as the dependent variable. Of the original 12 subscales, 7 remained in the final model (see table 4.5).

Table 4.5: Summary of regression analysis for variables explaining salty taste preference

Predictors	*B*	*SE B*	*β*
(Constant)	47.77	7.25	
NS2	1.42	0.73	0.11
NS4	-1.68	0.72	-0.14*
HA2	-1.09	0.85	-0.08
HA3	2.53	0.80	0.19**
HA4	-2.10	0.60	-0.20**
RD1	3.02	1.15	0.14**
PER	-1.50	0.68	-0.12*

*p<.05 **p<.01

The final model was significant (F(7,344)=4.80, *p*<.001), the association between the salty taste preference and the remaining predictors was moderate (Multiple R=0.30). Together the remaining predictors accounted for 7% of the variation in sweet taste preference (adjusted R^2). High scores on the RD1 subscale related to Sentimentality (t=2.62, *p*<.01) and high scores on the HA3 subscale related to Shyness with Strangers (t=3.18, *p*<.01) were found to be the best predictors of usual salty taste preference.

4.4.2.3 Umami/Artificially-enhanced Taste Preference

The correlation coefficients between the 12 facets of the TPQ and preference ratings for artificially-enhanced tastes are graphically represented in figure 4.6. Correlations of 0.11 and above reached significance at *p*=0.05. NS1 (Exploratory excitability) negatively correlated with artificially enhanced taste ratings (r=-0.11, *p*=0.04), as did Persistence scores (r=-0.11, *p*=0.05). No other associations reached significance.

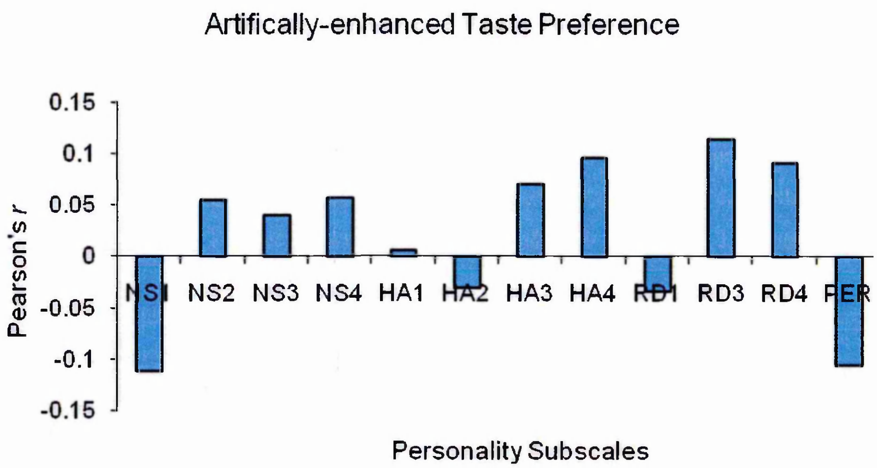

Figure 4.8: Correlation coefficients between subscales of the TPQ and artificially-enhanced taste preference scores

Backward regression was employed to see if the removal of any of the predictors (TPQ subscales) improved the regression model in terms of artificially-enhanced taste preference. After the removal of the weakest predictors for umami taste preference 4 predictor variables remained (see table 4.6). The regression analysis showed that the amount of variance in umami taste preference explained by these remaining predictors was significant ($F(5,346)=4.09$, $p=0.001$). The association between the dependent and predictor variables was low (Multiple $R= 0.24$). Together the remaining personality subscale measures accounted for 5.6% of the variation in umami taste preference (adjusted R^2). The table below shows coefficients and significance levels for each of the remaining TPQ subscale measures. The best predictor for artificially enhanced tastes was RD3 relating to Attachment ($t=2.64$, $p<.01$).

Table 4.6: Summary of regression analysis for variables explaining umami taste preference

Predictors	*B*	*SE B*	*β*
(Constant)	40.11	7.41	
NS1	-2.09	0.82	-0.15**
HA2	-1.64	0.83	-0.12*
HA4	1.13	0.61	0.10
PER	-1.22	0.70	-0.09
RD3	1.44	0.55	0.14**

*$p<.05$ **$p<.01$

4.4.2.4 Bitter Taste Preference

The correlation coefficients between the subscales of the TPQ and self-rated bitter taste preference can be seen in figure 4.9. Generally correlations above 0.13 reached significance at $p=0.05$. All relationships between the harm avoidance and reward dependence subscales and bitter taste that reached significance were negatively correlated; higher scores on these facets resulted in greater dislike for bitter tastes. Total harm avoidance and bitter taste preference were negatively correlated ($r=-0.17$, $p=0.002$), as were total reward dependence scores and bitter taste preference ratings ($r=-0.22$, $p<.01$).

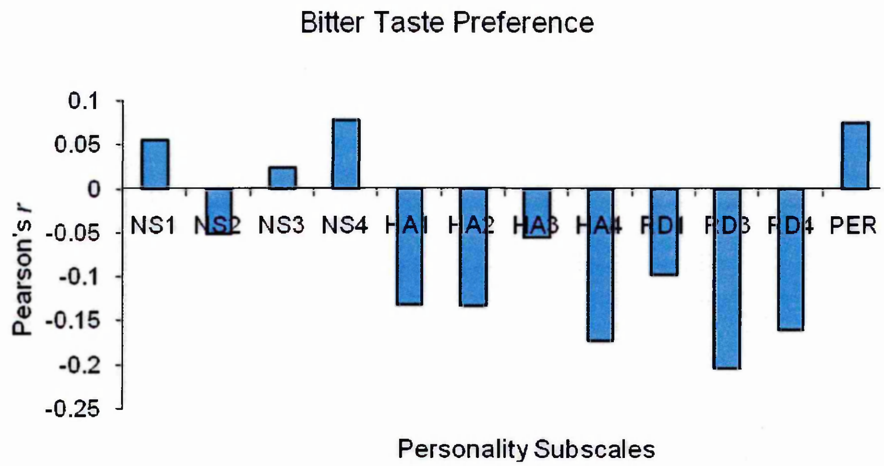

Figure 4.9: Correlation coefficients between subscales of the TPQ and bitter taste preference scores

Regression analysis was conducted to examine the amount of variance in bitter taste preference explained by subscales of the TPQ (Cloninger 1987). Backward elimination regression was employed to establish the best fit model by removing the weakest predictors (TPQ subscales). The analysis showed that the amount of variance in bitter taste preference explained by the remaining predictors was significant ($F(7,344)=5.95$, $p<.01$). The association between the dependent (bitter taste measure) and the predictor variables was moderate (Multiple R=0.33).

Table 4.7: Summary of regression analysis for variables explaining bitter taste preference

Predictors	*B*	*SE B*	*β*
(Constant)	40.17	6.04	
NS2	-1.36	0.67	-0.13*
NS3	0.89	0.67	0.07
NS4	1.11	0.60	0.11
HA2	-0.85	0.64	-0.08
HA4	-1.26	0.48	-0.14**
PER	0.97	0.55	0.09
RD3	-1.92	0.43	-0.23**

*$p<.05$ **$p<.01$

Together the remaining predictors accounted for 9% of the variation in bitter taste preference (adjusted R^2). Lower scores on the Attachment vs. Detachment subscale (RD3) were found to be the best predictor of bitter taste preference (t=-4.44, p<.01), suggesting that self-contained and distant types report liking bitter tastes.

4.4.2.5 Sour Taste Preference

The correlation coefficients relating to all subscales of the TPQ and sour taste preference ratings can be seen below (Figure 4.10). Correlations of 0.12 and above typically reached significance at p=0.05 level.

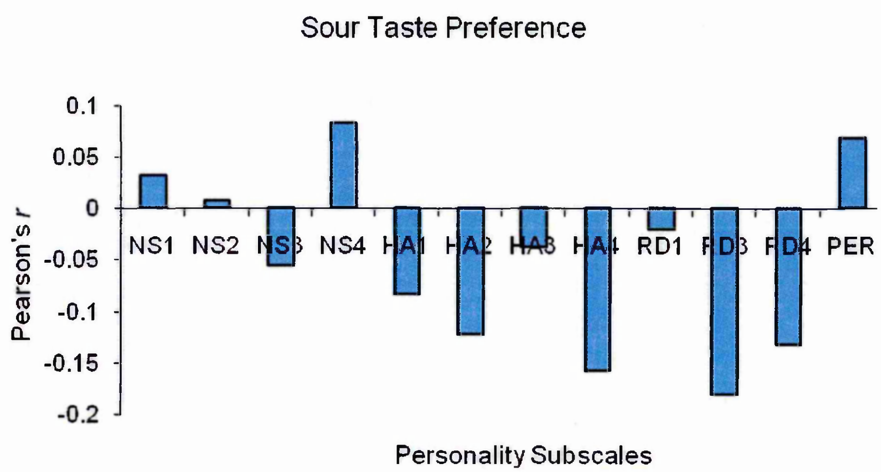

Figure 4.10: Correlation coefficients between subscales of the TPQ and sour taste preference scores

Relationships between total reward dependence and total harm avoidance were negatively related to sour taste preference, corresponding to the findings related to bitter taste preference. As figure 4.6 indicates all facets of harm avoidance and reward dependence negatively correlated with sour taste preference ratings, resulting in significant negative correlations between total harm avoidance (r=-0.13, p=0.01) and total reward dependence (r=-0.17, p=0.001).

Backward regression was conducted to examine the amount of variance in usual sour taste preference explained by personality; the 12 subscales of the TPQ were entered at the predictor variables and usual self-rated sour preference was input as the dependent variable. Of the original 12 subscales, 4 remained in the final model (see table 4.5). The final model was significant (F(4,347)=6.81, *p*<.01), although the association between the sour taste preference and the remaining predictors was fairly low (Multiple R=0.27). Together the remaining predictors accounted for 6.2% of the variation in sour taste preference (adjusted R^2). Lower scores on the Attachment vs. Detachment subscale (RD3) were found to be the best predictors of usual self-rated sour taste preference (t=-3.78, *p*<.01).

Table 4.8: Summary of regression analysis for variables explaining sour taste preference

Predictors	*B*	*SE B*	*β*
(Constant)	43.93	5.47	
NS4	1.12	0.57	0.10*
HA4	-1.31	0.48	-0.14**
PER	1.02	0.59	0.09
RD3	-1.76	0.46	-0.20**

**p*<.05, ***p*<.01

4.4.2.6 Spicy Taste Preference

Correlation coefficients between the facets of the TPQ and spicy taste preference ratings revealed a number of significant associations (see figure 4.11). In line with the experimental predictions high scores on the NS1 subscale (relating to Exploratory Excitability) positively correlated with high scores on the spicy taste measures (r=0.13, *p*=0.02), suggesting that individuals which sensation seeking traits rated spicy tastes favourably. In contrast a number of the facets of harm avoidance and reward dependence negatively correlated with spicy preference, resulting in negative correlations between total harm avoidance and spicy taste preference scores (r=-0.11, *p*=0.05), and total reward dependence and spicy preference (r=-0.12, *p*=0.03).

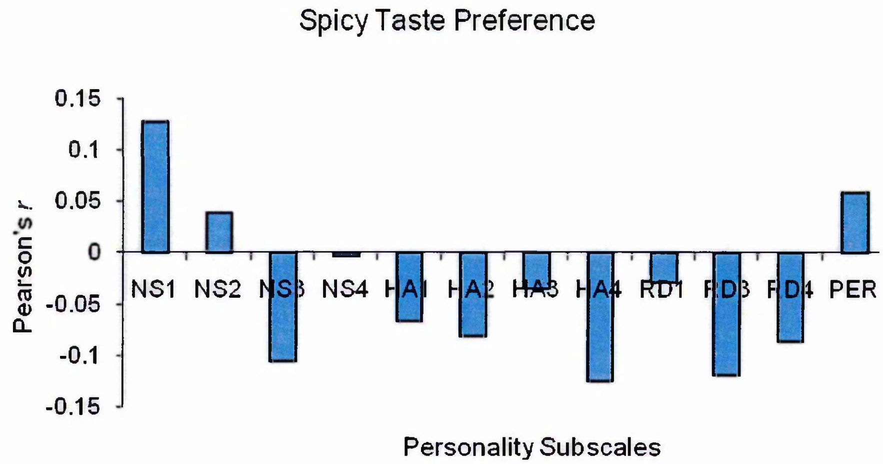

Figure 4.11: Correlation coefficients between subscales of the TPQ and spicy taste preference scores

Backward elimination regression techniques were employed to see if the removal of the weaker predictors could improve the model. After the removal of the weakest predictors for spicy taste preference the best fit model contained NS1, NS3, HA4 and RD3. The regression analysis showed that the amount of variance in spicy taste preference explained by these remaining predictors was significant (F(4,347)=5.25, *p*<.001). The association between the dependent and predictor variables was low (Multiple R= 0.24).

Table 4.9: Summary of regression analysis for variables explaining spicy taste preference

Predictors	*B*	*SE B*	*β*
(Constant)	70.89	5.95	
NS1	2.16	0.77	0.15**
NS3	-1.71	0.82	-0.11*
HA4	-0.99	0.57	-0.09
RD3	-1.19	0.54	-0.12*

**p*<.05 ***p*<.01

Together the remaining personality subscale measures accounted for 5.7% of the variation in spicy taste preference (adjusted R^2). Table 4.9 shows coefficients and significance levels for each of the remaining TPQ subscale measures. High scores in the subscale Exploratory Excitability (NS1) was found to be the best predictor of self-rated spicy taste preference (t=2.80, *p*=0.005).

4.5 Discussion

The correlation coefficients revealed many associations between personality variables and taste preference for the 6 tastes. Despite this these relationships were often weak to moderate in strength. Regression analysis further demonstrated that between 2-9% of the variance in self-rated taste preference could be explained by varied combinations of the personality variables depending on the specific taste. Models of best fit were developed to define the best predictors of each taste; these models are discussed in turn in the following sections. The findings are discussed with particular reference to the significant coefficients within each model or those with the highest beta values.

4.5.1. Sweet

Unsurprisingly sweet was rated with high preference across the sample, indicative of a universal liking of sweet tastes (Reed, Tanaka & McDaniel, 2006). Due to observed sex differences in both personality scores and preference for sweet tastes the interaction of sex differences and personality resulted in interesting findings. In females a relationship between RD4 scores (dependent on emotional support and approval from others) and high sweet taste preference emerged. Similarly a positive relationship was revealed in terms of female scores of HA3 (unassertive and shy traits) and sweet taste preference. It was predicted that traits associated with reward dependence and harm avoidance would relate to preference for the innate tastes (including sweet), due to observed links with the food neophobic trait and the development of acquired tastes. In terms of Reward Dependence, the Attachment related lower facet RD4 was found to be a good predictor of sweet taste preference after accounting for the interaction with sex difference. Different patterns of findings were revealed between the sexes when examining relationships between RD4 and sweet taste. For males, an increase in scores on the RD4 led to a decrease in sweet taste preference; males who rated themselves as high in attachment showed dislike for sweet tastes. Conversely, for females, scores on the RD4 scale were positively related to sweet taste preference; highly attached females showing a strong preference for sweet tastes.

Within the existing literature mixed findings relating to differences between males and females on sweet taste have been observed; sex differences in the taste detection and suprathreshold taste intensity for sucrose have not been supported by previous research (Hyde & Feller 1981; Chang, Rimm, Colditz, Stampfere & Willet, 2006), however elsewhere the rejection of food types as a consequence of taste was found to be mediated in all cases by sex (Mooney & Walbourn, 2001). In terms of sweet taste the current study provides support for the latter, demonstrating that in lower facets of reward dependence and harm avoidance sweet taste preference is moderated by sex.

Based on previous findings it was predicted that sweet taste preference would in part be explained by novelty seeking. A number of past studies have revealed relationships between novelty seeking (and similar traits such as sensation seeking and extraversion) and a high preference for sweet tastes and foods (Stone & Pangborn, 1990; McHale et al., 2002). A number of these studies have also linked alcoholism and drug taking to novelty seeking and a high preference for sweet tastes, linking these to the mesolimbic dopamine activity (Kampov-Polevoy et al., 1997, 1998 & 2004). The findings of this study did not confirm these aforementioned studies in terms of novelty seeking. This may reflect a problem with novelty seeking scores for this sample. Cloninger's normative data and evidence from elsewhere suggests that novelty seeking is influenced by age; high scores of novelty seeking are often displayed in young males (Cloninger et al., 1994). The descriptive data for the current study show that scores for novelty seeking were higher in females than males contrasting with US data (Cloninger et al., 1994) but importantly in line with UK data (Otter et al., 1995).

This study did expect to find relationships between the lower facets of harm avoidance and reward dependence and sweet taste preference. It was hypothesised that this relationship may be linked to innate liking; sweet tastes are universally liked and may be viewed as comforting by those individuals with less outgoing traits (Elfhag et al., 2006). Evidence linking sweet taste preference with increased activity within the amygdala strengthens this argument; sweet foods and tastes can act as comforters by alleviating and uplifting mood (Brand Miller, Holt, de Jong & Petocz, 2003). The consumption of sweet foods such as chocolate increases the availability of tryptophan (TRP) to the brain and subsequently enhances serotonin mediated mood (Brand Miller et al., 2003). High avoidance is associated with both increased risk of anxiety and depression (Cloninger, 1994); individuals with high harm avoidance temperaments experience a high serotonin turnover (Demitrack et al., 1992). In this way individuals with high scores of harm avoidance may show preference for sweet foods and tastes in order to increase serotonin levels, consequently alleviating stress and anxiety levels.

4.5.2 Salty

Salt taste preference is also thought to be an innate taste, thus similar relationships were expected in terms of harm avoidance and reward dependence; it was expected that individuals who achieved high scores on reward dependence and harm avoidance subscales would show high preference for salty tastes. The best fit model developed for salty taste preference did show some evidence to support this prediction; HA3, HA4, RD1 and PER (RD2) were all found to correlate with salt preference. Of all the facets of TPQ included in the model HA3 (Shyness with Strangers) was found to be the best predictor of salt taste preference. Individuals with high scores for HA3 tend to be unassertive and shy.

In addition the model of best fit including 2 facets of novelty seeking; NS2 (Impulsiveness vs. Reflection) and NS4 (Disorderliness vs. Regimentation). NS2 was found to positively correlate with salt taste preference suggesting that excitable, dramatic, "temperamental" individuals show great liking for salty tastes. Similar results were revealed elsewhere related to extraversion (Yeo et al., 1997), providing support for this finding in light of the observed similarities between extraversion and novelty seeking (Zuckerman & Cloninger, 1996; Fruyt et al., 2000).

Although few studies have examined individual differences in terms of personality and preference for salty tastes, a number of studies have found relationships between personality variables and salt intake which provide partial support for the findings of this current study. Relationships between extraversion and salt preference and high salt intake have been observed (Yeo, Trelor, Marks, Heath & Martin, 1997; Kikuchi & Watanabe, 1999). Similar findings from elsewhere indicated that salt intake was found to be significantly related to extraversion (Shepherd & Fairleigh, 1986a; Shepherd & Fairleigh, 1986b). Stone and Pangborn (1990) found that the combination of a number of 16PF subscales (Cattell 16 Personality Factor Questionnaire; Cattell & Eber, 1962); psychoticism and extraversion (EPQ) predicted 13% of the variance in salt intake. In addition to this it was also observed that individuals classified into a high salt intake group tended to consume and add more salt to their foods than the low-salt intake group (Stone & Pangborn 1990).

Usual salt consumption was not measured in this current study, thus comparisons could not be made between usual salt intake and self-rated salt preference. The findings of the current study do confirm these aforementioned studies; although these papers specifically regard salt intake, it makes sense that salt intake and salt preference are related as preference or liking leads to increased intake (Drewnowski, 1997). Indeed lower sensitivity to salt perception does lead to increased table salt intake (Contreras, 1978).

4.5.3 Artificially enhanced/Umami

The model of best fit for artificially enhanced tastes suggested that NS1 and RD3 were the best predictors of preference for artificially enhanced tastes. Surprisingly NS1 was found to be negatively associated with artificially enhanced tastes, which was not expected. Conversely RD3 was found to be positively associated with artificially enhanced tastes.

Mean scores for artificially enhanced tastes were very low; lower than half the possible total score. This may reflect a certain level of social desirability; not many individuals would perhaps admit to having a strong preference for tastes that have been artificially enhanced especially in light of the government and media promotion of healthy eating and the consumption of natural foods (i.e. 5-a-day campaign). The term artificially enhanced foods does elicit connotations of unhealthy, unnatural foods, therefore problems of terminology could have influenced these unexpected findings.

The term artificially-enhanced was used as it as thought that the term Umami would not be familiar to the lay person. Umami is used to described savoury and meaty tastes; tastes associated with the compound monosodium glutamate. Since monosodium glutamate is a flavour enhancing and often used in foods to enhance or strengthen the intensity of a particular flavour it seemed appropriate to describe this as artificially enhanced. How this term is then interpreted by the individual participant cannot be controlled for and so ratings for this measure may have been low due to individual differences in interpretation of the term, future studies should perhaps use umami but define it for participants.

4.5.4 Bitter

A number of relationships were revealed in terms of personality traits and preference for bitter tastes. These observed relationships were all negative, suggesting that individuals with high scores in lower facets of reward dependence and harm avoidance rated their preference for bitter tastes low, indicating a dislike for bitter tastes. This provides some support for the experimental prediction in terms of acquired liking for bitter tastes; traits characterised by Reward Dependence and Harm Avoidance rated bitter liking with low scores.

The mean score for bitter taste preference was fairly low overall. Bitter is thought to be the opposite of sweet; sweet is universally liked and bitter is assumed to be always bad and disliked (Reed, Tanaka & McDaniel, 2006). Bitter tastes are usually combined with desired drug effects (e.g. coffee) which may override the rejection of the bitter taste (Reed et al., 2006). In this study female scores for bitter preference were particularly low. This may reflect individual differences in terms of sex and bitter taste preference although sex differences in bitter taste preference were found in this study these findings were not confirmed by the regression analyses.

Elsewhere sex differences in bitter taste perception have been documented (Hyde & Feller, 1981; Bartoshuk, Duffy & Miller, 1994). Women tend to find suprathresholds of caffeine more intense than males suggesting sex factors in bitter taste perception (Hyde & Feller, 1981), and higher frequencies of females are found to be phenylthiocarbamide (PTC) and 6-*n*-propylthiouracil (PROP) tasters, not only confirming sex differences in the detection of bitterness but also differences in tolerance for bitter tastes (Bartoshuk et al., 1994). Furthermore, the discovery that women tend to have more fungiform papillae taste buds, provides anatomical evidence for sex differences in bitter taste detection (Bartoshuk et al., 1994). Although Bartsohuk and colleagues (1994) study was specific to bitter taste, these anatomical differences in males and females may have implications for the detection of other tastes and consequentially preference or liking of all tastes dimensions.

Non-acceptance of bitter tasting foods is thought to have been evolutionary adaptive; dislike of bitterness and consequential low intake of bitter foods is attributed to the avoidance of potential harmful and dangerous foods. Mattes (1994), describes this as an "inherent sensory characteristic". Alternatively it could be that bitter foods and drinks may simply be unappealing and undesirable; stimulus perceived as bitter is often disliked regardless of intensity (Drewnowski, Henderson & Shore, 1997; Reed et al., 2006). Indeed the bitterness of certain foods is often masked by other compounds (i.e. caffeinated drinks are often sweetened or milk is added). Universally "badness" in food is associated with bitterness (Reed et al., 2006). Genetic effects on bitter taste perception and biological evidence examining the heritability of bitter taste perception goes some way to explain individual variation in taste perception and preference for bitterness (Reed et al., 2006).

Evolutionary perspectives argue that humans have evolved to dislike bitter foods (Steiner, 1974; Steiner, 1977; Cowart, 1981); however in industrialised countries, with tight food safety and hygiene standards, exposure to potentially harmful food products is less likely. Consistent with this perspective, this study found very low scores in bitter taste preference across the sample; perhaps low scores in bitter preference reflect "normal" human preferences. This stance is supported by a number of studies which found overall preference for bitter foods and drinks commonly disliked (Tepper, 1998; Drewnowski, 2000; Goldstein, Daun & Tepper, 2005). Conversely low bitter scores may reflect difficulties in the perception of bitterness; bitter taste does not have an easily assessable frame of reference. Tastes such as sweet are associated with sugars and sour with citrus, bitter is harder to define. In this way rating preference for bitter taste reflectively (i.e. without an example or a taste sample) may represent a more difficult task than first envisaged.

4.5.5 Sour

Findings related to sour taste preference produced similar relationships observed with bitter taste preference. All facets of harm avoidance and reward dependence were significantly but negatively correlated with preference for sour tastes. This suggests that individuals with high scores in harm avoidance and reward dependence rated their preference for sour tastes low, providing support for the experimental predictions. A significant positive correlation was revealed suggesting that individuals high in NS4, a facet of novelty seeking related to disorderliness, rated sour tastes as highly liked. The model of best fit confirmed the correlational findings suggesting that preference for sour tastes could be predicted by positive scores on NS4, Persistence and negative scores on HA4 and RD3.

These findings confirm that preference for sour tastes are associated with outgoing traits and a dislike for sour tastes is associated with less outgoing traits. Previous research specific to individual differences in terms of personality and sour taste preference is limited, however this study is in agreement with Mattes (1994) who also found that sour taste preference to be positively related to scores of sensation seeking. This study is also consistent with classic studies which found that introverts produced increased saliva in response to lemon juice suggesting a dislike for this taste. It was thought that the increased saliva production acted by diluting the sour taste, masking the sourness (Eysenck & Eysenck, 1967; Howarth & Skinner, 1969).

Sex differences were again observed in ratings of preference for sour tastes, with men scoring sour tastes significantly higher than females. Sex differences in sour taste perception have been observed elsewhere, where women preferred lower concentrations of citric acid solutions compared to males (Hyde & Feller, 1981; Chauhan & Hawrysh, 1988). The anatomic evidence presented above (see section 4.5.3) may also explain why these sex differences occur; women display more fungiform papillae and taste buds than men, resulting in a greater sensitivity to taste sensations (Bartoshuk et al., 1994).

4.5.6 Spicy

Spicy taste preference was found to be significantly and positively related to NS1 (Exploratory Excitability vs. Stoic Rigidity). This result was in line with the experimental predictions and previous research which has shown that individuals with high scores of novelty seeking (particularly NS1 which is thought to be most similar to extraversion and sensation seeking) tend to express high preference for spicy foods (Logue & Smith, 1986; Venkatramaiah & Baby Devaki, 1990). The model of best fit confirmed this finding, including NS1 as the best predictor of spicy taste preference. Other subscales included in the model were found to be negatively related to spicy taste preference. NS3 (Extravagance vs. Reserve) was unexpectedly found to be negatively related to spicy taste preference. HA4 (Fatigability vs. Vigour) and RD3 (Attachment vs. Detachment) were also negatively related with spicy taste preference although HA4 was not a significant predictor.

Although spicy tastes are not defined as one of the basic taste a measure of spicy taste preference was included in the study based on casual observations of individual differences in chilli liking. Indeed humans do develop a liking for chilli based on exposure and frequency of use (Rozin & Schiller, 1980; Rozin, Ebert & Schull, 1982), suggesting that the taste is acquired. Despite this spicy tastes are not universally acquired, many individuals do not like spicy tastes and some cannot tolerate them, suggesting a degree of individual variation.

Food neophobia has also been linked to personality traits such as sensation seeking; it has found to be negatively correlated with experience seeking a subscale of Zuckerman's sensation seeking (Pliner & Hobden., 1992). Furthermore high sensation seekers tend to try more novel foods such as spicy, ethic foods, under low arousal conditions compared to low sensation seekers (Pliner & Melo, 1997). These findings provide more evidence to suggest that personality traits such as high sensation seekers and novelty seekers tend to seek out stimulation in various forms and in this sense it is perhaps unsurprising that high sensation seekers have been shown to be more willing to try novel foods compared to other types.

Sex differences in relation to preference ratings were again observed with regards to spicy tastes, with males rating spicy tastes as significantly more liked then females. Similar results have been found elsewhere, where participants were presented with a series of capsaicin solutions, females rated the sensation of chilli burn more intense than males (Stevenson & Yeomans, 1993).

4.5.7 Conclusion

The present study found that between 2-9% of the variance in self-reflective taste preference for the 6 taste dimension measures could be explained by varying combinations of personality variables. Liking for sweet tastes was best predicted by high scores of HA3 describing unassertiveness and shyness in females, although low scores of HA3 predicted sweet liking in males. High dependency (RD4) was also a good predictor of sweet liking in females, although low scores of dependency predicted sweet liking in males. Salt liking was best predicted by RD1 describing sentimental and sympathetic individuals, as well as HA3 describing unassertiveness and shyness. Umami (or artificially enhanced) liking was best predicted by RD3 describing individuals who are sensitive to rejection and highly attached. Low scores of RD3, describing individuals with disinterest in social relationships and who are contained and detached best predicted both bitter and sour liking. Spicy liking was found to be best predicted by high scores of NS1 describing individuals who seek exploratory excitability, traditionally described as sensation seeking. A number of difficulties were observed which may account for low levels of predictability. In general it is thought that rating usual taste preference reflectively may be a difficult task. Individuals may hold in their minds a different type of food when rating their preference e.g. one individual may think about bitter (alcohol) when thinking about bitter taste preference, someone else may think about tonic water (quinine); individuals may rate their taste preference based on their preference for that particular food. These are not directly comparable but at the same time these issues cannot be easily controlled for. Due to these difficulties observed with self-rating taste reflectively, taste preference is perhaps better measured empirically using food samples which give participants a point of reference to make a more informed judgement of their taste preferences.

Chapter 5

Exploring individual differences in taste preference for sweet, salty, bitter, sour, umami and spicy food samples (Study 2)

5.1 Overview

The second study aimed to further investigate relationships between taste preference for sweet, salty, bitter, sour, spicy and umami tastes and heritable personality traits. Extending study 1 (Chapter 4), this study asked participants to rate their usual taste preference for the taste dimensions (a replication of study 1), as well as rating pasta and tomato sauce taste samples manipulated by the same taste dimensions. In addition the study extended the previous study by measuring characteristics of eating behaviour using the TFEQ.

5.2 Introduction

The findings of study 1 demonstrated that individual differences in relation to biologically based personality traits may explain some of the variation in self-reported taste preference; between 2% and 9% of the variance in taste preference could be explained by personality variables. This experimental study further explored these findings by testing actual taste preference using a number of taste samples manipulated by taste dimension. Measures of liking for 6 taste samples representing the taste domains of sweet, salty, bitter, sour, umami and spicy were compared with participants self-rated usual taste preference for these same taste domains. Due to more general conclusions regarding dietary habits, eating behaviour and links with personality traits this study also examines relationships between eating styles or characteristics of eating behaviour as measured by the TFEQ (Stunkard & Mesick 1985) and personality variables as measured by the TPQ (Cloninger 1987). The TFEQ assesses characteristics specific to eating styles, few studies have sought to further understanding of the underlying psychological constructs in terms of personality traits, specifically temperament, in light of this the TFEQ was introduced in this second study to assess the relationships between characteristics of eating behaviour and temperament.

Conner (1994) asserted that individuals "mostly know and can say what they like and dislike, even when they find it difficult to say why" (pp. 170 in MacFie & Thomson 1994). This may be true when asked specifically about a particular food item but presents a more difficult task when individuals are asked to rate general liking, as study 1 highlighted. In light of this the second study is an extension of first study and includes measures of taste preference using real-food taste samples manipulated by taste dimension. The introduction of taste samples overcome the methodological difficulties encountered in relation to self-rated reflective measures of taste (see Chapter 4 - Discussion section).

Due to the lack of previous research investigating individual differences in taste preference, particularly in relation to personality, this second study is again exploratory in nature. Following from the first and the reviewed literature (see Chapter 4 section 4.2) it is predicted that acquired tastes such as bitter, sour, and spicy will be explained by traits associated with novelty seeking. Sweet and salty tastes, more often described as innate, will be explained by reward dependency and harm avoidant traits. Due to limited research specific to individual differences in umami preference it is unclear how patterns of findings will emerge. In addition in light of the research linking sweet taste, drug and alcohol intake with novelty seeking, extraversion and sensation seeking traits it is also likely that high scores of novelty seeking will explain preference for sweet tastes.

5.3 Method

5.3.1 Participants

One hundred and fifty participants were recruited from the Psychology undergraduate course at Sheffield Hallam University, parents from a local school and local professionals. The sample had a mean age of 26.3 years (SD=9.11, range between 18 and 57 years). The study included 114 females (mean age 25.4 years, SD= 8.82) and 36 males (mean age=29.3 years, SD=9.53). Participants were invited via posters and flyers (around the University Campus and local school) and via email invitation.

Occupation was coded according to the ONS Standard Occupational Classification (ONS, 2000). Students made up the majority of the sample (55.9%); the second largest group consisted of individuals with professional occupations (13.8%). See Figure 5.1 for the occupational breakdown of the sample.

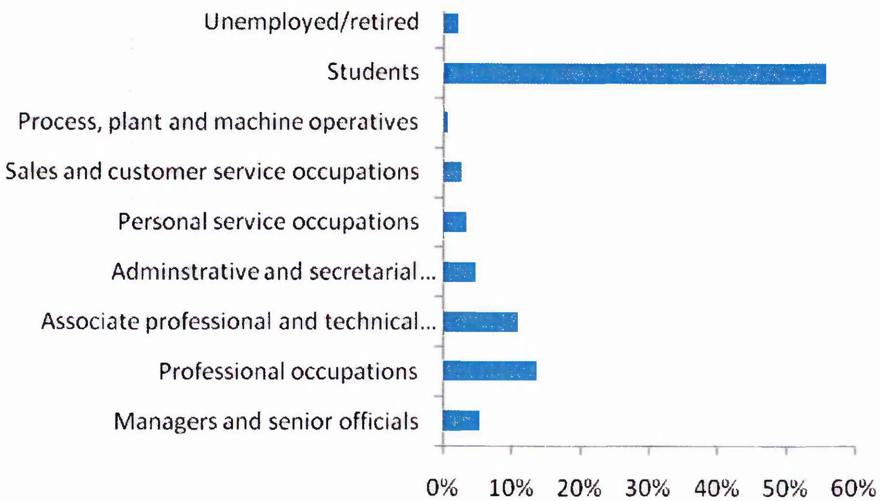

Figure 5.1: Bar chart to show the breakdown of occupations (percentages) of the sample (using the ONS Standard Occupation Classification, 2000)

Ninety-eight percent of participants reported being in "good health", 90% said that they were not currently attending a doctor or hospital and 83.3% did not report being on medication. Seventy-four percent reported partaking in regular exercise (this was defined as 2 or more sessions of at least 20 minutes exercise per week).

Almost 97% of participants said that they did not suffer any food intolerances or allergies, 5 people reported food allergies but not in relation to the test foods (food intolerances towards fish, prawns and chocolate were disclosed). All participants were further screened for wheat allergies, sensitivity to artificial flavour enhancers and health problems related to diet. The majority of the sample did not have any dietary restrictions (83.9%); the majority of those reporting dietary restrictions said that these restrictions were for ethical reasons. Measures of hunger and fullness were taken before the tasting session.

Participants were requested not to eat for at least 2 hours prior to testing. Participant consent was required prior to the investigation (see appendix 5 for consent form). Ethical approval was achieved via the Faculty Ethics Committee. The researcher held a Basic Food Hygiene certificate.

5.3.2 Design

The present study employed a correlational design using self-report measures and real-food taste stimuli. The study explored the relationship between the taste ratings of 6 taste dimensions (sweet, salty, bitter, sour, spicy and Umami) and temperamental personality (Cloninger, 1987). All participants completed a screening questionnaire, the TPQ (Cloninger 1987) and the TFEQ (Stunkard & Messick 1985 - all measures are described in more detail in section 5.2.3). The main task asked participants to rate 6 measures relating to their "usual" taste preference and also to taste and rate 7 pasta and tomato sauce taste samples (the 6 taste dimensions and the base sauce) on 100mm VAS. The food trials were counterbalanced using a Latin square design in order to eliminate confounds such as order effects.

5.3.2.1 Development of Taste Samples and Piloting Materials

Raw substances such as monosodium glutamate and salt are found to be unpalatable in isolation, as a result previous studies tend to present these mixed into a solution as a taste sample (Yamaguchi & Takashai, 1984; Beauchamp & Pearson 1991). Pilot studies were conducted in order to assess the palatability of 2 differing batches of food-base samples. A tomato sauce with pasta was used as it was thought that the sauce would provide a good vehicle for the manipulation of all the basic tastes, similar to that of Yeomans (1996) who also used pasta and a tomato sauce based food sample and manipulated the palatability of the sauce. The aims of the pilots were to test the suitability of the measures, the order of presentation of the measures and the suitability of the taste samples.

Ten participants were presented with and were asked to rate two batches of pasta with a tomato sauce. Batch 1 was made by heating 1 dessert spoon of oil olive in a heavy-based pan, with 1 clove of crushed garlic was added and fried briefly. A 400g tin of organic chopped tomatoes (with no salt or sugar) was then added, along with a pinch of oregano. This was left for 20 minutes to simmer and was then blended in a food processor into a smooth sauce. Batch 2 was made in exactly the same way as batch 1 but without adding garlic. The table below shows the amounts of additional ingredients added to each taste sample for batches 1 and 2. The ingredients were chosen specifically because they were readily available and as such may be encountered in a "normal" situation (i.e. at home) and because they could be easily blended with the tomato sauce.

Table 5.1: Additional ingredients added to Batch 1 and Batch 2 of the taste samples (per 30ml of base sauce)

Taste Sample	*Added ingredient*	*Amount of added ingredients (Batch 1 - garlic)*	*Amount of added ingredients (Batch 2 - no garlic)*
A (Salty)	Crushed sea salt	2.5ml	2.5ml
B (Umami)	Monosodium glutamate (MSG)	2.5ml	7.5ml
C (Spicy)	Tabasco	13 drops	16 drops
D (Bitter)	Angostura bitters	8 drops	8 drops
E (Sour)	Lemon juice	10 ml	10ml
F (Sweet)	Glucose	30ml	10ml
G (Base)	nothing added	-	-

Each taste sample was presented in a 60ml taste pot with one piece of pasta (Tesco *Farfalle* pasta). *Farfalle* pasta was selected as it has a large surface area compared to other readily available pasta shapes and because of this the tomato sauce covered the pasta piece completely and evenly.

A comparison was made between batch 1 (containing garlic) and batch 2 (no garlic). Participants were asked to taste and to rate how much they liked each taste sample on 100mm VAS anchored by "I don't like this at all" and "I like this very much". Participants also rated their usual taste preference on 100mm VAS anchored by "Not at all" and "Very much so".

After participants had completed the taste samples the researcher asked them if the basic taste was distinct for each taste sample. Unanimously all participants reported that batch 1 (containing garlic) was unsuitable. The garlic taste was described as "overpowering"; masking the basic taste and making it difficult to assess and detect the basic tastes, and in some cases, any differences between the taste samples. This was particularly true for the umami and the sweet taste samples. Since monosodium glutamate (MSG) acts as a flavour enhancer, the umami taste sample (sample B) was reported as having an overwhelming garlic taste; consequently the taste of the MSG was not distinctive. In the case of the sweet sample (sample F) the garlic and sweet combination made the sample "unpalatable".

As a result of this small pilot it was thought that the addition of garlic confounded the taste samples. Batch 2 was thought to be more suitable as it was easier for participants to detect differences between the taste samples than batch 1 (garlic). Participants rated these in line with their reported usual taste preference. Despite this participants collectively reported that the bitter taste sample was not bitter enough. As a result the bitterness levels were increased in the main investigation (see table section 5.3.2.3). It was also highlighted that the spicy taste sample influenced subsequent taste samples and that water alone did not neutralise the taste on the palate. In order to cleanse the palate after each taste sample it was decided that participants would receive a water biscuit and glass of water. A sip of water and small bite of the water biscuit would be consumed between each taste sample. It was also decided that the presentation of the taste samples should be varied in order to avoid confounds such as order effects.

As a result of the pilot it was also decided that the TPQ (Cloninger 1987) should be answered first as this questionnaire is long (100 items) and takes approximately

10-15 minutes to complete. If the usual taste preference was completed after the taste tests these ratings may influence participant's ratings of their usual taste preference therefore these VAS were presented before the taste tests. Finally, the TFEQ (Stunkard & Messick 1985) would be presented to avoid priming the participants that eating style was also under investigation.

Participants further suggested that the instructions should clearly indicate that the taste samples should be considered taste samples and not representative of "normal" food. In addition the term palatable was thought to be problematic as also suggested by previous literature (e.g. Rogers 1990; Berridge 1996; Yeomans 1996), this resulted in a second pilot investigation which would address the appropriate terminology to use in the main study (see Chapter 2 section 2.2). Results of this small pilot indicated that common understandings of the terms "palatable" and "palatability" refer to derivatives of the word "taste". Therefore in the main investigation participants would be asked to rate how much they liked the "taste" of the samples as opposed to how "palatable" they found them.

5.3.2.3 Preparation of the Taste Samples - Main Study

The pasta sauce and pasta were prepared the night before testing. Each participant would consume 7 taste samples therefore required 7 pieces of pasta each. The pasta (*Farfalle* pasta, Tesco) was cooked the morning of testing according to the instructions as shown on the packet and then placed in a clean plastic box in the refrigerator until testing.

The sauce was made in a heavy-based saucepan. In to which 1 dessert spoon of olive oil was placed and heated for 1 minute. A tin of organic chopped tomatoes (400g) was then added along with a pinch of dried oregano. This was left to simmer for 20 minutes stirring occasionally. The sauce was then placed into an electric blender and blended into a smooth sauce (for approximately 2 minutes).

The sauce was then divided up into clean plastic boxes by placing 2 table spoons (30ml) into each box. The boxes had been previously labelled (A-G) relating to the taste sample. Amounts of base sauce varied according to participant numbers, therefore the added ingredients (see table 5.2) were multiplied according to the amount of base sauce. A matrix was developed for ease of calculating the correct quantities of ingredients depending on participant numbers (appendix 6).

Table 5.2: Amount of additional ingredients added to each taste sample (per 30 ml)

Box (taste sample)	*Added Ingredient*	*Amount of added ingredient*
A (Salty)	Crushed sea salt	2.5ml (1/2 teaspoon)
B (Umami)	Monosodium glutamate	7.5ml (1 1/2 teaspoons)
C (Spicy)	Tabasco	16 drops
D (Bitter)	Angostura Bitters	12 drops
E (Sour)	Lemon juice	10ml (2 teaspoons)
F (Sweet)	Glucose	10 ml (2 teaspoons)
G (Base sauce)	nothing added	-

Table 5.2 (above) shows the amounts of additional ingredients added to each labelled box of sauce. These were thoroughly mixed using a clean spoon for each taste sample until the ingredients had fully dissolved into the sauce. The taste samples were left to cool, and then placed into the refrigerator (at 5°C or below) until testing.

5.3.3 Measures and Materials

5.3.3.1 Consent Form

The consent form gave participants a brief summary of the study and what they would be required to do. It also informed participants about confidentiality and the right to withdraw along with contact details for future reference (see appendix 5). On the overleaf of the consent form all nutritional information and ingredients of the test foods were clearly laid out; participants were asked to carefully study these before consenting to take part in the study. If participants declared any allergies in relation to these listed ingredients they did not take part in the study. Participants were then required to sign and retain the top part of the consent form and fill in their unique code on the detachable slip before handing this back to the researcher.

5.3.3.2 Screening questionnaire

This questionnaire acted as a selection and exclusion tool by ensuring that all allergies and health problems were recorded. Along with demographic information such as age, sex and occupation, participants were also asked about their health, illness and medication. In addition they were asked about smoking, the amount of alcohol they consume, and about any dietary restrictions they may have. Questions also covered issues surrounding general health and fitness.

Any participant indicating that they had a food allergy or intolerance was not permitted to continue their participation in the study. This was established if the participant answered "yes" to questions 13, 14a, 14b and 15 (all relating to allergies - see appendix 7), or if declared having food allergies and/or intolerances at the consent stage.

5.3.3.3 Main Experimental Measures

The experimental measures were presented in a thirteen page booklet. The first page gave participants information about how to complete the study. Initially participants had to complete three questions including "how hungry do you feel right now?", "how full to you full right now?" (rated on 100mm VAS) and were also asked to state when and what they last ate.

The Tridimensional Personality Questionnaire (TPQ; Cloninger 1987)

The TPQ (Cloninger, 1987) personality measure containing 100 short items relating to the temperamental personality and was presented in the booklet next (pages 2-8). The questionnaire covers the 4 domains; Harm Avoidance, Reward Dependence, Novelty Seeking and Persistence. Reward Dependence (24 items) has 3 subscales, Novelty Seeking (34 items) and Harm Avoidance (34 items) both have 4 subscales. Persistence (originally RD2) is made up of 8 items and is represented by a single subscale. A summary of the major domains and related subscales can be viewed in table 4.2 (see Chapter 4 section 4.3.3.2) and a more detailed summary of the characteristics associated with each subscale can be seen in the appendices (appendix 8).

Usual Taste Preference (VAS)

Page 9 of the questionnaire booklet contained 8 100mm VAS relating to usual taste preference of the basic tastes (sweet, spicy, salty, sour, bitter and Umami). In addition participants were asked to rate "savoury" tastes and tomato-based sauces. Participants were instructed to place a vertical mark on each line at the point which best described their usual taste preference. An example can be seen in figure 4.3 (Chapter 4 section 4.3.3.3)

Taste Samples (VAS)

Page 10 of the questionnaire booklet labelled "Taste Samples" instructed participants to inform the researcher that they had reached this stage.

1) I don't like this at all I like this very much

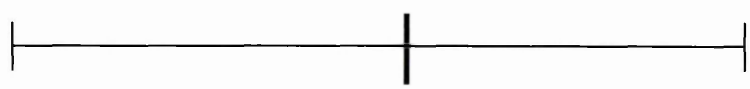

Figure 5.2: An example of a VAS for rating the taste samples

Participants were required to indicate how much they liked the taste of each sample by marking through 7 VAS (one per taste sample). They were instructed to rate the taste samples in the order they were presented on the tray. The researcher wrote this order on the top of the page for inputting purposes.

The Three-Factor Eating Questionnaire (TFEQ; Stunkard & Messick 1985)

The TFEQ consists of 51 items which measure three dimensions of eating behaviour; Cognitive Restraint, Disinhibition and Hunger. The concept of restrained eating was first developed by Herman (1975) and relates to the tendency for individuals to restrict their food (calorific intake) in order to control their body weight. The disinhibition dimension relates to the tendency to continue eating even when satisfied. The hunger dimension measures an individual's ability to cope with the sensation of hunger. The questionnaire is divided into two parts. Part one contains 36 items which require a true or false response. Part two is made up of 15 items; participants are to rate their response on 4-point Likert scales with the exception of item 50 which requires rating on a 6-point Likert scale. The responses were scored according to Stunkard and Messick's instructions (1985) which provided each participant with a total score for Restraint, Disinhibition and Hunger.

5.3.4 Procedure

5.3.4.1 Room layout and taste sample preparation

The room was set up before the arrival of the participants. Six metre-square sized tables with wipe-able surfaces were spread out facing away from one another. On each table 7 spoons, 1 paper napkin, 1 empty plastic cup, 1 water biscuit and 1 cup of water (25cl) were placed. In addition a consent form, a screening questionnaire and the main questionnaire booklet were placed (in this order).

Whilst the participants were completing the first part of the main questionnaire booklet the researcher prepared the taste samples in the kitchen area. Trays were laid out (one per participant) and 7 (60ml) small plastic taste sample pots (clearly labelled A-G) were laid out on the tray in the order they were to be consumed. The order they were to be consumed had been previously decided using a Latin square design in order to randomise the presentation of the taste samples.

One piece of pasta was placed in each taste pot (any remaining pasta was placed back in the fridge for later tasting sessions). The 7 boxes of pasta sauce were taken out of the fridge. A clean 5ml measure was assigned to each box. The researcher then took care to place 5ml of sauce A on top of the pasta piece in taste pot A. This procedure was then repeated for all sauces (A-G). Any remaining sauce was placed back into the fridge for later testing sessions. This process took approximately 10 minutes.

As the participants reached the stage where they required the taste samples the researcher heated up the taste sample by placing the 7 individual taste samples into the microwave for approximately 45 seconds on the high setting. These were then tested with a digital probe thermometer to check that the samples were at least 75°C (the safe temperature for consumption after reheating). These were then presented to the participant on a tray.

5.3.4.2 The Testing Session

Participants entered the room and were directed to a table previously set up by the researcher (see section 5.3.4.1). They were first asked to thoroughly read and study the ingredients on the reverse of the consent form. If after this they were happy to participate they signed and coded the consent form, handing the detachable slip back to the researcher. If they had any questions at this stage the researcher answered them. This part took approximately 5 minutes.

Participants were then asked to complete a screening questionnaire. The researcher checked if any of the participants had answered “yes” to 4 questions relating to food allergies and intolerances (see questions 13, 14a, 14b and 15 in appendix 7). If they had answered “yes” to any of these questions the researcher advised that they did not take part in the main study.

Participants were then asked to proceed to the questionnaire booklet and work through the questionnaires according to the written instructions quietly. They were asked to inform the researcher when they had reached the page entitled “Taste Samples”. This took about 10-15 minutes to complete.

5.3.4.3 Presentation of the taste samples to the participants

Participants were then handed an A4 sized tray containing 7 small taste samples. These were set out in the order that they should be consumed which was explained to the participant. The order had been previously determined using a Latin square design. The researcher took note of this order by writing it on the top of the page within each participant's questionnaire booklet (e.g. ABCDEFG or BCDEFGA etc).

Participants were asked to use a clean spoon for each taste sample. They were asked to carefully consider the taste of each individual taste sample before rating it on the appropriate VAS. Then they were instructed to sip some water and take a small bite of water cracker before proceeding to the next taste sample. These instructions were written on the taste sample page and also reiterated verbally. Although participants were instructed to swallow all the taste samples an empty receptacle was provided should the participants wish to expectorate any of the taste samples. This part took approximately 15 minutes to complete.

Participants were then asked to complete the final questionnaire in the booklet (the TFEQ). They were then provided with a debriefing sheet (appendix 9) and any questions were answered. After completion participants were offered an "after dinner mint" and research participation course credit codes if they were 1st year Psychology undergraduates at Sheffield Hallam University.

5.3.5 Analyses

Correlational analyses were conducted to examine relationships between measures of self-reported usual taste preference and taste preference for the taste samples. In addition backward elimination regression analyses were conducted as an exploratory technique to examine relationships between measures of taste preference (taste samples) and all personality variables (subscales). This method of analysis was selected in light of the limited research in this area resulting in difficulties establishing an explicit, testable model. Models of "best fit" were developed for each taste preference (taste samples), therefore the 6 taste dimensions were entered as the dependent variables and the 12 subscales of the TPQ were entered as the predictor variables. The most parsimonious model was selected on the basis of the adjusted R^2; data was explored for the solution that accounted for the maximum variance (Clark-Carter 2004). The participants who reported being regular smokers were excluded from the main analyses in light of well established evidence that smoking can lead to an impaired sense of taste (Grunberg 1982). Following this backward elimination multiple regression was also performed to assess relationships between the subscales of the TPQ (predictors) and the three domains of the TFEQ; Hunger, Restraint and Disinhibition were assessed separately and entered as the criterion variables.

5.4 Results

5.4.1 Treatment of the data

Items that were assessed using VAS were measured and inputted into SPSS in millimetres. The subscales of the TPQ (Cloninger 1987) and the TFEQ (Stunkard & Messick 1985) were calculated according to the instructions presented by the authors. Histograms and box plots were produced to examine the distribution of the scores on each variable. Inspection of the box plots showed that all variables (with the exception of measures usual Bitter liking and Taste A - Salty taste sample) demonstrated normal distribution and the skewness statistic for all variables fell within the guidelines of ±2.58 (Clark-Carter, 2004). Z scores were calculated for all taste and personality variables; two outliers were found one on NS2 and one on NS4 (subscales of Novelty Seeking). Data points were not adjusted as they were considered legitimate scores (Orr, Sackett & Dubois 1991). All other scores were within the guideline of ±3 for the detection of outliers (Clark-Carter 2004).

Additional assumptions for conducting multiple regression were tested. Variables were not highly correlated with each other; intercorrelations for predictors variables fell within the guidelines of ±0.8 (Clark-Carter 2004), therefore multicollinearity was not evident. In order to gain a medium effect size with 12 predictor variables at least 120 participants are required, therefore the sample size in this instance was deemed sufficient (based on the power tables in Clark-Carter 2004). Cook's distance was also obtained to measure any difference between an individual's scores on the DVs and IVs compared to other individuals in the sample, since all individual's scores were below 1 further investigation was not necessary (Stevens 2002). Furthermore correlational analysis (see below) found that the predictor variables were linearly related to the criterion variables, although the strength of these relationships were weak to medium.

5.4.2 Ratings of fullness and hunger

Before the taste session all participants were asked to rate how hungry and how full they felt using 100mm visual analogue scales. The mean score for hunger (50.66) was slightly higher than the mean for fullness (35.97). It was expected that these measurements should be negatively associated. The scores for these statistics were normally distributed therefore Pearson's correlation coefficient analysis was employed. A strong negative relationship was found to be significant between the participants' ratings of hunger and fullness ($r = -0.74$, $p < .01$), with high levels of hunger associated with low levels of fullness as expected.

5.4.3 Measures of taste preference

Participant's ratings for usual taste preference and the taste samples were measured on 100mm VAS. The descriptive statistics for the taste measures can be viewed in table 5.3. Usual sweet taste preference was highly rated across the sample. Although the sweet pasta/tomato sample equivalent was not as highly rated. Sex differences did emerge with females rating the sweet taste sample significantly more liked than males. In terms of usual salty taste preference ratings were low (below the mid-point of 50) with females rating their usual preference for salty tastes lower than males, the mean scores for taste sample A (salty) followed a similar pattern although ratings were very low.

Sex differences between usual ratings of bitter taste preference and also ratings of the bitter taste sample were evident. These, however, did not follow the same pattern; males rated usual bitter taste preference significantly higher than females and females rated the bitter taste sample significantly higher than males. No sex differences were found with regards to sour taste preference (both usual and taste sample), and generally ratings of these were low. Usual spicy taste preference was highly rated, particularly by male participants who rated their preference for spicy tastes significantly higher than female participants. A similar pattern emerged in response to the spicy taste sample, although this did not reach significance. No sex differences were found in terms of umami taste preference, although female participants rated their preference higher than males in both instances. Overall, all the real-food sample mean ratings were below the mid-point of 50. Despite observed sex differences in some of the taste measures (as highlighted above) these differences were not explored further due to the small number of male participants. The small male representation in this study introduced problems when drawing firm comparisons between males and females, due to the lack of statistical power. In light of these difficulties analyses was conducted on the sample as a whole.

Table 5.3: Means, standard deviations and p-values associated with sex differences for usual taste preference ratings and real-food sample ratings

	Usual taste preference Mean (SD)		*Sex Diff*	*Taste sample preference Mean (SD)*		*Sex Diff*
	Male	*Female*	*P*	*Male*	*Female*	*P*
Sweet	72.92 (21.90)	77.89 (17.32)	0.24	25.84 (22.54)	43.89 (28.60)	0.004**
Salty	49.92 (24.05)	41.28 (27.25)	0.15	31.16 (25.54)	20.27 (23.50)	0.05
Bitter	35.96 (23.07)	25.30 (19.39)	0.02*	34.29 (23.32)	46.87 (24.51)	0.03*
Sour	44.72 (26.21)	37.83 (23.81)	0.21	30.76 (26.22)	33.46 (23.71)	0.62
Spicy	82.88 (17.22)	54.31 (21.45)	0.001**	43.00 (32.80)	31.70 (26.68)	0.08
Umami	37.52 (30.25)	44.34 (26.34)	0.27	39.64 (28.35)	42.70 (25.67)	0.61

**p<0.05* ***p<0.01*

Correlations between measures of usual taste preference and taste preference for the taste samples were performed in order to ascertain if participants rated the taste samples in line with their "usual" self-rated taste preferences. Measures of usual sweet, sour, spicy and umami taste preference and preference for the taste samples met parametric assumptions and were therefore analysed using Pearson product-moment correlation-coefficient analysis. Measures of usual bitter preference and ratings of the salty taste sample showed a skewed distribution, therefore Spearman's Correlation Coefficient was used to analyse relationships between the bitter measures and the salt measures. The correlation analyses were performed for the total sample scores due to issues of statistical power, as previously stated.

Taste sample ratings positively correlated with their corresponding usual taste preference ratings, suggesting that participants rated the taste samples in line with their self-rated usual taste preference for the six tastes (see table 5.4). Taste ratings of the umami real-food sample and the usual umami preference did not reach the alpha level of 0.05. The correlations suggest that self-rated usual taste preference provides similar findings to measures of actual taste preference using real-food samples.

Table 5.4: Correlations and p-values between usual taste preference and real-food sample ratings

Taste Dimension	*Pearson co-efficient and p-value*
Sweet	r=0.20, p=0.017*
Sour	r=0.22, p=0.008**
Spicy	r=0.31, p<0.01**
Umami	r=0.15, p=.07
Taste Dimension	*Spearman's co-efficient and p-value*
Salty	*rho*=0.214, p<0.01**
Bitter	*rho*=0.22, p=0.009**

** significant at p<0.05 level* ***significant at p<0.01 level*

5.4.4 Personality

The means, standard deviations and associated sex differences for all subscales of the TPQ can be seen in table 5.5. Differences in scores between males and females were found in relation to NS3, where females achieved higher scores than males. This corresponded to Otter and colleagues (1995) UK normative data but not the US normative data (Cloninger et al., 1994). No differences between males and females were found in relation to Harm Avoidance, failing to replicate data from study 1 and Otter et al's (1995) UK data. In terms of Reward Dependence the current study found that females scored significantly higher on RD3 and total Reward Dependence, in line with study 1 and Otter et al's (1995) data. There were no differences between males and females in relation to Persistence consistence with study 1 and Otter et al's (1995) data. Overall the standard deviations were similar to those of study 1 and Otter et al's (1995) data suggesting similar patterns of variance across all subscales of the TPQ.

Table 5.5: Means, standard deviations and p-values associated with differences between males (n=36) and females (n=114) for personality subscales

	Men		*Women*		*Sex Diff*
	Mean	SD	Mean	SD	*P*
NS1	4.76	1.64	4.82	1.89	0.88
NS2	3.72	2.44	3.33	1.92	0.40
NS3	3.04	1.81	4.34	1.70	0.001**
NS4	5.60	1.84	5.37	2.16	0.63
Total Novelty Seeking	17.12	5.27	17.87	5.30	0.53
HA1	3.72	2.91	4.24	2.69	0.40
HA2	3.28	1.74	3.96	1.90	0.11
HA3	2.84	2.13	2.97	2.06	0.79
HA4	2.92	2.74	3.51	2.28	0.28
Total Harm Avoidance	12.76	6.58	14.67	6.94	0.22
RD1	3.52	1.29	3.88	1.04	0.15
RD3	6.04	2.92	8.00	2.48	0.001**
RD4	2.64	1.32	3.75	1.25	0.001**
Total Reward Dependence	12.20	4.11	15.63	3.41	0.001**
Persistence	4.96	2.49	5.24	2.00	0.56

**p*<0.05 ***p*<0.01

5.4.5 Individual Differences in Taste Preference - Regression Analyses

In light of the observed differences between males and females on some of the personality subscales and taste measures (see descriptive data table 5.3 and table 5.5), sex was added to the model to see if this explained any additional variance in taste over and above that explained by personality. Taste scores were entered as the criterion variables into 2 step hierarchical regression models in order to examine the interaction between sex and personality in patterns of taste preference. Z scores for sex and personality scores were created and new interaction variables were formed to combine sex and personality. The interaction variables were calculated by multiplying z scores for each personality subscale scores by z values for sex (previously dummy coded). Despite this relationships between taste and the new interaction variable (sex x personality) revealed that sex did not add to the amount of variance explained in taste. As a result and due to the exploratory nature of this study stepwise regression using the backward method was performed on each taste dimension in order to discover the most parsimonious model consisting of the best predictor variables.

Each taste was tested individually as it was not deemed appropriate to group the tastes together to form an overall taste preference measure. This was due to the amount of individual variation in preference for each taste and also after inspection of the intercorrelations between the tastes; multicollinearity was not evident which indicates that the taste measures should be treated as unique constructs. All predictors are presented in the tables summarising the regression model for each taste in the following sections, although only the best predictors are described in detail (i.e. the significant predictors and those with the highest beta values).

5.4.5.1 Innate Tastes

Sweet Taste Sample

The proportion of variance in preference for the sweet taste sample accounted for by the remaining predictor variables was 8.8% (adj. R^2). This model was significant ($F(3,112)=4.72$, $p=0.004$). The model retained 3 personality predictors, the lower facet of novelty seeking NS3 relating to extravagance ($t=2.41$, $p=0.02$) and RD3 relating to attachment (t=2.01, p=0.05) were the best predictors of preference for the sweet taste sample (see table 5.6) indicating that extravagant and socially attached temperaments were associated with high scores for the sweet pasta sample.

Table 5.6: Beta values, standard errors and standardised betas for taste preference of the sweet taste sample by personality variables

	B	*SE B*	*β*
(Constant)	2.27	10.70	
NS3	3.46	1.43	0.22*
Persistence	1.76	1.21	0.13
RD3	1.92	0.96	0.18*

$*p<0.05$

Salty Taste Sample

Scores for salty taste (Sample A) was found to be skewed, however the data collected was considered realistic and true scores. Since there is no non-parametric regression alternative exists, regression analysis was conducted.

Table 5.7: Beta values, standard errors and standardised betas for salty taste sample by personality variables

	B	*SE B*	*β*
(Constant)	38.68	10.58	
NS2	2.24	1.19	0.19
NS3	-2.56	1.28	-0.19*
NS4	-2.61	1.15	-0.22*
HA3	2.17	1.14	0.19
RD3	0.94	0.93	0.10
RD4	-3.61	1.88	-0.20

$*p <0.05$

The proportion of variance in preference for the salty taste sample accounted for by the remaining predictor variables was 8.2% (adj. R^2). This model was significant

(F(6,109)=2.71, *p*=0.02). The model retained 6 personality predictors (see table 5.8). NS4 (relating to disorderliness) was found to be the best predictor of preference ratings for the salty pasta sample (t=-2.26, p=0.03); indicating that quick tempered and disorderly temperaments were related to low scores of preference for the salty pasta sample.

Umami Taste Sample

The proportion of variance in preference for the umami taste sample accounted for by the remaining predictor variables was 6.1% (adj. R^2). This model was significant (F(2,113)=4.75, *p*=0.01). The model retained 2 personality predictors (see table 5.10). NS2 was found to be the best predictor of preference for the Umami taste sample (t=-2.25, *p*=0.03), this was a negative relationship suggesting that excitable, dramatic temperaments were related to ratings of dislike toward the umami manipulated pasta sample.

Table 5.8: Beta values, standard errors and standardised betas for taste preference of the umami taste sample by personality variables

	B	*SE B*	*β*
(Constant)	37.25	8.15	
NS2	-2.62	1.16	-0.03*
RD3	1.81	0.88	0.19*

**p<0.05*

5.4.5.2 Acquired Tastes

Bitter Taste Sample

The proportion of variance in preference for the bitter taste sample accounted for by the remaining predictor variables was 6.7% (adj. R^2). This model was significant (F(2,111)=5.08, *p*=0.008). The model retained 2 personality predictors, of these RD3 (Attachment) was found to be the best predictor of bitter taste preference (t=2.88, *p*=0.01) suggesting that higher scores on the attachment scale lead to an increased liking of the bitter taste sample.

Table 5.9: Beta values, standard errors and standardised betas for taste preference of the bitter taste sample by personality variables

	B	*SE B*	*β*
(Constant)	19.46	8.27	
Persistence	1.43	1.07	0.12
RD3	2.29	0.83	0.25**

***p<0.01*

Sour Taste Sample

The proportion of variance in preference for the sour taste sample accounted for by the remaining predictor variables was 10% (adj. R^2). This model was significant (F(4,111)=4.20, *p*=0.003). The model retained 4 personality predictors (see table 5.11). NS1 relating to exploratory excitability was found to be the best predictor (t=3.00, *p*=0.003), indicating that thrill seeking was associated with preference for the sour pasta sample.

Table 5.10: Beta values, standard errors and standardised betas for taste preference of the sour taste sample by personality variables

	B	*SE B*	*β*
(Constant)	6.86	9.50	
NS1	3.82	1.28	0.29**
HA1	-2.88	1.00	-0.33**
HA2	3.93	1.58	0.31**
HA4	1.35	0.95	0.13

***p<0.01*

Additionally HA2 relating to fear of uncertainty was a good predictor of sour taste preference (t=2.49, *p*=0.01), again a positive relationship emerged suggesting that tense and anxious types rated the sour pasta sample with high preference, this result was not expected.

Spicy Taste Sample

The association between preference for the spicy taste sample, and the explanatory variables was moderately weak (Multiple R=0.21). The remaining personality variables in the model of best fit were NS3 (Extravagance) and Persistence. These predictors accounted for 2.7% % of the variation in spicy taste preference (adjusted R^2). The model was not significant ($F(2,113)=2.62$, $p=0.08$).

Table 5.11: Beta values, standard errors and standardised betas for spicy taste preference by personality subscales

	B	*SE B*	*β*
(Constant)	35.20	9.51	
NS3	-2.45	1.46	-0.16
PER	1.72	1.24	0.13

5.4.5.3 Comparisons with Study 1

Table 5.12 presents a summary of the models of best fit for the present study with the findings of study 1. With the exception of bitter and spicy tastes the introduction of taste samples to further examine ratings of taste preference resulted in an increase in the amount of variance explained by the remaining personality variables (adjusted R^2). Although at least one personality predictor remained in the model at study 2, these models were not consistent in terms of all remaining personality variables in the models. This was particularly true of sweet taste preference where none of the original personality variables (study 1) remained in the model in study 2. This may reflect problems with the taste samples (see discussion). Overall the models from study 2 are more parsimonious; containing fewer personality variables, yet explaining more of the variance.

Table 5.12: Summary of the models of best fit explaining the amount of variance in taste preference (adj. R^2) accounted for by the remaining personality variables for study 1 and study 2

	Study 1		**Study 2**	
Sweet	6%	RD4xSex, HA3xSex	9%	NS3, PER, RD3
Salty	7%	**NS4(-)**, HA3, HA4 (-), RD1, PER(-)	9%	NS3(-), **NS4(-)**
Sour	6.2%	NS4, **HA4(-)**, RD3(-)	10%	HA1(-), HA2, **HA4**
Bitter	9%	NS2(-), HA4(-), **RD3(-)**	7%	**RD3**
Umami	5.6%	NS1(-), HA2(-), HA4, PER(-), **RD3**	6%	NS2(-), **RD3**
Spicy	5.7%	NS1, NS3(-), HA4, RD3(-)	3%	Not Significant

Note: (-) after the variable denotes a negative relationship. Figures highlighted in blue indicate that the variables were present in both models (study 1 and study 2)

5.4.6 Eating Behaviour

Table 5.13 gives the mean and standard deviations for scores of Restraint, Disinhibition and Hunger as measured by the TFEQ. Differences were found between males and females on scores of restraint and disinhibition, but not on scores of hunger.

Table 5.13: Means and standard deviations of eating behaviour scores

	Females		*Males*		*Sex Diff*
	Mean	SD	Mean	SD	*p*
TFEQ Restraint	7.66	5.67	4.28	4.10	0.001**
TFEQ Disinhibition	7.82	3.49	6.22	3.26	0.02*
TFEQ hunger	6.47	3.38	6.00	3.62	0.47

* p<0.05   ** p<0.01

Pearson Product-Moment Correlation analysis was employed to examine the relationships between the subscales of the TPQ and the TFEQ (see figure 5.4). Score of disinhibition and hunger were significantly and positively related to the subscales of reward dependence and harm avoidance. Generally correlations above 0.18 reached statistical significance at p=0.05.

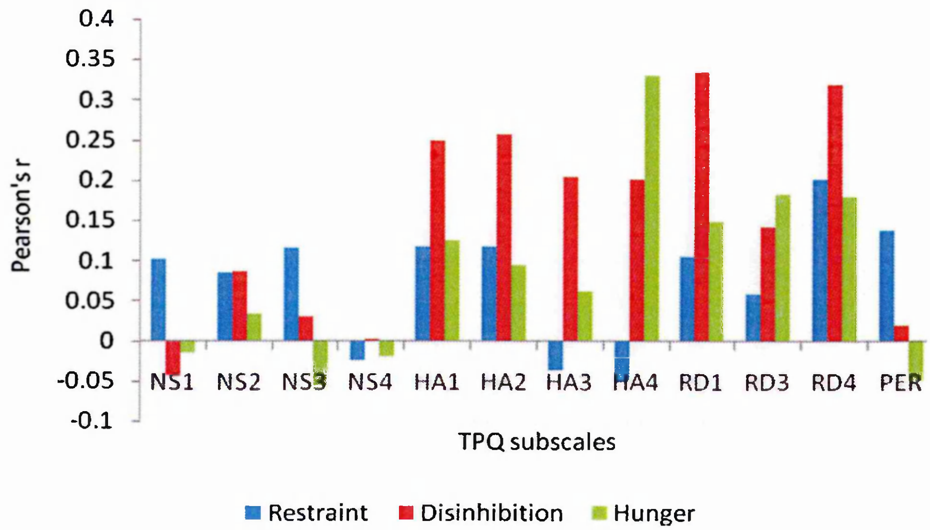

Figure 5.3: Correlation Coefficients between the personality subscales (TPQ) and eating behaviour measures (TFEQ)

Backward stepwise multiple regression was conducted to establish models of best fit in relation to personality and eating behaviour variables. The personality subscales of the TPQ were entered as predictors and the dimensions of restraint, disinhibition and hunger were entered as the criterions. Separate regression analysis was performed for each of these eating behaviour measures in turn. The coefficients selected for discussion relate to those deemed as the best predictors for each regression model (i.e. significant coefficients or those with the highest beta values).

5.4.6.1 Restraint

The association between the criterion, Restraint scores, and the explanatory variables was moderately weak (Multiple R=0.26). The remaining personality variables RD4 (Dependence), NS3 (Extravagance) and Persistence accounted for 5% of the variation in levels of dietary restraint (adjusted R^2). This model was significant ($F(3,146)=3.58$, $p=0.02$). RD4 (Dependence vs. independence) was found to be the best predictor of dietary restraint ($t=2.26$, $p=0.03$), suggesting that high scores of dependency on social support and the need for approval from others were associated with high scores of dietary restraint. See table 5.14 for details of the model coefficients.

Table 5.14: Beta values, standard errors and standardised betas for scores of the Restraint subscale of the TFEQ by personality subscales of the TPQ

	B	*SE B*	*β*
(Constant)	0.87	1.91	-
NS3	0.32	0.24	0.11
PER	0.37	0.21	0.14
RD4	0.76	0.34	0.18*

**p<0.05*

5.4.6.2 Disinhibition

The proportion of variance in scores of disinhibition accounted for by the remaining predictor variables was 23% (adj. R^2). This model was significant ($F(4,145)=10.91$, $p<.01$). The model retained 4 personality predictors (see table 5.15). Inspection of the coefficients indicated that of the remaining predictors RD1 relating to sentimentality ($t=4.33$, $p<.01$) and RD4 relating to dependence ($t=3.56$, $p<.01$) were found to be the best predictors of disinhibited eating behaviour, indicating that sentimental, sympathetic and highly dependent temperaments were related to high scores of disinhibition (see table 5.15).

Table 5.15: Beta values, standard errors and standardised betas for scores of the Disinhibition scale (TFEQ) by personality subscales (TPQ)

	B	*SE B*	*β*
(Constant)	0.06	1.17	-
NS2	0.18	0.12	0.11
HA3	0.26	0.13	0.15*
RD1	0.92	0.21	0.32**
RD4	0.70	0.20	0.27**

**p<0.05* ***p<0.01*

5.4.6.3 Hunger

The proportion of variance in scores of hunger as measured by the TFEQ accounted for by the remaining subscales of the TPQ was 14% (adj. R^2). This model was significant (F(2,147)=11.90, *p*<.01). The model retained 2 personality predictors (see table 5.16) of these HA4 relating to fatigability was found to be the best predictor of scores of hunger (t=4.25, *p*<.01), indicating that individuals with less energy than most people tended to achieve high scores on the hunger subscale. See table 5.16 for details of the coefficients.

Table 5.16: Beta values, standard errors and standardised betas for scores of the hunger subscale of the TFEQ by personality subscales of the TPQ

	B	*SE B*	*β*
(Constant)	3.04	0.88	-
HA4	0.44	0.10	0.33**
RD3	0.23	0.10	0.18*

**p<0.05   **p<0.01*

5.4.7 Summary of Findings

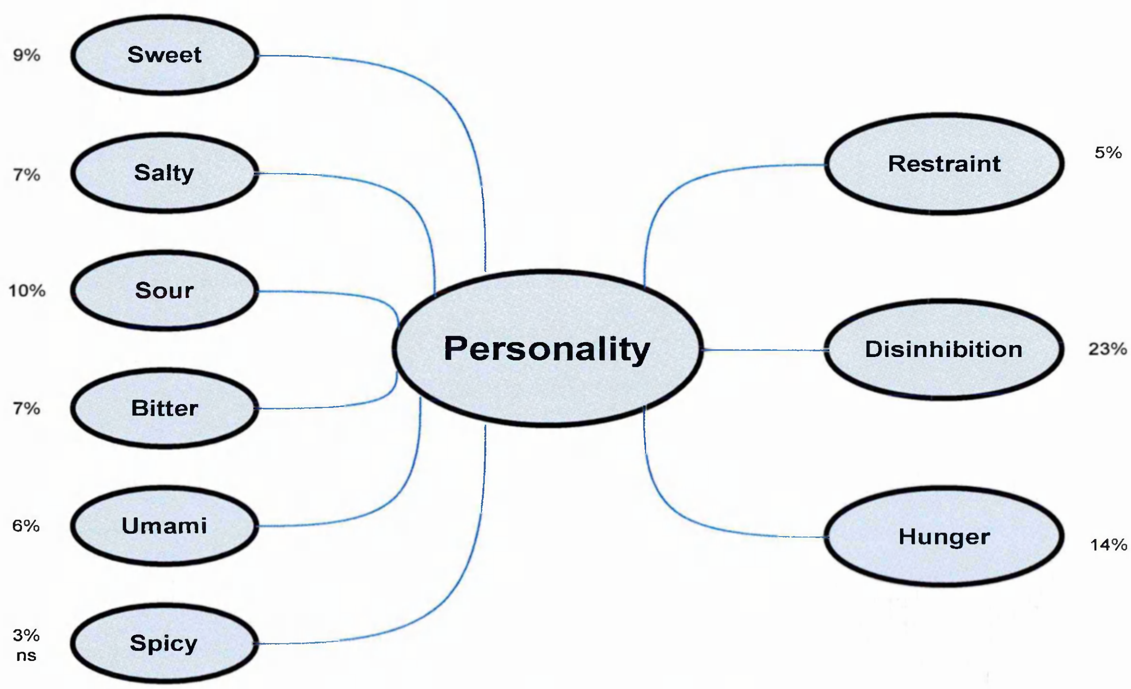

Figure 5.4: Summary of findings: models of best fit explaining the percentage of variance (adj. R^2) in taste preference and eating behaviour accounted for by the remaining personality subscales measured by the TPQ (Cloninger, 1987)

5.5 Discussion

5.5.1. Measures of Taste Preference

Generally measures of self-rated taste preference in this study significantly positively correlated with participants' preference for the taste samples. This was particularly true for measures of salty, sweet, sour and spicy tastes. Despite this the correlations were weak to moderate in strength, suggesting that the taste samples were not truly accurate measures of participants perceived "usual" taste preference. Conversely, difficulties arise when asked to reflectively rate taste preference without a frame of reference as highlighted from study 1. This creates problems when comparing reflective "usual" taste preference and taste preference for taste samples. For example, since sweet tastes are usually associated with sugars, responses to a sweet pasta taste sample may not be directly comparable as this combines sweet and savoury tastes.

Measures of sweet preference also followed this pattern; although positive correlations occurred between self-rated sweet taste preference and preference for the sweet taste sample, the mean sweet taste preference was much lower than the mean of usual sweet taste preference. Anecdotal comments from participants suggested that the combination of the sweet and savoury of the pasta sample was unusual. Generally sweet tastes are associated with sugars and foods which are sweet in nature and not savoury.

Salty taste was found to be the best measure, although closer inspection of these results shows that preference ratings for the salty taste sample were low in comparison to "usual" self-rated salty preference. Casual observations suggest that the salty taste sample was the most distinct; participants could detect the salt immediately with some participants finding this sample unpalatable.

Ratings for umami preference also showed to be unrelated to preference ratings for the umami taste sample. The mean ratings for usual umami taste preference were found to be lower than preference for the umami taste sample. Since the term "umami" is not familiar to the lay person, the term "artificially enhanced" was used in place of umami on participant rating scales. The term "artificially enhanced" may carry connotations of undesirability and unhealthy foods. In this way participants may have rated their preference for artificially enhanced tastes with a degree of social desirability; reflectively rating this taste with dislike but rating the corresponding real-food sample more favourably.

The bitter taste sample results did not correlate with the corresponding usual self-rated bitter taste measures, indicating that this was not a good measure of bitter taste preference. This may have resulted for a number of reasons; the taste sample may not have been obviously bitter to taste, on the other hand the sample may have been too bitter to taste. Yeomans (1998) found that bitter taste manipulation led to reduced palatability of food samples. Despite this, inspection of the mean scores for bitter taste show that participants rated their usual bitter taste preference very low, comparing this with the average preference ratings for the bitter taste sample revealed that participants rated the actual bitter taste sample more favourably. These contradictory ratings may show that participant's subjective dislike of bitter tastes is not consistent with the actual preference for bitter tastes following tasting. Additionally the genetic evidence for PROP tasters vs. non-PROP tasters may also be a contributory factor.

5.5.2. Personality Data

Comparisons between the current study's data and that of Otter and colleagues (1995) seem most appropriate as these both employ a British sample, whereas Cloninger and colleagues (1994) normative data is based on a US sample and Otter's (1995) paper clearly presents population differences between these countries.

The current sample showed slightly higher levels of Novelty Seeking (NS), especially among the male participants, compared to Otter et al's study. This may be attributed to the age differences between these samples (the current study being 4 years younger than Otter and colleagues study). Female novelty seeking scores were higher than males in the current study following in the same pattern as

Otter et al's data, but contrasting with Cloninger and colleagues (1994) where novelty seeking was found to be highest among young males perhaps reflecting cultural differences between the US and UK. Scores of Harm Avoidance (HA) were similar for females compared to Otter et al's data but again slightly higher among males. Reward dependence scores are lower in the current study in comparison to Otter et al's, again this may be related to age differences between the two samples. Persistence scores were in line with Otter et al.

In terms of differences between males and females on the personality subscale, these were not, in all cases, consistent with Otter et al and study 1. This study found sex differences in relation to scores of RD3 and total reward dependence, in line with Otter's data and study 1. However the current study did not show differences between males and females in relation to scores of Harm Avoidance where females generally achieve higher scores (Otter et al., 1995; Cloninger et al., 1994; Chapter 4). These differences may result from the small sample size and small proportion of male participants in this current study compared to previous studies.

5.5.3. Taste Preference and Personality

Previous to this, there is a paucity of research which has examined associations between taste preference and personality. This is particularly true for the range of taste dimensions examined in this study. This second study sought to explore relationships between taste preference and personality for 6 taste dimensions (sweet, salty, umami, bitter, sour and spicy) using pasta and sauce taste samples manipulated by taste dimension. Between 2% and 10% of the variance in preference for the taste samples could be explained by some personality variables, consistent with study 1. These are discussed in turn in the proceeding sections.

5.5.3.1 Innate Tastes

Sweet Taste Preference

In line with study 1 usual sweet taste preference was rated with high preference across the sample, further confirming a universal liking for sweet tastes (Reed et al., 2006). Ratings for the sweet pasta sample were not as high and sex differences emerged with females rating the sample significantly more liked than the males. The model of best fit suggested that a tendency to be extravagant and unrestrained (characterised by high scores on the NS3 scale) was associated with taste preference for the sweet taste sample, in line with previous findings (McHale et al., 2002). This also corresponds to previous studies linking outgoing traits and sweet preference (Stone & Pangborn 1990). This finding is also supported by the clinical literature where sweet taste preference has been linked to high scores in novelty seeking and alcoholism (Kampov-Polevoy et al., 1997; Kampov-Polevoy et al., 1998; Kampov-Polevoy et al., 2004). This was not supported by study 1 where no relationship was found linking novelty seeking and sweet preference. This may be due to inconsistencies in scores of novelty seeking compared to other normative data (Cloninger et al., 1994; Otter et al., 1995).

A tendency to be highly attached and sensitive (characterised by high scores on the RD3 scale) was also found to be associated with sweet taste preference. This provides some support for the experimental hypothesis which predicted that high scores on the reward dependent and harm avoidance subscales would be related to sweet taste preference. Consistent with previous research linking introverts with a tendency to avoid unusual, novel foods and prefer "safe" foods often characterised by the innate tastes (Pliner & Hobden 1992; Pliner & Melo 1997), this study provides further support for the idea of food neophobia. Less out-going individuals with high introversion scores (similar to reward dependence) tend to achieve low scores on the Food Involvement Scale suggesting an avoidance of novel foods and a preference for the innate tastes (Van Trijp et al., 1996).

Salty Taste Preference

A tendency to be extravagant and unrestrained (characterised by high scores on the NS3 subscale) and quick tempered and disorderly (characterised by high scores on the NS4 subscale) were found to negatively related to salty taste preference; individuals achieving high scores on NS3 and NS4 subscales disliked the salty taste sample. Conversely this would suggest that individuals achieving low scores on these subscales rated the salty pasta sample with strong preference; a tendency to be reserved, controlled and restrained (low scores on NS3) and a tendency to be orderly and methodical (low scores on the NS4 subscale) was associated with preference for the salty pasta sample. NS4 was found to be the best predictor of preference for the salty pasta sample, consistent with study 1.

Other predictors remaining in the model of best fit related to reward dependence and harm avoidance. A tendency to be dependent on support from others (characterised by high scores in RD4) was negatively related to preference for the salty pasta sample, just falling short of the set alpha level.

Research linking salt preference and personality is sparse, consequently it is difficult to draw direct comparisons. Stone and Pangborn (1990) found similar results relating to salt and sweet preference finding that 13% of variance in salt and sweet preference could be explained by personality traits. A number of studies have examined salt intake and personality traits concluding that salt intake is significantly related to high scores of extraversion (Shepherd & Fairleigh 1986a: Shepherd & Fairleigh 1986b; Kikuchi & Watanabe, 1999). The findings of the current study contradict these previous studies and those of study 1. However, these findings do support other previous research which found a negative association between salt preference and extraversion (Yeo et al., 1997).

Umami Taste Preference

The model of best fit for the umami taste sample suggested that NS2 and RD3 were the best and only predictors of preference for this dimension. In line with study 1 a lower facet of novelty seeking, in this case NS2 (previously NS1) was found to be negatively related to preference for the umami taste sample. On the contrary RD3 (related to attachment) was found to positively relate to preference ratings of this sample, providing additional support to study 1. Literature searches on umami taste preference revealed no previous research specific to personality influences on umami preference as such the patterns of findings in relation to this dimension were unanticipated. It is, therefore, encouraging comparing the pattern of findings revealed from this study with those of the previous questionnaire study (Chapter 4) as similar relationships were revealed.

Monosodium glutamate (MSG) is found to be unpalatable when consumed alone as an aqueous solution (Yamaguchi & Takashai 1984). In light of this studies using MSG tend to use soup diluents as these are more positively received (Beauchamp & Pearson, 1991; Steiner, 1987). MSG has been found to increase the palatability of foods and the addition of MSG can condition a liking for novel flavours (Prescott, 2004). In this way it may be interesting to further investigate the addictive effects of MSG have on the acceptance of novel foods in individuals with high scores of food neophobia, often found in individuals with less out-going traits.

It is interesting to note that the mean scores for usual umami (termed "Artificially enhanced" here) were almost identical to the mean scores for the MSG containing taste sample. Study 1 found low scores for this measure, these were linked to possible social desirability effects; it was thought that ratings were low due to negative connotations associated with the term artificially enhanced. Since this study produced similar ratings for this measure reflectively and after tasting it is unlikely that social desirability was a contributory factor. As MSG acts as a flavour enhancer the manipulation of the pasta taste sample with the addition of MSG may have resulted in increased palatability of the base sauce.

5.5.3.2 Acquired Tastes

Bitter Taste Preference

The removal of predictor variables resulted in only 2 predictors of bitter taste preference making up the model of best fit. Of these only RD3 relating to attachment was found to be a significant predictor. It is somewhat surprising that scores of RD3 were positively related to preference scores for the bitter taste sample, as it was expected that lower facets of reward dependence and harm avoidance would be associated with dislike for the bitter sample. This may reflect problems with the taste sample. The overall mean score of this sample was also very low, indicating a universal dislike for bitter tastes in line with study 1 which resulted in very low scores for this taste dimension as well. In other studies liking scores for bitter-tasting foods and beverages was found to be associated with variety seeking and sensation seeking (Mattes 1994). Additionally high levels of food neophobia were associated with dislike for bitter foods and drinks (Mattes 1994). In the literature high levels of food neophobia have been found to positively correlate with neuroticism and introversion (traits similar in nature to reward dependence). Thus it was expected that reward dependence and harm avoidance would be associated with dislike for bitter tastes; this was not confirmed by the current study.

Differences between males and females were revealed in response to the bitter taste sample; female participants rated the bitter taste sample significantly higher than males. This finding was again unexpected as prior studies have found that females find suprathresholds of caffeine more intense than males (Hyde & Feller, 1981), and are more sensitive to the detection of PTC and PROP (Bartoshuk et al., 1994). Detection may not directly reflect to palatability, but if certain individual's are more sensitive to bitter tastes this could confound perceived palatability, or have an impact on liking scores for bitter tastes, particularly if they are perceived as extremely bitter.

It is difficult to explain this result but due to these unexpected findings it is suspected that the bitter pasta sample was not a good measure of bitter taste preference. The mean score for females increased after tasting the pasta sample. In light of the anatomical evidence indicating that females have more fungiform papillae and taste buds (Bartoshuk et al,, 1994) this may suggest that the bitter taste was not easily detected or was not distinctive.

Certain foods and drinks are distinctively bitter or sour tasting (i.e. gooseberries, coffee, bitter ale etc). Foods that do not usually taste bitter or sour may be thought to be bad or "off" (e.g. sour milk). It is perhaps unfamiliar and unexpected, therefore, for pasta to be bitter-tasting. This may have resulted in negative expectancy effects in this study. Participants may have had an expectation of the taste of the food samples in line with their usual experience of pasta and sauce. Indeed prior eating is thought to influence future eating, and memory for specific attributes of foods is likely to affect future intake (Higgs, 2005).

This study clearly shown demonstrates the difficulties of measuring taste preference for a number of taste dimensions across one food. In addition, testing taste preference for a range of taste dimensions across one food may not necessarily reflect usual taste preference. This seems particularly apparent for the bitter taste dimension; the mean score was very low, indicating a universal dislike for this food sample.

Sour Taste Preference

The model of best fit found that a combination of novelty seeking and harm avoidance traits explained the most variance in preference for the sour pasta sample. A tendency to seek thrills, excitement and adventure (characterised by high scores in NS1)[11] was found to be the best predictor of sour taste preference. This finding is consistent with classic studies which suggested that positive responses to sour tasting stimuli were associated with outgoing, adventurous traits such as extraversion[1] (Eysenck & Eysenck 1967; Howarth & Skinner 1969). More recently Mattes (1994) discovered that sour taste preference was positively correlated with scores of sensation seeking, providing further support for the current findings.

In line with the theoretical perspective of acquired and innate taste preference it was expected that outgoing types would like sour tastes and on the contrary, less out-going types would dislike acquired tastes such as sour. In agreement with this perspective and the existing literature the current study found that a tendency to find uncertainty and unfamiliar circumstances intolerable (characterised by high scores on the HA2 subscale) related to dislike for the sour taste sample. Contrary to this and expectations, HA3 was found to be negatively related to sour taste preference; individuals who tend to be unassertive and shy highly rated the sour

[11] NS1 has found to highly correlate with sensation seeking and extraversion (Zuckerman & Cloninger 1996)

taste sample favourably. Although studies that examine individual differences in sour taste preference are fairly sporadic, this finding relating to HA3 does not fit with the existing literature.

Spicy Taste Preference

The model of best fit developed to explain the variance in response to the spicy taste sample did not reach the set alpha level. It was expected that high scores in novelty seeking would be associated with high preference ratings for the spicy pasta sample. Study 1's examination of usual spicy preference supported this claim and measures of usual spicy taste preference ratings in this current study also followed this similar pattern. Unfortunately preference ratings for the spicy taste sample in this study did not follow this pattern. This may reflect problems with the taste sample. The pasta sample may have been too spicy or not spicy enough. The introduction of relative-to-ideal scales may have overcome this by examining the "ideal" level of spiciness. This method is more common to studies using range intensities and would perhaps have been inappropriate in this instance as the introduction of a series of taste samples for each individual taste would have resulted in a great deal of taste samples and as a result the addition of a great deal of variables. This would have a negative impact on the statistical power of the data.

5.5.4. Eating Behaviour and Personality

The current study discovered a number of relationships between measures of eating behaviour and personality traits. In particular lower facets of reward dependence and harm avoidance were associated with high levels of disinhibition and hunger. A strong model was revealed linking dependent, sensitive and strongly attached, unassertive and easily inhibited individuals to high levels of disinhibited eating styles. These results are consistent with previous findings which also identified personality subscales such as neuroticism, reward dependence and harm avoidance as good predictors of disinhibition (van Strien et al., 1985; Gendall, Sullivan, Joyce & Bulik, 1998; Elfhag, 2005; van den Bree et al., 2006; Provencher et al., 2008). High harm avoidance is also found in bulimic patients who alternately binge and purge (Kleifield et al, 1993; Brewerton, Hand & Bishop, 1993; Waller et al., 1991; Waller et al., 1993). Since disinhibited eating behaviour is characterised by binging and purging the current findings accord with previous research.

The susceptibility to hunger scale appears to be the least researched and least discussed dimension of eating behaviour measured by the TFEQ, particularly in relation to personality predictors. This may be explained by high intercorrelations observed between hunger and disinhibition and also low internal consistency of this domain compared to the restraint and disinhibition subscales (Shearin et al., 1994). High reward dependence and harm avoidance scores were also found to correlate with susceptibility to hunger scores. This is concurrent with other studies that have found less out-going and unassertive traits linked with high scores on the hunger subscale (Elfhag, 2005; Provencher et al., 2008). Previous examinations of the personality correlates of the TPQ with the TFEQ have found positive relationships between harm avoidance and susceptibility to hunger (Gendall et al., 1998; van den Bree et al., 2006) which were further confirmed by the present investigation.

The model of best fit for restraint was the weakest of the three models. These data suggest that individuals who have dependent temperaments and tend to seek out approval from others have high levels of dietary restraint. This result lends support toward associations found between low self esteem and high dietary restraint (McLean & Barr 2003). Additionally since low self esteem is thought to be a prerequisite for the onset of eating disorders it has been suggested that low self-esteem increases sensitivity towards societal pressures of the "ideal" body (particularly in women), and consequently increased susceptibility to restrained eating (Silverstone 1992; Button, Sonuga-Barke, Davies & Thompson, 1996). The current study also found that high scores of dietary restraint were associated with extravagance (characterised by NS3) and persistence although these relationships fell short of the set alpha level. Previously relationships have been found between dietary restraint and personality traits. A study using the DEBQ found that traits relating to neuroticism and conscientiousness were associated with eating behaviour (Heaven, Mulligan, Merrilees, Woods & Fairooz, 2001). Specifically they found that cautious individuals with low self-efficacy (high neuroticism and conscientiousness) tend to show high levels of dietary restraint. It has been previously shown that these traits highly and positively correlate with harm avoidance and reward dependence, thus providing partial support for the current findings. Contrary to this Jansen and colleagues (1989) found that restrained eaters achieved high scores on the short form of the Sensation Seeking Scale which was not confirmed by the current findings.

5.5.5. Limitations

A number of important limitations need to be considered, particularly in relation to the taste measures. Participants were instructed to swallow the taste samples, yet some participants did expectorate the taste samples if they strongly disliked them. This was, in all cases, perceived as accidental and the data was included in the analysis. It has been previously observed that the expectoration of taste samples generates more consistent and repeatable findings than if taste samples are swallowed (Mattes & Mela, 1986). Any replication of the current study should employ the "sip and spit" technique, and make sure this is strictly adhered to. Secondly, the pasta samples were developed to represent taste samples that explicitly reflected the taste dimensions under examination and were not meant to represent food that would be consumed outside of the laboratory. Although taste is often the deciding factor of food acceptance, food preference as measured by hedonic ratings of taste samples do not necessarily reflect usual consumption or usual preference (Mattes & Mela, 1986; Drewnowski, 1997). In light of this caution should always be applied when generalising responses toward taste samples to "real-life" preference or intake. A further limitation of the development of the taste samples is reflected by the pilot study; ratings were not taken to verify any difference in taste between the samples and to check if the taste samples represented the taste dimensions they were developed to represent.

In terms of the taste measures a number of these resulted in very low preference ratings. The samples were developed with an aim to be palatable but it was also important that the different taste dimensions were distinct. This was confirmed by the pilot study however anecdotal responses suggested that of the samples the salty sample (Sample A) was perceived to be too salty. Taste testing involving a range of taste intensities may overcome this issue. The procedure where by participants are given a range of the same taste dimension of different intensities and asked to select their preferred sample is frequently employed in the literature (see Drewnowski 1997). It further suspected that the bitter taste sample was perceived as fairly unpalatable as consistently low ratings were revealed for this taste sample. It is speculated that this might be due to taste expectancy; certain foods are expected to taste bitter, those that are not may be perceived as bad or 'off'. This reflects inherent problems with testing a number of taste dimensions across the same food sample. Using multiple foods to test taste preference for a number of different taste dimensions may be more appropriate in future studies.

Due to limited previous research in this area it is difficult to draw direct comparisons with previous findings. In light of this the current study was exploratory in nature and may be criticised for the statistical procedures used. Despite this, regression analysis was conducted using the backward function as other procedures were not deemed appropriate due to issues of sample size, large number of variables and consequently statistical power. As a result caution should be applied when making generalisations about the findings revealed here.

5.5.6. Conclusion

This investigation aimed to further assess relationships between taste preference and temperamental personality. This study extended study 1 (Chapter 4) by examining these relationships more directly by using taste samples to gain more realistic measures of taste preference. Despite a number of observed limitations particularly in relation to the taste samples the study confirmed some aspects of previous research and the findings of study 1. Overall between 2% and 10% of the variance in taste preference for the different pasta samples could be accounted for by the personality variables. The regression analysis revealed that the best models related to sweet (9%) and sour (10%) taste preference. In addition between 5% and 23% of the variance in eating behaviour (as measured by the TFEQ) could be explained by personality. It is important to reiterate that although taste may be the dominant influence in food acceptance and preference it is not an exclusive factor; taste preference is one of many determinants on food acceptance and food choice. The findings here may add to existing models of food choice but only provide a partial explanation. Large amounts of variance in taste preference were not expected to be explained by personality alone, there are many other factors known to influence preference. This study does suggest, however, that some individual differences in taste preference exist and it may be important to think about this in terms of food marketing and health promotion. Taking a bottom-up perspective; variance in taste influences food choice and subsequent food purchase.

Chapter 6

Individual differences in taste preference for a range of sweet and sour drinks (Study 3)

6.1 Overview

This study aimed to explore relationships found in the previous study between sweet and sour taste preference and temperamental personality. Extending study 2 (Chapter 5), this study asked participants to sample and rate their preference of a range of intensities of aqueous solutions (lemon drinks). In addition measures of sweet tooth, usual sweet preference and usual sour preference were taken along with demographics, background health and diet information and also participant self-report responses to the TPQ and TFEQ used previously.

6.2 Introduction

The findings of the two previous studies (see Chapter 4 and 5) demonstrated that between 2-10% of the variance in usual self-rated taste preference and taste preference for food samples could be explained by personality variables. The reliability of self-rated measures of taste preference used in study 1 were highlighted as problematic and therefore study 2 introduced taste samples to gain more valid measures of taste preference. In study 2 the regression analysis revealed that the strongest models related to sweet taste preference where 9% of the variance was accounted for by personality, and sour taste preference where 10% of the variance was accounted for by personality. Despite this, study 2 identified some problems with the real-food samples, particularly the bitter taste sample (see section 5.5.1 and 5.5.5). These were found to lack ecological validity and it was suspected that there may be expectancy effects related to the taste of certain foods. The best models developed in study 2 corresponded to sweet and sour taste preference. With an aim to develop these findings study 3 (reported in this chapter) explored these relationships further by examining taste preference for a range of glucose and lemon-flavoured drinks. A range of lemon drinks varying in glucose concentrations were used in this study to increase the ecological validity and to reduce expectancy effects. Previously aqueous solutions have been found to be good measures of taste preference and accurately reflect actual intake (Perez et al., 1994). The interaction between these sweet and sour taste ratings were also explored in this study. Finally the TFEQ was also included to further the relationships between characteristics specific to eating style and temperament, as previous to this few studies have sought to fully understand these underlying psychological constructs in terms of personality traits, specific to temperament.

Previous research, both academic and industrial, investigating taste perception and taste preference have tended to favour aqueous solutions over solid taste samples (Ayan et al., 2001). This may be, in part, due to the methodological issues demonstrated with other measures such as checklists which often result in social desirability effects and response bias. Taste samples with complex interactions between taste, texture, appearance and olfaction are likely to influence the subjective rating of the pure taste dimension. Consequently studies examining taste preference, taste perception and hedonic preferences employ aqueous solutions to overcome these issues. Aqueous solutions tend to be presented in small quantities as a result of reports that pleasantness decreases as consumption increases (Cabanac, 1971).

Humans have an innate preference for sweet tastes (Desor et al., 1973; Steiner, 1974). Previous research suggests that variation in liking for sweetness varies across individuals, indicative of individual differences in sweet liking and an underlying genetic component (Keskiatelo et al., 2007). Sweet taste preference related traits have been found to be inherited; approximately 50% of the variation in sweet liking can be explained by genetic factors and 50% can be explained by environmental factors unique to the individual (Kestitalo et al., 2007). Cloninger's (1987) biopsychosocial model of personality places great emphasis on the interaction between temperament and character, relating these to the dissociation of major brain systems. Cloninger describes temperament as unconscious, or the heritable part of personality. Considering that individual differences in personality are thought to have an underlying genetic component and sweet liking has also reported to be inherited to some degree, it is expected that variation in sweet liking could be explained, in part, by temperamental personality, and indeed this was found in studies 1 and 2 by self-report and real food samples.

This study is again exploratory in nature. It is anticipated that similar patterns of findings will emerge strengthening those found in study 1 and study 2. Examination of the results from study 1 and study 2 suggest that relationships between sweet preference and scores of novelty seeking (particularly NS3 characterised by extravagance and a lack of restraint) and reward dependence (particularly RD3 characterised by attachment and sensitively) are likely to occur. As liking for sweet tastes is acquired it is again expected that sour liking will be positively related to Novelty Seeking. It is also expected that as glucose concentration increases, the perception of sourness will become less apparent.

6.3 Method

6.3.1 Participants

Potential participants were informed that the study had exclusion criteria; participants would not be able to take part if they smoked, if they suffered allergies or intolerances to lemon and/or glucose, or if they had health problems that may affect their diet (i.e. diabetes, hypoglycaemia etc). This was made clear in the study advertisements and emails sent to potential participants, and reiterated via the consent form (see section 6.3.3.2). In total 87 Psychology undergraduate and Psychology Graduate Diploma students took part in the study, of which 28 were male and 58 were female. The average age was 23.5 years (SD=6.61), ranging from 18-39 years. First year Psychology undergraduate students received Research Credits in exchange for participation.

6.3.2 Design

The present study employed a correlation and questionnaire design, involving practical taste stimuli. The aim of the study was to further investigate relationships between taste preference for sweet and sour tastes discovered previously (see

Chapter 4 and Chapter 5), personality variables and measures of eating behaviour. All participants completed a consent form, the TPQ (Cloninger 1987) and the TFEQ (Stunkard & Messick 1985). In addition all participants rated 3 measures relating to their "usual" taste preference and 5 aqueous lemon and glucose solutions on 100mm visual analogue scales (VAS) ranging in glucose content. The presentation of the 5 taste samples was randomised using a computer-based number generator in order to eliminate confounds such as order effects.

6.3.3 Materials/Measures

6.3.3.1 Development of taste samples

Sweet and sour taste preferences are often measured using aqueous solutions with hedonic rating scales (see Drewnowski, 1997). Since the aim of the current study was to further investigate sweet and sour taste preference a range of aqueous solutions were thought to be appropriate vehicles. A series of pilot studies were conducted in order to test the suitability and palatability of these aqueous solutions.

Pilot studies were conducted in order to select the most suitable solutions to measure sweet and sour taste preferences within the main study. During these participants were instructed to use the 'sip and spit technique' (Moskowitz, 1986) and to rinse between each taste sample. Taste solutions were presented in a random order. Each sample was rated on 100mm line measures (VAS) indicative of how sweet the sample tasted, how sour and how much the sample was liked. Additionally participants were asked to select their preferred solution after tasting all 5 solutions. The first pilot study revealed a ceiling effect; the preferred solution was the sweetest (solution E, 30g glucose). This suggested that the range of solutions were too sour, resulting in another pilot with adjusted lemon quantities. The solutions used in this pilot were deemed suitable for the main study; producing individual variation in preferred solution and sweet and sour ratings. Table 6.1 shows the quantities of glucose and lemon for each taste sample used in the main study.

Table 6.1: Quantities of glucose and lemon juice per taste sample used in main study

	Glucose (g) per 100ml	*Lemon per 100ml*
Solution A	0	25
Solution B	5	25
Solution C	10	25
Solution D	20	25
Solution E	30	25

6.3.3.2 Consent Form

The consent form gave participants brief details about the study and what they would be expected to do. It also provided participants with information related to ethics issues such as confidentiality and their right to withdraw along with contact details for future reference (see appendix 10). Participants were required to complete the bottom section of the consent form, including ticking boxes to confirm that they suited the participation criteria. This section was returned to the researcher and the top section was retained by the participant. Participants were also required to complete a personal identification code.

6.3.3.3 Main Measures

The test booklet comprised of 16 pages. Page one listed the completion instructions, asked for the participants' personal identification code and asked for general ratings of hunger and fullness, measured on 100mm VAS, as well as details of what and when participants had last eaten. Following this 15 background questions were presented relating to demographical information, health and diet (see appendix 11).

Personality

Personality was measured using the TPQ (Cloninger 1987). Refer to chapter 4 and 5 for thorough details of this measure and see appendix 8 for a detailed summary of the characteristics of the subscales.

Taste Measures

Three measures of usual taste preference were presented; one for sweet taste preference, one for sour taste preference and one measure for self-rated "sweet tooth". These measures were represented by 100mm VAS anchored each end by "not at all" to "very much so" (see figure 6.1 below for an example). Participants were instructed to place a vertical mark on the line at the point which best described their sweet tooth rating.

3) I would describe myself as having a "sweet tooth"

Not at all — Very much so

Figure 6.1: An example a visual analogue scales used to measure usual taste preference

Visual analogue scales were also employed to measure hedonic ratings of the 5 taste samples. Each taste sample accompanied 3 VAS scales; one to measure perceived sweetness, one to measure sourness and one to measure how much the taste sample was liked. See figure 6.2 below for an example of the VAS presented for each taste sample.

Sample 1

1) How sour was the taste?

Not at all sour — Extremely sour

2) How sweet was the taste?

Not at all sweet — Extremely sweet

3) How much do you like the taste?

Not at all — Very much so

Figure 6.2: An example of the set of VAS presented for each taste sample

Following the completion of the VAS for each taste sample participants were then asked to select their preferred taste sample.

Eating Behaviour

Dietary Restraint, Disinhibition and Hunger were measured using the TFEQ (Stunkard & Messick 1985). For thorough details of this measure see chapters 4 and 5.

6.3.3.4 Preparation of taste samples

The taste samples were freshly prepared before each testing session. Each sample was made up in 1.5 litre plastic fridge jugs with lids, each clearly labelled A (0g glucose) to E (30g glucose). Depending on the number of participants booked into the session different amounts of ingredients were added (see appendix 12 for ingredient quantities). Brand PLJ Lemon Juice was used, this is a lemon concentration with no additional ingredients and Boots own-brand Glucose powder was used to sweeten the lemon juice.

The following description is based on the preparation of taste samples for 6 participants. Into each of the 5 jugs 100ml of chilled mineral water was added with 25ml of PLJ Lemon juice. The table 6.2 shows the quantities of glucose then added to each jug.

Table 6.2: Amount of glucose added to each taste solution (for 6 participants)

	Glucose (g) per 100ml
Solution A	0
Solution B	5
Solution C	10
Solution D	20
Solution E	30

The correct amount of glucose was weighed using electronic scales and added to the appropriate jug, then thoroughly mixed with a clean metal spoon until fully dissolved. Taste samples were maintained at ambient room temperature and discarded after the testing session.

Previously it has been reported that pleasantness ratings of a food often decrease as the food is consumed (Cabanac, 1971; Rolls et al., 1981). In this way taste samples particularly beverages are often served in small quantities; generally enough to fill the mouth (Ayan et al., 2001). In light of this the serving size of the taste samples in the current study was restricted to 15 millilitres per solution.

6.3.4 Procedure

Participants were invited to participate in the study via email invitation and advertisements on the Blackboard Research Participation site (an intranet system available to Psychology undergraduate students). The adverts clearly stated that the study had exclusion criteria (see section 6.3.1). Potential participants were asked to email the researcher to organise an appropriate time to participate.

Six to eight participants could attend a testing session at a time. The room was laid out with six to eight wipe-able tables facing away from each other. On each table a questionnaire booklet and consent form was placed. When the participants entered the room they were directed to a table and asked to read and complete the consent form. The researcher then checked that each participant fulfilled the participation criteria by checking that they had ticked the boxes on the consent form. The researcher retained the bottom section of this form and returned the top section of the form to the participant. Participants were then instructed to begin completing the questionnaire booklet, it was emphasised that they should follow the written instructions. They were asked to let the researcher know once they have reached page 11, labelled "Taste Trials" and await further instruction.

Whilst participants completed the first part of the questionnaire booklet the researcher organised the taste samples. On a small tray 6 labelled opaque plastic cups (25cl) were placed, 5 were labelled to correspond to the taste solutions and one for still mineral water. Fifteen millilitres of each solution was poured into the appropriately coded cup. An expectoration receptacle and napkin was also placed on each tray. The taste solutions were presented to each participant in a random order to avoid order effects.

Once each participant had reached page 11 of the booklet the researcher gave them a tray and asked them to carefully read the instructions laid out on page 11. These were reiterated verbally; participants were instructed to take the first solution, sip it and swish it around their mouth and then spit it out into the provided receptacle. They were then instructed to rate the solution on the 3 VAS (see figure 6.2) and then rinse with water until they could no longer taste the solution, before proceeding to the next taste sample. This procedure was repeated for all 5 taste samples. Additional mineral water was provided if necessary. Participants were then asked to select and record their preferred solution.

Following this, participants completed the remaining pages of the test booklet and were then given a debriefing sheet (see appendix 13). Any questions were answered at this stage and 1st year Psychology undergraduate students were given 35 minutes worth of research participation credits.

6.3.5 Analysis

Correlational analyses were conducted to examine relationships between measures of self-reported usual sweet taste and sweet tooth with the taste samples responses. Correlations between taste and personality and additionally eating behaviour and personality were also examined. The main analyses employed regression analyses using the backward function, as used in the previous studies as an exploratory technique to examine relationships between measures of usual sour taste preference, usual sweet taste preference, self-rated sweet tooth and also preferred drink selection (entered as separate criterion variables) and all personality variables (subscales entered as predictors in both instances). This method of analysis was again selected in light of the limited research in this area resulting in difficulties establishing an explicit, testable model. Models of "best fit" were developed to examine the variation in sweet tooth and preferred drink selection. The most parsimonious model was selected on the basis of the adjusted R^2; data was explored for the solution that accounted for the maximum variance (Clark-Carter 2004). Multiple regression using the backward function was also performed to assess relationships between the subscales of the TPQ (predictors) and the three domains of the TFEQ; Hunger, Restraint and Disinhibition were assessed separately and entered as the criterion variables.

6.4 Results

6.4.1 Treatment of Data

Almost half of the sample (45.3%) consisted of young students aged 18 and 19 years resulting in difficulties answering question 25 of the TFEQ relating to weight fluctuations over the last 10 years. Due to these difficulties and the physical changes which occur between the ages of 8/9 years to 18/19 years this question was excluded from the subtotalling of the disinhibition subscale and therefore all analysis. Otherwise the three factors of the TEFQ were entered and subtotalled according to the authors (Stunkard & Messick 1985). The subscales of the TPQ (Cloninger 1987) were also entered and calculated according to Cloninger's instruction. Items that employed VAS (usual sweet, sour and sweet tooth ratings and also all taste sample measures) were measured and inputted in millimetres, ranging from 0 to 100. Histograms and box plots were produced to examine the distribution of the scores on each variable. Inspection of the box plots showed that all variables demonstrated normal distribution and the skewness statistic for all variables fell within the guidelines of ±2.58 (Clark-Carter, 2004). Z scores were calculated for all taste and personality variables; all scores fell within the guideline of ±3 for the detection of outliers (Clark-Carter 2004).

6.4.2 Ratings of fullness and hunger

Before the taste session all participants were asked to rate how hungry and how full they felt on 100mm VAS ranging from “not at all” to “very much so”. The mean score for hunger (49.16) was slightly higher than the mean for fullness (33.34). It was expected that these measurements should be negatively associated. These scores were similar to those obtained for study 2 (see chapter 5, section 5.4.2).

The scores for these statistics were normally distributed therefore Pearson's correlation coefficient analysis was employed. A strong negative relationship was found to be significant between participants' self-rated hunger and fullness (r= -0.60, p<.01); high levels of hunger were associated with low levels of fullness as expected.

6.4.3 Taste Measure Analysis

Each drink was rated on 3 individual VAS scales relating to sweetness, the sourness and the liking of the taste sample. The descriptive statistics for the taste measures can be viewed in table 6.3. Usual sweet preference and usual sweet taste was also rated along with self-rated sweet tooth. Usual sweet preference was highly rated overall and sex differences emerged where females rated their usual sweet taste preference significantly higher that the male participants. This was in line with the previous studies (See chapters 4 and 5). Usual sour taste preference was rated fairly low (below the mid-point) again in line with studies 1 and 2 where low mean scores of usual sour taste preference were found.

Table 6.3: Mean VAS scores (and standard deviations) for the usual taste measures and overall liking for the taste solutions shown for the overall sample, males and females and sex differences

	Overall Liking	*Male*	*Female*	*Sex Diff (p)*
Usual sweet	72.94 (21.11)	66.32 (25.66)	76.56 (17.08)	0.03*
Usual sour	42.54 (23.92)	47.18 (23.02)	41.07 (24.34)	0.27
Sweet tooth	62.16 (25.22)	51.29 (28.16)	68.55 (20.85)	0.002**
Solution A	21.15 (20.50)	21.29 (18.44)	21.71 (21.31)	0.92
Solution B	29.96 (26.08)	38.39 (24.88)	25.81 (25.25)	0.03*
Solution C	45.39 (27.00)	52.71 (26.85)	42.66 (26.83)	0.11
Solution D	59.32 (22.50)	59.79 (17.57)	58.96 (24.36)	0.87
Solution E	55.94 (21.04)	55.11 (17.59)	57.52 (21.99)	0.61

Self-rated sweet tooth scores were much higher and sex differences were observed with females describing themselves as having a sweet tooth significantly more so than males. This confirmed expectations that similar patterns of results would emerge in terms of usual sweet taste preference and sweet tooth ratings. In terms of the preference ratings for the taste solutions overall liking steadily increased across the taste samples and then dropped at solution E (the sweetest containing 30g glucose per 100ml). Significant differences in liking ratings for the solutions were only observed between males and females for solution B where males rated the sample higher than females. Mean scores for liking, sweetness and sourness ratings across the taste samples can be viewed in more detail in figures 6.3.

6.4.3.1 Preferred Drink Choice

In terms of the preferred taste sample, the majority of the sample (45.3%) selected solution D (containing 20g of glucose per 100ml) as their preferred drink. Fifty percent of the male participants selected taste sample D as the most preferred drink compared to 43.1% of female participants. Table 6.4 shows this in more detail.

Table 6.4: Frequency table for preferred drink selection

		Preferred drink selection				
		A	B	C	D	E
Male	*Count*	2	2	9	14	1
	% within sex	7.1%	7.1%	32.1%	50%	3.6%
Female	*Count*	1	5	11	25	16
	% within sex	1.7%	8.6%	19%	43.1%	27.6%
Total	*Count*	3	7	20	39	17
	% of total	3.5%	8.1%	23.3%	45.3%	19.8%

In order to examine if the selection of preferred drink was related to scores of liking a series of point-biserial correlations were performed. Preferred drink was dummy coded (0= not selected, 1=selected) and correlated with liking scores each drink, for example, drink A (preferred) was correlated with liking scores for drink A (all the point biserial correlation results can be viewed in appendix 15).

Liking scores were significantly related to preferred drink choice for samples B, C and D. Sample D was found to be the most frequently selected drink (see table 6.4), the point biserial correlation suggested that of all the relationships between liking and preferred drink choice, this had the strongest relationship with liking scores (r=0.32, *p*=0.003). Liking scores accounted for 10% of the variability in the selection of sample D (preferred drink).

6.4.3.2 Sweet, Sour and Liking

The mean VAS ratings for the 5 taste samples show that sweetness ratings increased across the taste samples as expected. In contrast VAS ratings for sourness steadily decreased across the samples despite lemon content remaining constant across the 5 solutions (see figure 6.3).

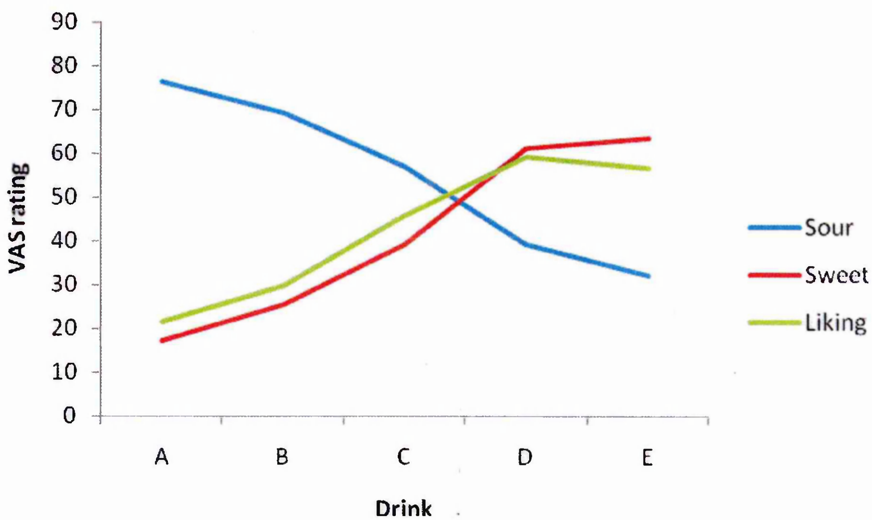

Figure 6.3: Line graph to show the relationship between sweet, sour and liking scores across the 5 drinks

Mean ratings for taste sample liking increased as glucose levels increased up until sample E (30g glucose) where mean liking dropped slightly. The mean ratings suggest that overall sample D was the preferred taste sample, perhaps indicating that sample E was perceived as too sweet. Figure 6.3 shows that sweet and liking scores follow a similar pattern whereas sour scores drop just before drink D (20g glucose), indicative of an interaction effect between sweet and sour ratings. In order to test this further and examine the relationship between sweet and sour on liking scores, a multilevel model was developed (appendix 16 for full model). The drink variable was entered as a fixed factor and scores of liking were entered as the dependent variable. Scores of sweet and sour, and an interaction variable *sweetxsour* were entered as covariates. These were found to significantly predict liking scores (F(1, 9)=16.59, p<.01), a strong interaction was found between sweet and sour scores which significantly predicted scores of liking for each drink (*b*=205.53, *p*<.01).

6.4.4 Personality

The descriptive data collated from the TPQ personality major domains and subscales are summarised in table 6.5. Generally the means for the subscales were in line with Otter and colleagues (1995) UK data. No sex differences were found in relation to Novelty Seeking corresponding with Otter (1995) but contrasting with Cloninger's normative data (1994).

Table 6.5: Means, standard deviations and p-values associated with sex differences for personality subscales

	Men		Female		Sex Diff
	Mean	*SD*	*Mean*	*SD*	*p*
NS1	5.07	1.92	5.38	1.95	0.49
NS2	3.07	1.80	2.88	2.04	0.67
NS3	4.36	1.99	4.31	1.70	0.91
NS4	5.46	1.63	5.10	2.08	0.42
Total Novelty Seeking	17.96	4.83	17.67	4.80	0.79
HA1	3.36	2.25	5.02	2.63	0.005**
HA2	2.89	1.91	3.72	2.14	0.09
HA3	3.21	2.17	3.14	1.85	0.87
HA4	2.29	2.11	4.38	2.13	<.01**
Total Harm Avoidance	11.75	6.07	16.26	5.73	0.001**
RD1	3.07	1.30	3.79	0.97	0.005**
RD3	5.68	2.91	8.43	2.19	<.01**
RD4	3.04	1.45	3.78	1.33	0.02*
Total Reward Dependence	11.79	3.94	16.00	3.34	<.01**
Persistence (RD2)	4.32	2.20	4.41	2.16	0.85

**p<0.05* ***p<0.01*

Total Novelty Seeking scores were slightly lower in comparison to Otter (1995) particularly so amongst the female participants. In contrast total Harm Avoidance scores were slightly higher than those obtained by Otter et al (1995). The current study found sex differences between all Harm Avoidance subscales with the exception of HA3, in line with Otter et al (1995). Reward Dependence scores also followed a similar pattern as the data provided by Otter et al (1995); sex differences were observed on all subscales with females scoring higher than males on all counts. This also follows Cloninger's data (1994). No sex differences were observed in relation to Persistence, although females tended to score marginally higher than males, again following Otter et al data (1995). The standard deviations showed similar patterns to the previous studies and Otter et al suggesting similar variation in scores across the subscales.

6.4.5 Individual Differences in Taste Preference - Regression Analyses

Backward multiple regression analysis was used to examine relationships between taste preference in relation to the usual sweet preference, usual sour preference, sweet-tooth rating and preferred drink selection with the personality variables. The amount of individual variation in preference for each dimension and also after inspection of the intercorrelations highlighted that the taste measures should be treated as unique constructs. Each taste was therefore tested individually. Additional assumptions for conducting multiple regression were tested. Variables were not highly correlated with each other; intercorrelations for predictor variables fell within the guidelines of ±0.8 (Clark-Carter 2004), therefore multicollinearity was not evident. Cook's distance was also obtained to measure any difference between an individual's scores on the DVs and IVs compared to other individuals in the sample, since all individual's scores were below 1 further investigation was not necessary (Stevens 2002). Furthermore correlational analysis (see below) found that the predictor variables were linearly related to the criterion variables, although the strength of these relationships were weak to medium. All predictors are presented in the tables summarising the regression model for each taste, although only the best predictors are described in detail. The best predictors were deemed as those which reached the significance level, and/or those with the highest beta values.

6.4.5.1 Usual Sour Preference

The association between the criterion variable, sour taste preference, and the remaining predictor variables was moderate (Multiple R = 0.35).The proportion of variance in preference for usual sour taste preference accounted for by the remaining predictor variables was 7.8% (adj. R^2). This model was significant ($F(4,80)=2.78$, $p=0.03$). The model retained 4 personality predictors. NS4 (Disorderliness vs. Regimentation) and HA2 (Fear of Uncertainty) were found to be the strongest predictors of usual sour taste preference. This suggests that high scores on the NS4 subscale were related to high preference for sour tastes ($t=2.06$, $p=0.04$) and high scores on the HA2 subscale were related to low preference ratings for sour tastes ($t=-2.07$, $p=0.04$). Table 6.6 gives details of the coefficients for the model developed for usual sour preference.

Table 6.6: Beta values, standard errors and standardised betas for usual sour taste preference by personality variables

	B	*SE B*	*β*
(Constant)	38.36	10.31	-
NS2	-2.01	1.40	-0.16
NS4	2.87	1.39	0.23*
HA2	-2.68	1.30	-0.24*
HA4	1.34	1.09	0.13

*$p<0.05$

6.4.5.2 Usual Sweet Preference

The association between usual sweet taste preference and the remaining predictor variables was moderate (Multiple R = 0.37). The proportion of variance in preference for usual sweet tastes accounted for by the remaining personality predictors was 9.1% (adj. R^2). This model was significant ($F(4,80)=3.10$, $p=0.02$).

The model retained 4 personality predictors. RD3 (Attachment vs. Detachment) was the strongest predictor of usual sweet taste preference (t=2.28, *p*=0.03). This suggests that high scores on the RD3 subscale, where high scorers prefer intimacy over privacy, were related to high preference for sweet tastes (see table 6.7).

Table 6.7: Beta values, standard errors and standardised betas for usual sweet taste preference by personality variables

	B	*SE B*	*β*
(Constant)	67.19	10.52	-
NS2	-1.78	1.15	-0.17
HA3	1.94	1.23	0.18
PER	-2.08	1.01	-0.22*
RD3	1.89	0.83	0.25*

*p<0.05

6.4.5.3 Sweet Tooth

The association between the criterion variable, self-rated sweet tooth, and the remaining predictor variables was moderate (Multiple R = 0.45). The model of best fit was significant (F(5, 80)= 4.52, *p*=0.001) and together the remaining predictors (NS3, HA3, RD1, PER and RD4) accounted for 17% of the variation in self-rated sweet-tooth (adjusted R^2). Table 6.8 shows details of the coefficients associated with sweet tooth ratings.

Table 6.8: Beta values, standard errors and standardised betas for self-rated sweet tooth by personality subscales (TPQ)

	B	*SE B*	*β*
(Constant)	30.53	12.52	-
NS3	1.47	1.38	0.11
HA3	3.58	1.26	0.28***
RD1	4.56	2.36	0.21*
PER	-3.02	1.21	-0.26**
RD4	3.32	1.81	0.19

** just fell short of significance at p>0.05 **p<0.05 ***p<0.01*

HA3 (Shyness with Strangers) was found to be the strongest predictor of sweet-tooth rating, suggesting that unassertive and shy characteristics were associated with high sweet-tooth ratings ($t=2.83$, $p=0.006$). Persistence was also a strong predictor of sweet-tooth ratings although this relationship was negative; industrious, hard-working and persistent traits were associated with low self-ratings of sweet tooth. Conversely, low scores on the Persistence subscale (associated with inactive, unreliable, unstable and erratic types) were positively related to high sweet-tooth ratings.

6.4.5.4 Preferred Drink Selection

As the preferred drink variable is categorical level data with 5 outcome categories, multinomial logistic regression was the most appropriate analysis to explore the variance explained in the drink selection by the personality predictors. Initially this analysis was run with drink D as the reference point as this was the most selected drink. Unfortunately warnings were revealed suggesting that a number of zero frequencies had occurred. As this type of analysis relies on the Chi-square statistic the presence of a number of zero frequencies causes problems with the interpretation of the model. Due to the number of predictors and the 5 outcome categories, the number of combinations of these variables causes a large escalation in variables and subpopulations. For example, as only three participants selected Drink A, it is likely that they will not score on all subscales of the TPQ, resulting in zero frequencies. Due to the problems with this type of analysis multiple regression using the backward function was run on Drink D alone, liking scores for Drink D were entered as the criterion and the subscale scores from the TPQ were entered as the predictors (see table 6.9). Unfortunately this means that the analysis of the less sweet drinks and the sweetest (E containing 30g glucose) is not possible due to the small number of data points, resulting in problems of statistical power.

The association between the criterion variable, liking scores for Drink D (30g glucose per 100ml), and the remaining predictor variables was moderate (Multiple $R = 0.57$). The model of best fit was significant ($F(6, 38)= 2.62$, $p=0.04$) and together the remaining predictors accounted for 20% of the variation in overall liking for Drink D (adjusted R^2). HA4 (Fatigability) was found to be the strongest predictor of liking scores for Drink D, suggesting that high scores on this scale which describe low energy and tired temperaments were associated with the high liking scores for this drink (t=2.61, *p*=0.01). NS3 (Extravagance vs. Reverse) was also a strong predictor of liking for Drink D; low scores on this scale, describing reversed, and restrained temperaments, were associated with high liking scores for Drink D (t=-2.07, *p*=0.05). Table 6.9 shows details of the coefficients.

Table 6.9: Beta values, standard errors and standardised betas for liking of Drink D by personality subscales (TPQ)

	B	*SE B*	*β*
(Constant)	58.67	16.51	-
NS3	-3.17	1.53	-0.32*
NS4	2.74	1.66	0.25
HA1	-1.81	1.18	-0.24
HA4	4.06	1.56	0.42**
RD1	-3.58	2.84	-0.20
PER	2.61	1.59	0.25

** p<0.05   **p<0.01*

6.4.5.5 Comparisons with Study 1 and Study 2

A summary of the regression models found in the current study is provided in figure 6.5. Additionally the significant coefficients also found to explain sweet and sour preference in the previous 2 studies are highlighted. As the previous studies did not measure self-rated sweet tooth this has been compared with previous ratings of usual sweet tooth preference since these measures were found to be linearly related in this study (see section 6.4.3). Preferred drink selection has also been compared with sweet taste ratings from the previous studies as the preferred drink was fairly sweet (20g glucose per 100ml). Figure 6.4 shows that HA3 characterised by unassertive and shy traits features in two of the regression models relating to sweet preference for study 3. In all cases this relationship was positive indicating

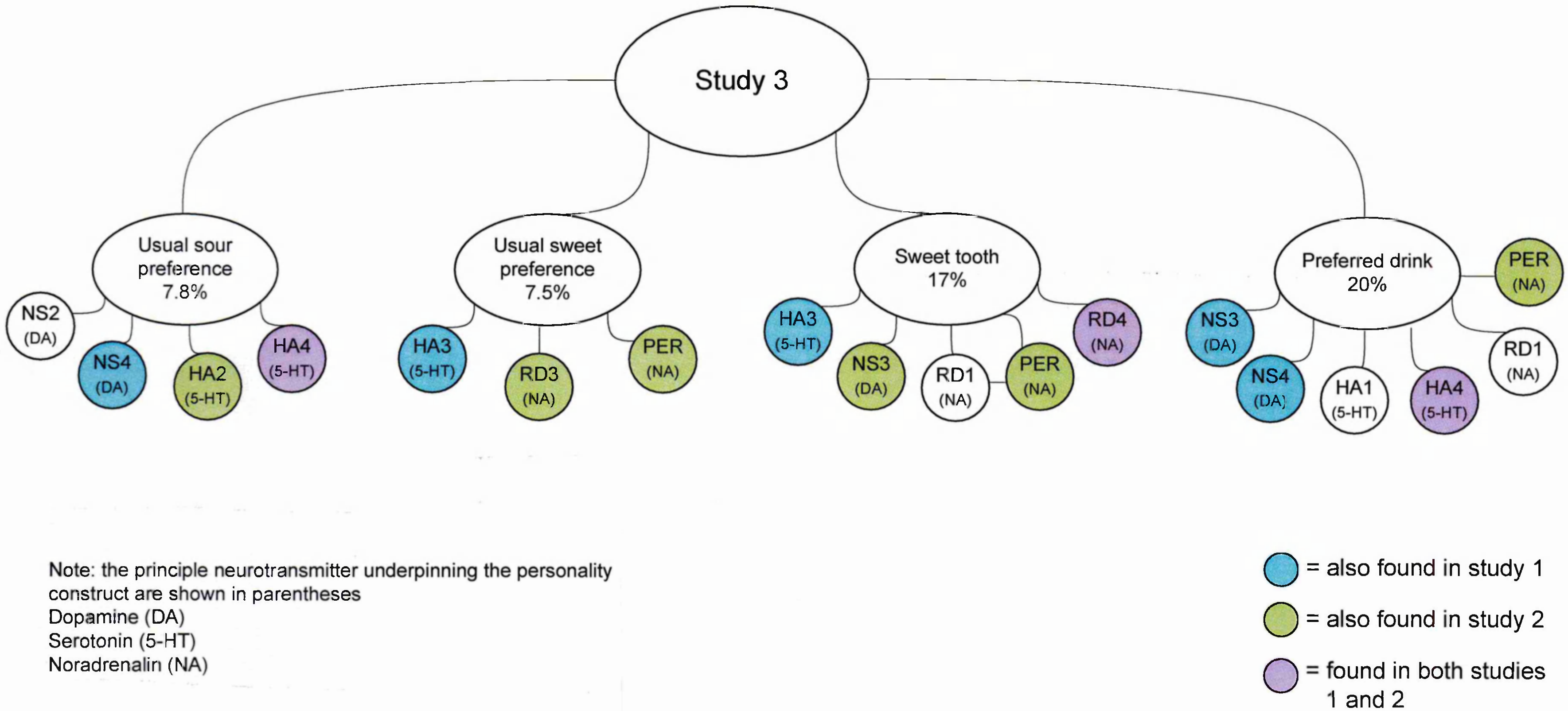

Figure 6.4: Diagram to show a summary of study 3 findings highlighting similarities with studies 1 and 2

that individuals rating themselves as unassertive and shy also tended to rate all measures associated with sweet taste high, providing good evidence that high sweet preference is associated with a tendency to be unassertive and shy in social situations.

6.4.6 Eating Behaviour

Sex differences were found between males and females on scores of dietary restraint in line with previous research and study 2 (see table 6.10). No sex differences were found in relation to disinhibition and perceived hunger. Female restraint scores were slightly lower in this study than study 2 and hunger scores were higher. In males, scores on all measures were in line with study 2. Despite sex differences in scores of dietary restraint all further analysis was conducted on the sample as a whole due to small numbers of males creating problems with statistical power.

Table 6.10: Means and standard deviations of eating behaviour scores showing differences between male and female scores on the subscales of the TFEQ

	Females		Males		Sex Diff
	Mean	*SD*	*Mean*	*SD*	*p*
TFEQ Restraint	6.95	3.12	4.71	3.62	0.03*
TFEQ Disinhibition	7.76	3.39	6.89	2.86	0.20
TFEQ Hunger	7.05	3.03	6.14	3.12	0.25

** p<0.05 level*

Pearson's correlational analysis between the subscales of the TFEQ and the personality subscales of the TPQ revealed a number of relationships between eating behaviour and personality. Disinhibition and hunger were found to negatively relate to subscales of novelty seeking; NS1 (Exploratory excitability) negatively related to disinhibited eating ($r=-0.28$, $p=0.009$) and NS2 was found to be negatively related to hunger ($r=-0.21$, $p=0.05$). Total harm avoidance (and subscales HA1 and HA4) were found to positively relate to disinhibition in line with study 2 (r=0.28, *p*=0.01). Generally correlations above 0.21 reached statistical significance (see figure 6.5).

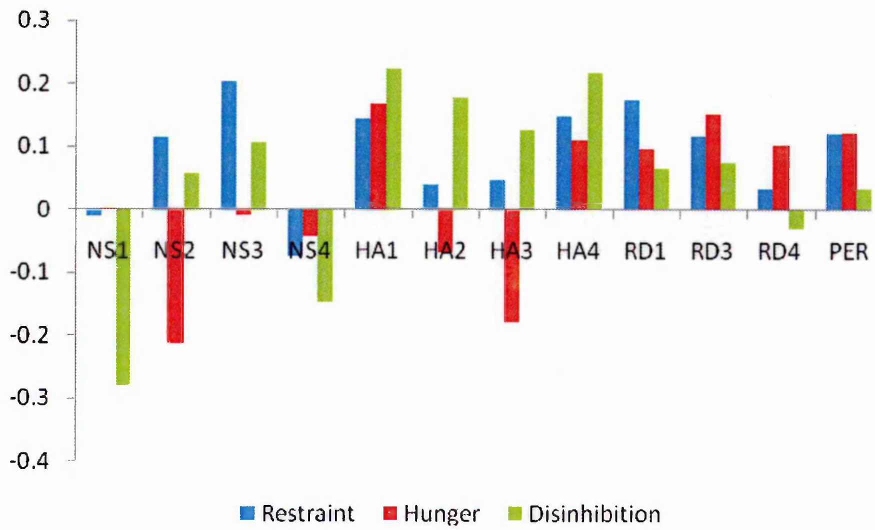

Figure 6.5: Correlation coefficients between the personality subscales of the TPQ and the eating behaviour measures of the TFEQ

These relationships were further examined using multiple regression (using the backward function) to establish models of best fit. The personality subscales were again entered as the predictors and the measures of eating behaviour (restraint, hunger and disinhibition) were entered as the criterions in 3 separate regression analyses. All predictors are presented in the tables summarising the regression models in the following sections, only the best predictors are described in detail. The best predictors are defined as those which reached the significance level and/or those with the highest beta values).

6.4.6.1 Restraint

The proportion of variance in dietary restraint accounted for by the remaining predictor variables was 17.2% (adj. R^2). This model was significant ($F(7,78)=3.52$, *p*=0.002). The model retained 7 personality predictors (see table 6.11). NS1 relating to exploratory excitability was found to be the best predictor (t=-3.56, *p*=0.001), this was a negative relationship, indicating that thrill seeking was associated with low levels of dietary restraint (see table 6.11 for details of the coefficients).

Table 6.11: Beta values, standard errors and standardised betas for scores of the Restraint subscale of the TFEQ by personality subscales of the TPQ

	B	*SE B*	*β*
(Constant)	7.27	1.71	-
NS1	-0.74	0.21	-0.44*
NS2	0.25	0.18	0.15
NS3	0.39	0.19	0.21*
HA1	0.33	0.14	0.26*
HA2	0.29	0.19	0.19
HA3	-0.43	0.23	-0.28*
HA4	0.19	0.15	0.19

**p<.05*

6.4.6.2 Hunger

The association between the criterion variable, the hunger subscale of the TFEQ, and the 5 remaining predictor variables was moderate (Multiple R = 0.43). The model of best fit was significant (F(5, 80)=3.70, *p*=0.005) and together the remaining predictors (NS1, NS2, HA1, HA3, and HA4) accounted for 13.7% of the variation in perceived hunger (adjusted R^2). HA3 (Shyness with Strangers) was found to be the strongest predictor of perceived hunger (t=-3.38, *p*=0.001). This was a negative relationship suggesting that unassertive and shy individuals tended to achieve low scores on the hunger subscale reflecting low levels of perceived hunger. Conversely low scores on the HA3 subscale, characterised by bold, forward and outgoing types, were associated with high hunger scores. Table 6.12 provides details of the coefficients.

Table 6.12: Beta values, standard errors and standardised betas for scores of the Hunger subscale of the TFEQ by personality subscales of the TPQ

	B	*SE B*	*β*
(Constant)	9.24	1.58	-
NS1	-0.24	0.19	-0.15
NS2	-0.37	0.17	-0.34*
HA1	0.28	0.13	0.24*
HA3	-0.70	0.21	-0.45**
HA4	0.22	0.14	0.17

**p<.05* ***p<.01*

6.4.6.3 Disinhibition

The association between the disinhibition subscale of the TFEQ, and the 4 remaining personality predictors was again moderate (Multiple R = 0.34). The model of best fit was significant (F(4, 81)=2.57, *p*=0.04) and together the remaining predictors (NS2, NS3 HA1, and RD1) accounted for 7% of the variation in characteristics of disinhibited eating (adjusted R^2). NS3 (Extravagance vs. Reserve) was the strongest predictor of disinhibited eating behaviour (t=2.09, *p*=0.04). This positive relationship suggested high scores of this scale describing extravagant, flamboyant and unrestrained individuals were related to high scores of Disinhibition (see table 6.13 food details of the coefficients).

Table 6.13: Beta values, standard errors and standardised betas for scores of the Disinhibition subscale of the TFEQ by personality subscales of the TPQ

	B	*SE B*	*β*
(Constant)	-0.59	2.22	-
NS2	0.32	0.25	0.14
NS3	0.56	0.27	0.22*
HA1	0.29	0.19	0.17
RD1	0.61	0.42	0.16

**p<.05*

6.5 Discussion

6.5.1 Taste measures

It was expected that sweetness ratings for the taste samples would follow an inverted U pattern and sourness would follow the opposite pattern. These patterns did transpire although there was a positive skew towards the sweeter taste samples. The pilot study indicated that the range of intensities of the drink samples was not appropriate as a ceiling effect was detected. The change in intensities, tested in the second pilot study, suggested that the quantities of ingredients in these drinks were more appropriate; the pattern of scores for the selection of preferred drink was normally distributed.

Despite this, the findings from the main study suggest that a slight ceiling effect may have been present; overall the participants indicated that sample D (20g glucose) was the preferred taste sample. This supports the notion of a universal liking for sweet tastes but also suggesting an optimal level of sweet liking. Increasing the range of glucose intensities may have shown this further. Ratings for liking decreased after this; at sample E (the sweetest sample) liking dropped. This follows the pattern of the "hedonic breakpoint"; it has been observed previously that preference rises across a range of sweet samples and then decreases at higher sweetest levels (Moskowitz, 1971; Drewnowski & Greenwood, 1983).

An interaction of sweet and sour scores impacted upon liking scores for the drinks in this study. Sour intensity remained constant across the drinks, only glucose levels were manipulated. Mixture suppression describes the process whereby the intensity of 2 mixed tastes is perceived to be less than if they were not mixed, but tasted at the same concentrations (Lawless & Heymann, 1998). Sweet tastes have been found to interact with other tastes resulting in varied effects. At low intensities the effect of sweetness is varied, while at medium to high intensities sweetness can suppress other basic tastes (Keast & Breslin, 2002). This is evident with binary taste interactions of sweet and sour; high intensities of sweetness were found to suppress the intensity of sour tastes (Keast & Breslin, 2002).

Sour concentrations were not altered across the taste samples in the current study, yet there was an apparent interaction between perceived sweet and sour intensities; higher sweetness levels appeared to suppress the perceived intensity of sourness. Elsewhere sourness has been found to be suppressed by increased sweet concentrations in a range of age groups (Pelletier, Lawless & Horne, 2004).

6.5.2 Personality Data

The TPQ data reflected similar patterns found in the previous studies. Comparisons with Otter's (1995) UK normative data seem most appropriate due to previously reported differences between the US and the UK in terms of the TPQ personality domains and lower facets (Cloninger 1994; Otter 1995; Stewart, 2004).

Novelty seeking scores were generally in line with Otter and colleagues (1995); no sex differences were found on any of the subscales. Total novelty seeking was found to be higher across the sample in the current study compared to Otter et al. (1995). Despite this the pattern of findings was also apparent in the previous studies (see Chapter 4 and 5). These differences may be attributable to the age differences between these populations, Otter et al reported a mean age of 30 years whilst the current sample had a mean age of 23.5 years (over 6 years younger than Otter's study). All of the major domains of the TPQ are thought to be stable across age with the exception of novelty seeking which has found to decline with age (Cloninger et al., 1991, 1994), this may explain why novelty seeking scores were higher in the current study compared to Otter et al.

Differences between males and females were observed on all lower facets of harm avoidance with the exception of HA3 (fear of uncertainty), despite this these patterns of findings mirrored those of Otter et al's normative UK data. Again sex differences were observed across the reward dependent subscales, where, in all cases females scored higher than males, again reflecting Otter and colleague's UK data. Persistence scores were also in line with Otter. The consistency between other UK data and that of the current study is reflective of the higher internal reliability and validity of the TPQ (Otter et al., 1995; Stewart et al., 2004).

6.5.3 Taste Preference and Personality

The current study found that 7-20% of the variation in sweet liking (measured by sweet tooth, sweet preference and 20g glucose drink D) could be explained by some aspects of temperamental personality traits adding strength to the previous studies reported in the thesis.

Sweet liking is thought to be innate and present from birth, yet individual differences have been frequently observed in sweet liking suggesting individual variation in sweet preference and a role for personality. In line with the previous studies this study also found that sweet liking was highly rated across the sample, further confirming a universal liking for sweet tastes (Reed et al., 2006). Recent findings suggest that variation in sweet liking can, in part, be explained by hereditary factors (Kestitalo et al., 2007). The current study builds upon these findings, indicating that individual differences in hereditary temperamental personality traits are also involved.

The regression models for sweet tooth and preferred drink explained the most variance compared to the models for usual sweet and usual sour liking. These models shared 3 predictors, persistence, sentimentality (RD1) and extravagance (NS3). High scores of Reward Dependence (RD) are associated with activation of the brain's maintenance system (NE), and conditioned signals of reward. Previously CHO self-medication behaviour has been found to increase 5-HT and NE turnover, consequently up-lifting mood and symptoms of depression (Wurtman & Wurtman, 1995). It is likely that the combination of consuming foods high in CHO (sweet foods) and the associated up-lifting mood effect could result in a conditioned signal of reward, reinforcing the mood-changing quantities after consumption. Introverts tend to be high in food neophobia, preferring "safe foods" and tend to avoid novel, unusual foods (Pliner & Hobden, 1992; Pliner & Melo, 1997). They also achieve low scores of the Food Involvement scale further indicating an avoidance of novel foods (Van Trijp et al., 1996). Introvert traits and reward dependency are similar constructs (Cloninger et al., 1994), therefore theoretically it is likely that high scores of RD will also be associated with high scores of food neophobia. The models developed here do suggest that high scores of RD were associated with increased liking for sweet tastes.

High scores of sweet tooth liking and also preferred drink were positively related to high scores of Extravagance (NS3). Previously NS and preference for sweet tastes have been positively related in alcoholic groups (Kampov-Polevoy et al., 1997, 1998, 2002). McHale et al (2002) also found that high scores of extravagance (NS3) were related to sweet tooth and sweet taste preference in undergraduates. Theoretically, as high scores of NS are characterised by a tendency towards excitement and sensitivity to rewards, sweet foods may lead to increased dopamine turnover and therefore simultaneously cause rewarding effects.

Individual differences in sweet food consumption have been observed both in humans and animals. When sugars are freely available, individual variably in the amount of consumed sugar varies widely across individual rats (Brennan et al., 2001). Animal studies have suggested that individual differences in sweet consumption may be attributable to a complex interplay between differential motivational behaviours (Brennan et al., 2001). The rewarding aspect of sweet foods is highly influenced by the dopaminergic system which has been found to influence motivation toward sugar consumption in rats and the opioidergic system. This is thought to be related to the reinforcing effects (particularly in terms of the hedonic value) of sugars (Brennan et al., 2001; Sills & Vaccarino, 1996) and also linked to self-administrative and addictive behaviours both in animals and humans (Perl et al., 1997; Kampov-Polevoy et al., 1997, 1999).

This study may further confirm that sweet liking has a genetic basis as described elsewhere (Bachmanov et al., 1997). It is common to see participants categorised, often into 3 groups, based on their taste perception; non-tasters, medium tasters and super-tasters (Bartoshuk et al., 1997). Categorising variables is often criticised as it can reduce statistical power by approximately one third (Streiner, 2002). Furthermore in the current study is was not possible to categorise individuals in this way; separating participants into 3 groups in terms of sweet tooth ratings or usual sweet taste preference would have escalated the number of variables further which would have resulted in very complicated models and a further reduction in statistical power.

The model of best fit for usual sour preference confirmed the findings in study 2. Subscales of novelty seeking and harm avoidance were found to predict usual sour taste preference. Quick tempered, disorderliness (high scores of NS4) were positively related to sour taste preference. This is consistent with study 2 and previous research which found relationships between positive responses to sour tastes and out-going, adventurous traits often observed in extraverts and sensation seekers (Eysenck & Eysenck, 1967; Howarth & Skinner, 1969; Mattes, 1994).

6.5.4 Eating Behaviour and Personality

Relationships were revealed in terms of the 3 dimensions of eating behaviour as measured by the TFEQ. These provided partial support for those relationships found in study 2. In terms of dietary restraint females scored significantly higher than males, confirming the findings in study 2. This pattern of findings was also observed in scores of disinhibition, again females scoring significantly higher. There were no significance differences with males and females in hunger scores, also following patterns discovered in study 2.

In terms of the regression models hunger was predicted by subscales of harm avoidance, particularly, HA4 relating to fatigability. This model was similar to study 2 and resulted in similar variance. Harm avoidance has previously been found to be a good predictor of susceptibility to hunger (Gendall et al., 1998; van den Bree et al., 2006). In theoretical terms in makes sense that fatigability be positively related to hunger; low carbohydrate diets have been shown to increase fatigability and hunger and decrease the desire to exercise (White, Johnston, Swan, Tjonn & Sears, 2007).

In terms of dietary restraint this was the weakest model in study 2. The current study produced a strong model for where restraint was found to be predicted by all subscales of harm avoidance. Individuals high in harm avoidance tend to be cautious, careful, apprehensive, insecure, nervous and pessimistic. They tend to have low energy and are easily fatigued. They are careful planners and take great care in anticipating possible danger. In this way it is not surprising that they are restrained eaters. Previously restraint has been found to be influenced by neuroticism and conscientiousness, specifically cautious individuals with low self-esteem were found to have high levels of dietary restraint confirming the present study (Heaven et al., 2001). Elsewhere a lack of assertiveness and embitterment was found to be related to dietary restraint (Elfhag, 2005).

Disinhibition was predicted by a combination of novelty seeking subscales (NS2 and NS3 relating to impulsiveness and extravagance), sentimentality (RD1) and anticipatory worry (HA1). This model provided partial support for the model developed in study 2, although the model here was weaker. Impulsivity is characterised "by the inclination of an individual to act on impulse rather than thought" (Corsini, 1999 p. 476). Impulsivity has been linked to various aspects of abnormal eating, particularly bulimia (Penas-Lledo, Vaz, Ramos & Waller, 2002) and binge-eating disorder (Nasser, Gluck & Geiliebater, 2004). Recently the disinhibition scale has been linked to impulsivity, suggesting that a tendency to overeat is characteristic of impulsive personalities (Yeomans, Leitch & Mobini, 2008). The current study supports this finding.

6.5.5 Conclusion

The current study extended study 2 by further examining the relationship between sweet taste preference and personality using aqueous solutions. Providing partial support for previous research and the previous studies, this study found that sweet tooth; usual sweet preference and preferred drink were predicted by persistence, sentimentality and extravagance. These predictors featured both in the model developed for sweet tooth ratings and preferred drink. Calorie dense foods tend to be high in sugar and fat and are highly palatable, consequently they are frequently over-consumed (Raynor & Epstein, 2001). This study has shown that preference for highly sweet drinks are associated with personality factors. This study also found that between 7% and 17% of the variance in eating behaviour as measured by the TFEQ could be explained by some aspects of personality, building upon the existing body of literature which links individual differences and problem eating-behaviour.

Chapter 7

Preference for Dietary Fat (Study A and B)

7.1 Overview

This chapter presents 2 studies relating to dietary fat preference. The first is a large-scale questionnaire study which aimed to produce UK normative data for The Fat Preference Questionnaire© (FPQ©: Ledikwe et al., 2007). The second study aimed to investigate the extent to which eating behaviour (measured by the TFEQ), body mass (measured by BMI) and personality variables predict preference for dietary fat.

7.2 Introduction

The previous chapters have examined relationships between personality, eating behaviour and preferences for tastes. Chapter 6 showed that individual differences in preference for highly sweetened lemon drinks could be explained, in part, by personality factors. This suggests that personality may be involved in preference for high-calorie dense foods. Dietary fats are also high calorie-dense foods and are often over eaten. Dietary fat is a fundamental contributor to the selection of food; not only does it influence the taste of food but also the texture (Aaron, Evans & Mela, 1995) and the palatability (Crystal & Teff, 2006). Factors that determine fat intake and preferences for dietary fats are of present interest and concern given the dramatic rise in obesity observed in recent years (IC, 2008). A combination of unlimited availability and the low cost of high-density convenience foods, particularly in westernised societies, have resulted in the over-consumption of fat and sugar, and consequently a dramatic rise in obesity. In the UK obesity figures have risen by over 10% from 1993, to 24% in 2006 (IC, 2008). A rise so dramatic is unlikely to have arisen by a change in genetics but is more likely a consequence of the changes observed in the food market and food environment (Hetherington & Rolls, 2008). Models of food choice have highlighted the array of factors involved in the selection and purchase of foods. Although many biological and social aspects govern intake, sensory and hedonic processes remain the most influential predictors of food choice. Therefore examining individual differences in preference for dietary fat is fundamental to further our understanding and combat rising obesity levels.

It is perhaps unsurprising that preference for high-fat foods has been found to be positively associated with higher levels of the consumption of highly-fattening foods compared to individuals who show a preference for low-fat foods (Drewnowski & Hann, 1999). Preliminary evidence from elsewhere suggests individual variability in fat taste, further suggestive of a role for individual differences (Mattes, 2005). Despite this, to date, only 2 studies have investigated associations between fat preference and personality. Davis and colleagues (2006) found that Sensitivity to Reward (STR) was positively related to preference for sweet and fatty foods and also related to overeating. Sensitivity to Reward (STR) is a subscale from the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (Torrubia et al., 2001). It is thought to be similar in nature to novelty and sensation seeking in that it is believed to be rooted in the transmission of dopamine and the dopamine system. They concluded that personality traits such as STR can influence body weight indirectly by the way it co-varies with eating behaviours and food preferences that contribute directly to variation in the outcome variable. Taking a different approach, Elfhag and Erlanson-Albertsson (2006) found that while a strong preference for sweet tastes was associated with more neurotic personality traits, fat preference was better explained by eating behaviour, particularly dietary restraint, rather than personality traits directly. These studies focussed on an obese population (Elfhag & Erlanson-Albertsson, 2006) and a sample of pre-menopausal women (Davis et al., 2006); previous to this no studies have examined personality and fat preference in a non-clinical sample, representative of “normal eaters”.

Research specific to personality and fat preference is sparse, however a number of studies have found strong links between eating characteristics and preference for dietary fat. Restrained eaters typically avoid or reduce their consumption of high fat foods compared to unrestrained eaters (Tushl, 1990; Alexander & Tepper, 1995).

Previous research indicates that the avoidance of high-fat is not due to taste or palatability as restrained eaters tend to give similar hedonic values to high-fat foods and low-fat foods (Chapelot et al., 1995; Roefs et al., 2005). This suggests that restrained and unrestrained eaters may like high-fat foods to the same extent, but may differ in their craving and perception of these foods as "forbidden". This was further confirmed by Rideout and colleagues (2004), who also found that women with high scores of cognitive dietary restraint choose foods lower in fat and energy than those with low dietary restraint, but did not necessarily prefer the low-fat options in terms of taste.

The previous studies have focussed on individual differences for the 5 commonly defined basic tastes and glucose. This will be extended within this current chapter to examine individual differences in preference for other high calorie dense food groups, in this case dietary fat. The examination of individual differences in preference for dietary fat has a current and obvious interest given the rapid growth in rates of obesity. Furthermore, to date studies examining individual differences in preference for dietary fat are few and far between (Elfhag & Erlanson-Albertsson, 2006). Within this chapter the first study (fat study A) presents normative UK data for the FPQ© (Ledikwe et al., 2007) as this does not exist elsewhere. The second study (fat study B) will build on previous research by investigating the relationship between biologically-based personality and preference for dietary fat by taking factors such as eating behaviour and body mass into account.

7.3 Fat Study A: The Fat Preference Questionnaire© in a UK population

7.3.1 Introduction

The FPQ© (Ledikwe et al., 2007) was developed to measure preference for dietary fat. It was developed in order to overcome observed difficulties and limitations of methods that aim to measure preference for dietary fat (this is discussed in more detail in Chapter 2, section 2.4.4). As the measure is in it's infancy it has not been used elsewhere in a UK based population (at the time of writing). Due to the difficulties observed in measuring preference for dietary fat the introduction of the FPQ© (Ledikwe et al., 2007) has meant that it is now possible to examine preference for dietary fat using this self-report measure. The measure has been found to a reliable, valid, easily administered questionnaire (Ledikwe et al 2007). The current study sought to produce some UK normative data from the FPQ as it does not currently exist elsewhere. This normative data may be useful in providing a basis for comparison with subsequent studies examining preference for dietary fat in UK samples.

7.3.2 Method

7.3.2.1 Recruitment

One thousand five hundred questionnaire booklets were distributed to Psychology undergraduate students at Sheffield Hallam University, Leeds Metropolitan University, The Open University and also Student Union employees at both the University of Sheffield and Sheffield Hallam. Additionally questionnaires were distributed to employees from several local businesses with their prior permission; a covering letter was included offering information about the study and contact details. First year undergraduate students studying Psychology at Sheffield Hallam could receive research participation credits upon completion and return of the completed questionnaire.

Permission was granted in advance to distribute the questionnaires and ethical approval was achieved via the Faculty Ethics Committee. Questionnaires were either returned to the researcher via free-post envelopes or collected up at the work place in a secure "return box" and then later collected by the researcher. A total of 508 questionnaires were returned equating to a return rate of 38.4%. Eight questionnaires were not completed appropriately or contained a large number of missing responses; therefore 500 completed questionnaires were used to generate the normative data.

7.3.2.2 Health and Diet Characteristics

The sample consisted of 393 females and 103 males (4 respondents did not answer this question). The age ranged from 18 to 80 years, the mean age being 28 years (SD=12.09). According to the World Health Organisation between 30-80% of people in the European region are classified as overweight, with almost 60% of adults in the UK having a body mass of 25 or more.

Within this current sample 36.2% of individuals were classified as overweight based on body mass index scores of 25 or more (table 7.1 shows this in more detail). The mean BMI was 24, varying between 16 (underweight) and 47 (morbidly obese). Thirty six respondents (7.2% of the total sample) did not disclose information regarding their weight and/or height therefore BMI could not be calculated for these respondents.

Table 7.1: Sample characteristics: BMI organised by weight category[12]

	Percentage of participants based on BMI
Underweight	5.6 %
Ideal/normal weight	58.2%
Overweight	28.2%
Obese	7.1%
Morbidly obese	0.9%

On average the sample reported consuming a total of 15 units of alcohol per week (SD = 15.07); mean alcohol units for men was 23 units (SD=19.24) and for women was 13 units (SD=13.30). According to the Department of Health "safe" consumption of alcohol is defined as 3-4 units per day for men and 2-3 units per day for females, equating to no more than 28 units per week for males and no more than 21 units per week for females (Department of Health, 2007). Taking this into consideration the average alcohol consumption for the sample can be classed as safe based on the Government guidelines. It is, however, important to recognise that the standard deviations were fairly high suggesting that the quantity of alcohol consumed weekly was extremely varied across the sample. This was further confirmed by the range of alcohol units consumed in a week which varied from 0 units to 84 units, which exceeds Government recommendations.

[12] BMI was calculated using the formula weight in pounds/height in inches^2 x 703
Underweight was defined by a BMI score of 18.4 or less. Ideal/normal weight was defined by a BMI score between 18.5 and 24.9. Overweight was defined by a BMI score between 25 and 29.9. Obese was defined by a BMI score between 30 and 39.9. Morbidly obese was defined by a BMI score of 40 or more.

A summary of other health and diet-related characteristics of the sample is provided in table 7.2. The majority of the sample reported being non-smokers, in good health and not currently on any medication. A number of respondents reported suffering from food allergies or intolerances, particularly towards wheat, fish (including shellfish), fruit and nuts. Ten percent of respondents reported being on a diet; the majority were female and who stated that they were on calorie-controlled diets or the Weight Watchers® programme. Dietary restrictions were reported by 72 respondents who said that they were either vegetarian or vegan, largely due to ethical or religious reasons.

Table 7.2: Sample health and diet characteristics

	Percentage
Smokers	13.6%
Reporting good health	95.4%
Currently on medication	9.2%
Suffer food allergies/intolerances	13.2%
Suffer health problems that affect diet	8.8%
Currently on a diet	10%
Dietary restrictions	14.4%

7.3.3 Design

The purpose of this study was to collect and produce some normative data specific to a UK population and male data because this is not available elsewhere. Participants were asked to complete a questionnaire relating to demographical information about them which also included details of health and diet, in additional participants were asked to complete FPQ© (Ledikwe et al., 2007) and the TFEQ (Stunkard & Messick, 1985).

7.3.4 Measures

The following questionnaires were presented in the following order in a booklet. Instructions were clearly presented on the front page describing how to complete the questionnaires and details of how to complete the personal code. Participants were instructed to give a personal code, and were given an example of what it could include (e.g. the first 2 initials of their mother's maiden name followed by the day of their birthday, followed by their house number). Respondents were instructed to use the same code if they had taken part in any previous studies conducted by the main researcher, in order to avoid repeated data. Contact details of the researcher were also provided along with details for returning the completed questionnaires.

Background Measures

Typical demographic information (age, sex, occupation etc) was collected. Respondents were also asked how much alcohol they consumed on an average week, whether they smoked and about their health and diet (i.e. any medication or treatment that had affected their diet or sense of taste). Respondents were also asked to give details of their weight (in stones and pounds) and height (in feet and inches) in order to calculate body mass using the Body Mass Index (BMI). See appendix 17 for background measures taken in this study.

Eating Behaviour

Measures of eating behaviour were also taken using the TFEQ (Stunkard & Messick 1985). For details of this measure see chapters 4 and 5.

Preference for Dietary Fat

In light of the observed difficulties measuring fat preference empirically due to large variation across the food groups in terms of fat content, texture and viscosity, a self-rated measure was employed to determine preference for high fat foods. The FPQ© (Ledikwe et al., 2007) was developed in order to measure fat preference across a number of foods. The instrument has been found to be consistent over time, valid and reliable (Ledikwe et al., 2007). This is a self-rated questionnaire comprising of 19 sets of foods. The food sets come from a variety of food groups and each food set is made up of 2 or 3 similar foods varying in fat content. For example, the food set that includes cheese has a low-fat option and a high-fat option. Table 7.3 shows each food set with the high- and low-fat options.

Table 7.3: Food sets with high and low fat choices from the FPQ© (adapted from Ledikwe et al., 2007)

Food Set	*High Fat Choice*	*Low-Fat Choice*
1. Sweets	Chocolate	Boiled sweets
2. Bagel Spreads	Regular cream cheese, butter or margarine	Reduced-fat cream cheese, butter or margarine; or plain bagel (no spread)
3. Potato	Chips or baked potato with sour cream or butter	Baked potato with reduced-fat topping; or plain baked potato
4. Ice Cream	Full-fat ice cream	Low-fat ice cream
5. Soup	Cream soups	Clear soups
6. Vegetables	Sautéed or fried vegetables	Plain steamed or boiled vegetables
7. Sandwich spreads	Regular mayonnaise	Reduced-fat mayonnaise; or without mayonnaise
8. Cheese	Full-fat cheese	Low-fat cheese
9. Toast spread	Butter or margarine	Low-fat margarine; or without butter/margarine
10. Fish	Baked, steamed or grilled fish	Fried fish
11. Burger	Hamburger	Grilled chicken sandwich
12. Salad dressing	Full-fat dressing	Low-fat dressing; or without dressing
13. Pasta sauce	Cream or cheese sauce	Tomato sauce
14. Pizza	Pizza with extra cheese or meat	Regular cheese pizza
15. Vegetable dip	Vegetables with full-fat dip	Vegetables with low-fat dip; or plain raw vegetables
16. Biscuits	Full-fat biscuits	Reduced-fat biscuits
17. Chicken	Fried chicken	Grilled or baked chicken
18. Crisps	Full-fat (normal) crisps	Low-fat crisps
19. Milk	Whole milk	Semi-skimmed; or skimmed; or other

Due to language and cultural differences between the US food descriptors used within the original questionnaire and typical UK equivalents, some of the food descriptors were changed to reflect more typical UK food. For example the food set *candy* was changed to include *chocolate* instead of *chocolate candy* and *boiled sweets* instead of *hard candy*. These changes were made with prior agreement from the authors (see appendix 18 for the amended version suitable for use with a UK population and the original version). Question 2 relating to bagels was left in as although bagels are not as popular as they are in the US they are available in the UK and a suitable UK equivalent could not be found.

When administered to respondents the questionnaire is entitled "Food Preference Questionnaire" in order to distract respondents' attention away from the main purpose of the instrument i.e. measurement of dietary fat preference. For each food set participants are asked to answer 3 questions; a) if they have ever eaten the foods listed (a tick box response), b) to choose which food in the list (high fat, low fat or non-fat option) tastes better (indicated by circling the appropriate response) and c) which food in the food list they eat more often (also indicated by circling the appropriate response). Figure 7.1 shows an example item from the FPQ©. If respondents were to indicate that they have never eaten any of the foods in the food set, i.e. tick "no" to all options in part a) of the set, they are directed to the next food set.

4. Full-fat Ice Cream *or* low-fat Ice Cream

a. Have you ever eaten: Full-fat ice cream? Yes ☐ No ☐
Low-fat ice cream? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 5.

b. Which food tastes better? (Circle one)
Full-fat ice cream ------------------ 1
Low-fat ice cream ----------------- 2

c. Which food do you eat more often? (Circle one)
Full-fat ice cream ------------------ 1
Low-fat ice cream ----------------- 2
I no longer eat any of these foods 3

Figure 7.1 Example item from the FPQ©

Three scores can be calculated from the FPQ©; TASTE, FREQ and DIFF scores (Ledikwe et al., 2007). TASTE scores relate to the percentage of high-fat foods selected from the food sets indicated to "taste better". FREQ scores relate to the percentage of high-fat foods from the food sets selected as "eaten more often". A DIFF score can be calculated by subtracting TASTE scores from FREQ scores, a DIFF score reflects dietary restraint specific to high-fat consumption. TASTE, FREQ, and DIFF scores were calculated according to the instructions set out by the original authors (Ledikwe et al., 2007). The reliability and validity of the FPQ has been tested by Ledikwe and colleagues (2007) via three studies with exclusively female samples (these are discussed in more detail in Chapter 2, section 2.4.4).

7.3.5 Procedure

After receiving permission and ethical approval, the questionnaire booklets were distributed to the establishments and participants who agreed to take part in the study. Each questionnaire was accompanied by a consent form (appendix 19) which also acted as an information sheet about the study (this also included contact details). The researcher handed the questionnaires out to undergraduate students at Sheffield Hallam University during Research Methods laboratory sessions and explained what the study was about. Students were asked to bring the completed questionnaire back to the following teaching session (generally a week later), where they would receive research participation credits if they were 1st year Psychology undergraduates at Sheffield Hallam University. Other questionnaires were sent to a number of local professionals who had previously agreed to distribute these to their work colleagues. These were accompanied by a covering letter giving details about the study, assurances about ethical approval of the study and contact details of the researcher. Free-post envelopes were also provided and respondents were instructed to return the booklets using these envelopes.

7.3.6 Results

7.3.6.1 Treatment of Data

Participants were asked to give their weight in stones and pounds and their height in feet and inches. In order to calculate body mass, weight was converted to pounds and height was converted to inches using conversion tables. Body mass was then calculated in Excel using the following formula:

$$\text{BMI} = (\text{weight in pounds}/\text{height in inches}^2) \times 703$$

One third of the current sample (33%) consisted of young undergraduate students aged between 18 and 20 years. In light of this and the perceived difficulties answering question 25 of the TFEQ as highlighted in the previous study (see section 6.4.1) this question was excluded from the calculation of the Disinhibition subscale and therefore all analysis. Otherwise the TFEQ was inputted and the 3 subscales were calculated as proposed by the original authors (Stunkard & Messick, 1985).

Three scores were calculated from the FPQ© responses. TASTE scores were calculated based on the percentage of the 19 food sets in which the high-fat food options were selected as tasting better. FREQ scores were calculated based on the percentage of the food sets in which the high-fat food options were selected as eaten more often. Following the instructions of the original authors if respondents indicated that they had never eaten any of the food items within the food sets or no longer ate these foods, these were excluded from the calculations for TASTE and FREQ scores. The DIFF score was obtained from subtracting FREQ scores from TASTE scores. The DIFF score reflects a measure of dietary restraint specific to fat consumption. Histograms and boxplots were produced to examine the distribution of scores on all variables. These suggested that all variables demonstrated scores that were normally distributed and the skewness statistic for all variables fell within the guidelines of ±2.58 (Clark-Carter, 2004). Z scores were calculated for all eating behaviour and fat preference variables; these were found to fit within the guidelines of ±3 for the detection of outliers (Clark-Carter, 2004).

7.3.6.2 Descriptive Data

Descriptive data collated from the TFEQ and the FPQ© by sex can be seen in table 7.4. Ledikwe et al's (2007) original studies employed an all-female sample, in light of this the descriptive data will be compared to the UK female scores only; male data is not available elsewhere. Data from Ledikwe et al (2007) free-living study[13] is also presented for comparison purposes.

[13] The free-living study included 148 lean and obese females (Ledikwe et al., 2007). Therefore for comparison purposes the male and female scores from the current study have been separated in this table

Table 7.4: Comparisons between measures of eating behaviour (TFEQ) and measures of dietary fat preference (FPQ©)[14]; descriptive data[15] collated from Ledikwe and colleagues (2007) and the UK sample (current study)

	Free living study (n=148)[3]	UK sample data (n=393)	UK sample data (n=103)
	Females	Females	Males
Sample Characteristics			
Age	37	27	32
BMI	27	23	25
Restraint[16]	8.3±0.4	7.3±0.4	4.8±0.6
Disinhibition[16]	7.1±0.3	6.26±0.2	5.0±0.3
Hunger	4.9±0.3	5.6±0.2	6.2±0.6
FPQ Scores			
TASTE (%)			
Mean ±SE[16]	58.1±1.3	53.9±.08	60.6±1.6
Standard deviation	-	16.8	16.2
Range	11.8 – 94.8	5.26 – 94.7	5.26 – 94.7
FREQ (%)			
Mean ±SE[16]	43.7±1.4	41.6±1.3	52.5±2.2
Standard deviation	-	17.7	15.4
Range	5.3 – 83.2	0 – 73.7	21.1 – 79.0
DIFF (%)			
Mean ±SE	14.3±1.2	14.0±1.0	11.8±1.6
Standard deviation	-	14.4	11.3
Range	-10.5 – 63.2	-15.8 – 68.4	-5.26 – 42.11

The mean age of the female participants from the Ledikwe et al (2007) free-living study is also 10 years higher than the females in the current study; this should be taken into account when examining these data. Body mass was also slightly higher in the Ledikwe et al study but their study sought to examine obese participants as well as lean participants so this may account for these differences. Restraint scores obtained from the TFEQ were found to be slightly higher in Ledikwe et al's

[14] The means ±SE are presented for comparison purposes with Ledikwe et al. (2007) data. Standard deviations are reported for the UK sample data in relation to the FPQ© but not for Ledikwe et al. (2007) as these were not available.
[15] Data is reported to 1 decimal place in this table in line with the data presented in the original paper (Ledikwe et al., 2007)
[16] Sex differences were observed between males and females in the UK sample on these variables ($p<0.01$)

study compared to the current female scores and scores of disinhibition were found to be similar. Hunger scores were slightly higher among the UK females; but marginally so.

The original study observed a mean TASTE score of 58.1% compared to 53.9% in UK females. This suggests that just over half the high-fat options were depicted as tasting better than the low-fat options. The range of scores was very similar among these samples. The FREQ scores suggest that the high-fat options were eaten less often than the low-fat options; just over 40% was observed in both female samples suggesting that the low-fat options were selected as "eaten more often". Dietary fat restraint scores as measured by the DIFF subscale were fairly low but again very similar among female participants across the 2 samples; 14% of the high-fat options were chosen over the low-fat options to taste better but chosen less often reflecting low dietary restraint in terms of fat preference.

Male data is not currently available elsewhere for the FPQ© and so direct comparisons cannot be made at present. Despite this, sex differences within the current sample were observed in relation to TASTE and FREQ scores. These findings suggest that the males selected the high-fat options as tasting significantly better compared to the female participants selection of the high-fat options, and that the high-fat options were eaten significantly more often by males than female respondents.

7.3.6.3 Scale Reliability

In order to test the internal consistency reliability of the items within the subscales of FPQ© Cronbach's alpha statistics were explored. As the DIFF subscale is calculated by subtracting FREQ scores from TASTE scores, Cronbach's Alpha is only reported for the FREQ and TASTE subscales. Cronbach's alpha for the TASTE subscale showed an acceptable level of internal consistency within this subscale ($r = 0.62$). For FREQ Cronbach's alpha was also found to suggest acceptable internal consistency ($r = 0.75$). A Cronbach's alpha of 0.60 is deemed acceptable, although Cronbach's alpha of 0.70 (and above) is defined as the ideal cut-off (Cronbach, 1951).

Close inspection of the frequencies indicated that question 2 relating to bagel consumption had questionable relevance to a UK population; almost half of the respondents indicated that they had never consumed bagels before. For all other questions the listed food items (see table 7.3 for the food items used within the FPQ©) had been consumed previously by the majority of the sample.

7.3.6.4 Relationships between the FPQ©, BMI and subscales of the TFEQ

The intercorrelations between the subscales of the TFEQ, BMI and the FPQ are reported in table 7.5. TASTE and FREQ scores were found to intercorrelate in line with Ledikwe. FREQ and DIFF scores were found to negatively correlate; as frequency of consumption of high fat foods increased, dietary restraint (specific to high fat foods) decreased. Similarly, TASTE and DIFF scores were found to negatively correlate suggesting that as preference for the taste of high fat foods increased, dietary fat restraint scores decreased. A negative correlation was observed between scores of dietary restraint and FREQ scores, suggesting that as frequency of eating high fat foods increased scores of dietary restraint decreased.

Table 7.5: Intercorrelations between the subscales of the FPQ©, the TFEQ and BMI

	TASTE	*FREQ*	*DIFF*	*Restraint*	*Disinhibition*	*Hunger*	*BMI*
TASTE	-						
FREQ	0.67**	-					
DIFF	0.33**	-0.48**	-				
Restraint	-0.28**	-0.56**	0.39**	-			
Disinhibition	0.12**	-0.04	0.20**	0.21**	-		
Hunger	0.12**	0.20**	-0.04	-0.14	0.55**	-	
BMI	-0.09*	-0.21**	0.15**	0.14**	0.24**	-0.04	-

** p<0.05* ***p<0.01*

In terms of the subscales of the TFEQ Restraint and TASTE scores were found to negatively correlate in line with Ledikwe and colleagues (2007). Disinhibition and TASTE, and Hunger and TASTE positively correlated; this is not in agreement with

Ledikwe. Ledikwe and colleagues (2007) did not find any significant relationships between BMI and the subscales of the FPQ. The current study observed significant negative relationships between BMI and TASTE scores, and BMI and FREQ scores. A positive relationship was also found between BMI and DIFF scores.

7.4 Fat Study B: examining the extent to which characteristics of eating behaviour, BMI and temperament variables predict preference for high fat foods

7.4.1 Introduction

Dietary fat significantly enhances the palatability of foods often resulting in over consumption (Ledikwe et al., 2007). Furthermore, dietary fat has a high density (9kcal/g) and so over consumption can lead to significant weight gain (Rolls et al., 2005). Predictors of high fat consumption warrant investigation given the dramatic rise of obesity observed in westernised societies. Study 3 demonstrated that preference for glucose, also a high density substance, could in part, be explained by temperamental personality variables. This present study sought to examine established relationships between eating behaviour (Restraint, Disinhibition and Hunger) and preference for dietary fat (Ledikwe et al., 2007), but to extend this to consider whether BMI and temperament personality characteristics also predict preference for dietary fat and to what extent.

7.4.2 Method

7.4.2.1 Participants

A sub-sample of the participants from fat study A completed a full battery of measures (see measures section 7.4.2.3). In total 244 completed questionnaires were returned. The sample included 49 males and 194 females (1 respondent did not answer this question). The mean age was calculated to be 24 years (SD = 10.27), the age ranged from 18 to 69 years. Body mass was calculated[17]; the mean BMI score was found to be 23 which is classed as "normal weight". BMI ranged between 16 (underweight) and 43 (morbidly obese). The majority of the sample

[17] 22 respondents did not disclose details of either their weight or weight (or both) and so BMI could not be determined for these individuals. Therefore BMI was coded as missing data.

could be classified as “normal weight” and almost one-third of the sample were found to have a BMI score over 25 (overweight/obese). Table 7.6 shows this in more detail.

Table 7.6: Sample characteristics: Body mass index organised by weight category[18]

	BMI categories (%)
Underweight	7.7%
Ideal/normal weight	63.1%
Overweight	22.5%
Obese	6.3%
Morbidly obese	0.5%

The majority of the sample reported being in good health (96%), did not report health problems associated with their diet (94%) and were non-smokers (90%). Ten percent of the sample said that they were vegetarian or vegan (for ethical or religious reasons). Just over 7% of respondents said that they were currently on a diet (the majority were women). A small number of respondents reported food allergies or intolerances (11%), though none the reported intolerances were towards dairy or high fat-containing foods.

7.4.2.2 Design

The current study utilised a correlational design to examine relationships between preference for dietary fat, characteristics of eating behaviour, BMI and temperamental personality. Participants were asked to complete a series of questionnaire measures relating to their health, diet, eating behaviour and personality.

7.4.2.3 Measures

The measures used in this study were identical to those employed in fat study A. In addition to these measures temperamental personality was also measured using the TPQ (Cloninger 1987). Previous Chapters 4 and 5 provide thorough details of

[18] The percentages have been adjusted to exclude missing cases

this measure and also see appendix 8 for a detailed summary of the characteristics associated with each subscale.

7.4.2.4 Procedure

All aspects of the procedure were identical to fat study A (see section 7.3.5); the only exception being that the questionnaire booklet in this study additionally included the TPQ.

7.4.2.5 Analysis

Hierarchical regression was employed to examine the amount of variance in preference for foods high in dietary fat explained by characteristics of eating behaviour, BMI and personality factors. Due to the existing literature that demonstrates relationships between the TFEQ and FPQ© (Lediwke et al., 2007), and BMI and preference for high- over low-fat foods (Davis et al., 2006), measures of eating behaviour (TFEQ) and BMI were entered as predictors of fat preference at step 1. As the relationships between temperamental personality and preference for high fats have not been previously examined, the lower facets of the TPQ were entered as predictors of fat preference at step 2 of the analysis.

7.4.3 Results

7.4.3.1 Treatment of raw data

The data obtained from the TPQ responses were inputted and the 4 main dimensions and lower subscales were calculated according to Cloninger's instructions (Cloninger 1987), along with the subscales of the TFEQ (Restraint, Hunger and Disinhibition), which were also calculated according to the authors (Stunkard & Messick, 1985). The 3 scales of the FPQ© were also calculated according to the authors (Ledikwe et al., 2007. Also see section 7.3.6.1). After calculation of the DIFF subscale it was noted that many of the data points were found to be negative values, a constant (+10) was added to the raw scores of all three FPQ© subscales (Tabachnik & Fidell, 2000). BMI was calculated as before (see section 7.3.6.1 above).

Z-scores were calculated; the majority of these scores fell within the guidelines of ±3 for the detection of outliers (Clark-Carter, 2004). However a few outliers were discovered on a number of the lower facets of the TPQ particularly RD4 and Total Reward Dependence. Unsurprisingly the largest BMI score was also found to be an outlier. It was not deemed appropriate to adjust these outliers as they reflected "true" scores, obtained from self-rated measures (Orr, Sackett & Dubois, 1991) and since individual differences is fundamental to this research the outliers remained in the data set.

7.4.3.2 Descriptive Statistics

The descriptive data collated from the TPQ major personality dimensions and subscales, for the overall sample and separated by males and females is presented in table 7.7. Descriptive data is also given for the TFEQ and the FPQ©. Compared to the descriptive data obtained from the previous reported studies scores for novelty seeking reflected similar patterns. Additionally no sex differences were observed in scores of novelty seeking in line with the previous studies and with other UK data (Otter et al., 1995). The current study found sex differences between all lower facets of harm avoidance with females scoring higher than males in all instances, again reflecting similar patterns of findings to those of Otter and the previous studies reported in the thesis. Sex differences were also observed on all lower facets of reward dependence in line with Otter; where females scored higher than males on all lower facets. Scores of Persistence were in line with Otter (1995) and the other studies presented in the thesis; sex differences were not observed.

Significant sex differences were observed in scores of Dietary Restraint; females displayed higher levels of dietary restraint than male participants in line with previous findings (van den Bree et al., 2006). Females also scored significantly higher than males in terms of Disinhibition again reflecting similar scores obtained elsewhere (van den Bree et al., 2006). Similar scores of Hunger were observed between males and females in this study compared to studies 2 and 3; in all instances females scored slightly higher than males but no significant differences occurred. Van den Bree (2006) also found that females tended to score higher on the Hunger subscale, finding significant sex differences on this scale also.

Table 7.7: Means, standard deviations and p-values associated with sex differences, for TPQ, TFEQ and FPQ©

	Overall		*Males*		*Females*		*Sex Difference*
	Mean	SD	Mean	SD	Mean	SD	*P*
NS1	5.03	1.83	5.25	1.87	4.96	1.81	0.34
NS2	3.41	2.03	3.37	2.15	3.42	2.01	0.87
NS3	3.89	1.80	3.59	1.75	3.96	1.80	0.20
NS4	5.24	2.13	5.59	2.25	5.14	2.10	0.19
Total Novelty Seeking	17.58	5.27	17.80	5.68	17.49	5.17	0.72
HA1	4.50	2.93	2.94	2.58	4.88	2.89	<.001
HA2	4.00	2.16	2.76	1.92	4.30	2.11	<.001
HA3	3.25	2.01	2.49	2.11	3.43	1.93	0.003
HA4	3.68	2.54	2.61	2.38	3.94	2.52	0.001
Total Harm Avoidance	15.43	7.18	10.80	6.21	16.55	6.94	<.001
RD1	3.73	1.14	3.35	1.35	3.82	1.07	0.01
RD3	7.68	2.53	6.92	2.94	7.87	2.39	0.02
RD4	3.40	1.33	3.10	1.36	3.46	1.32	0.09
Total Reward Dependence	14.82	3.71	13.37	4.20	15.16	3.50	0.002
Persistence	5.09	2.16	5.02	2.16	5.11	2.17	0.79
Restraint	6.77	5.25	4.82	4.43	7.26	5.34	0.003
Disinhibition	7.11	3.72	5.94	3.40	7.40	3.75	0.01
Hunger	5.75	3.45	6.20	4.23	5.65	3.23	0.32
TASTE (%)[19]	58.05	17.93	64.34	13.89	56.48	18.55	0.01
FREQ (%)[9]	43.77	17.71	52.52	15.36	41.56	17.66	<.001
DIFF (%)[9]	13.55	13.80	11.82	11.30	14.00	14.39	0.33

[19] Means for the FPQ© subscales are presented before the transformation for comparison purposes with Ledikwe et al. (2007)

Scores obtained from the FPQ© generally showed similar patterns to the mean scores obtained in the original free-living study conducted by Ledikwe and colleagues (2007). The original study employed a female sample, in light of this the means will be compared to the female scores only; male scores are compared with the normative data reported in study one (see table 7.4 above). The original study observed a mean TASTE score of 57.8%, marginally higher then the mean obtained in the current study suggesting that on average high fat options were preferred over the low-fat alternative. Male TASTE scores were slightly lower in the current study (64.34%) compared to UK normative data (60.6%). A significant difference was observed between males and females with regards to TASTE scores; males rated the high-fat options as tasting significantly better than the low fat alternatives compared to females.

FREQ scores were very similar; the original free-living study conducted in the US found a mean FREQ score of 43.7% compared to the current study which found that on average 41.56% of the high-fat options were selected as "eaten more often" (in females). Male FREQ scores were in line with the normative data. Interestingly the current study found a significant sex difference in scores of FREQ where males selected the high-fat option as "eaten more often" more so than female participants. DIFF scores were calculated by subtracting FREQ scores from TASTE scores, reflecting a measure of dietary fat restraint. The mean DIFF score in the current study was in line with Ledikwe and colleagues (2007); 14% of the high-fat options were selected as tasting better but chosen less often. Male DIFF scores were in line with the normative data presented here. DIFF scores were lower in males within the current study suggesting that that males displayed less dietary restraint specific to high fat foods than females, although this difference was not found to be significantly different.

7.4.3.3 Additional Assumptions for Regression

Additional assumptions for conducting multiple regression were tested. Variables were not highly correlated with each other; intercorrelations for predictors variables fell within the guidelines of ±0.8 (Clark-Carter 2004), therefore multicollinearity was not evident. The correlations between the predictor variables (see table 7.8) found that some of the predictor variables were linearly related to the criterion variables, although the strength of these relationships were weak to medium and non-significant in some cases.

Table 7.8: Linear relationships between the criterion variables (FPQ©) and the predictor variables (TFEQ, BMI and TPQ)[20]

	TASTE	*FREQ*	*DIFF*
Restraint	-0.22**	-0.54**	0.44**
Disinhibition	0.11	-0.03	0.16*
Hunger	0.16*	0.21**	-0.08
BMI	-0.05	-0.27**	0.28**
NS1	0.07	0.09	-0.04
NS2	0.06	0.13*	-0.10
NS3	0.13*	0.10	0.02
NS4	0.10	0.17**	-0.10
HA1	-0.04	-0.05	0.02
HA2	-0.15	-0.21	0.10
HA3	-0.05	-0.05	0.01
HA4	0.08	0.08	-0.01
RD1	0.01	0.01	0.01
RD3	0.15	0.08	0.06
RD4	0.07	-0.03	0.09
PER	-0.08	-0.12	0.06

In order to gain a medium effect size with 16 predictor variables at least 178 participants are required, therefore the sample size in this instance was deemed sufficient (Tabachnik & Fidell, 1996). Cook's distance was also obtained to measure any difference between an individual's scores on the DVs and IVs compared to other individuals in the sample, since all individual's scores were below 1 further investigation was not necessary (Stevens 2002). Subscales of the TFEQ and BMI have been previously found to predict fat intake and preference (see section 7.2) and so those were entered in the regression models at step 1. As there is not a direct theory to link personality and preference for dietary fats the

[20] Values shown are Pearson correlation coefficients.

personality predictors were entered at step 2 of the regression models. This method of developing regression models is recommended when there is interest in findings a model to fit the data rather than testing existing theory (Menard, 1995). The models presented include significant predictors only due to the number of predictors entered into the models. These are presented in the following sections and the full models including all predictors may be viewed in appendix 20.

7.4.3.4 High Fat Taste Preference (TASTE)

In the hierarchical regression at step 1 of the analysis Restraint, Disinhibition, Hunger and BMI were entered as the predictors whilst TASTE was entered as the criterion (see table 7.9). The association between the criterion and predictor variables was weak (Multiple R=0.28). Together the predictor variables accounted for 6.3% of the variance in TASTE scores (adjusted R^2). The analysis showed that the proportion of variance in preference for the taste of high fat foods accounted for by the predictor variables was significant ($F(4,239)=5.11$, $p=0.001$).

The additional contribution of the personality variables on the model was assessed at step 2. The association between the criterion and predictor variables at this stage was also moderate but slightly higher than observed in step 1 (Multiple R=0.37), explaining 7.3% of the variance in TASTE scores (adjusted R^2). The analysis showed that the amount of variance explained by personality scores, Restraint, Disinhibition, Hunger and BMI combined was significant ($F(16,227)=2.21$, $p=0.006$). The R Square Change statistic indicated that the personality variables did not significantly contribute to the model despite increasing the adjusted R^2 (R^2 Change =0.06, $p=0.27$).

The significant coefficients at step 1 and step 2 are presented in table 7.9 (see appendix 20 for the full models). Examination of the coefficients at step 2 indicates that Restraint was the best predictor of preference for the taste of high fat foods (t=-3.10, p=0.002). As this was negative it suggests that as scores of dietary restraint increased by 1, preference for the taste of high fat foods fell by 0.22. Fear of uncertainty was also a good predictor of preference for the taste high fat foods (t=-1.99, p=0.05), suggesting that as Fear of Uncertainty (a lower facet of Harm Avoidance) scores increased by 1, preference for the taste of high fat foods decreased by 0.24.

Table 7.9: Beta values, standard errors and standardised betas for preference for high fat foods (TASTE scores)

		B	SE B	β
Step 1				
	(Constant)	21.43	1.18	-
	Restraint	-0.13	0.04	-0.24**
Step 2				
	(Constant)	20.40	1.89	-
	Restraint	-0.12	0.04	-0.22**
	HA2	-0.24	0.12	-0.18*

*$p<.05$ **$p<.01$

7.4.3.5 Frequency of Consumption of High Fat foods (FREQ)

In step 1 of the analysis restraint, disinhibition, hunger and BMI were again entered as the predictors whilst FREQ was entered as the criterion. The association between the criterion and predictor variables was moderate in strength (Multiple R=0.58). Together the predictor variables accounted for 33% of the variance in FREQ scores (adjusted R^2). The analysis showed that the proportion of variance in preference for the frequency of consumption of high fat foods accounted for by the predictor variables was significant ($F(4,239)=30.93$, $p<0.01$).

The additional contribution of the personality variables on the model was assessed at step 2. The association between the criterion and predictor variables at this stage increased (Multiple R=0.62) to explain 33.6% of the variance in FREQ scores (adjusted R^2). The analysis showed that the amount of variance explained by personality scores, Restraint, Disinhibition, Hunger and BMI combined was also significant ($F(16,227)=8.68$, $p<0.01$). The R Square Change statistic indicated that the personality variables did not significantly contributed to the model (R^2 Change

=1.17, p=0.31). The significant coefficients at step 1 and step 2 are presented in table 7.10 (see appendix 20 for the full models).

Table 7.10: Beta values, standard errors and standardised betas for frequency of consumption of high fat foods (FREQ)

		B	*SE B*	*β*
Step 1				
	(Constant)	23.09	1.12	-
	Restraint	-0.33	0.04	-0.51**
	BMI	-0.15	0.05	-0.18**
Step 2				
	(Constant)	22.58	1.81	-
	Restraint	-0.32	0.04	-0.50**
	BMI	-0.15	0.05	-0.17**
	HA2	-0.25	0.12	-0.16*

**p<.05 **p<.01*

7.4.3.6 Dietary Restraint for High Fat Foods

In the hierarchical regression Restraint, Disinhibition, Hunger and BMI were entered together in the first step whilst DIFF scores were entered as the criterion. The association between the criterion and predictor variables was moderate (Multiple R=0.49). Together the predictor variables accounted for 22.5% of the variance in DIFF scores (adjusted R^2). The analysis showed that the proportion of variance in dietary restraint score for high fat foods accounted for by the predictor variables was significant (F(4,239)=18.60, p<0.01).

At the second step the additional contribution of the personality variables on the model was examined. The association between the criterion and predictor variables (Multiple R=0.52) was found to explain 21.5% of the variance in DIFF scores (adjusted R^2). The analysis showed that the amount of variance explained by personality scores, Restraint, Disinhibition, Hunger and BMI combined remained significant (F(16,227)=5.17, p<0.01). The R Square Change statistic indicated that the personality variables did not significantly contribute to the model (R^2 Change =0.76, *p*=0.69). The significant coefficients at step 1 and step 2 are presented in table 7.11 (see appendix 20 for the full models).

Table 7.11: Beta values, standard errors and standardised betas for dietary restraint for high fat foods (DIFF)

		B	*SE B*	*β*
Step 1				
	(Constant)	8.34	1.54	-
	Restraint	0.19	0.03	0.38**
	BMI	0.12	0.04	0.18**
Step 2				
	(Constant)	7.82	1.54	-
	Restraint	0.20	0.03	0.39**
	BMI	0.13	0.04	0.19**
	RD3	0.14	0.07	0.14*

**p<.05 **p<.01*

7.5 Overall Discussion

This chapter presents 2 studies; fat study A provided UK normative data for the FPQ© and fat study B explored relationships between preference for dietary fats, BMI, eating behaviour and personality variables.

7.5.1 The Fat Preference Questionnaire©

Overall the utility of the FPQ© (Ledikwe at al., 2007) within the reported studies provided interesting data. The first study in this chapter reports UK normative data in relation to the FPQ©. The generation of data specific to the UK is important due to obvious cultural differences in the eating preferences and habits between the US and UK. In addition, male data for the FPQ does not exist elsewhere. The female data collected for fat study A was in line with the original data obtained by Ledikwe and colleagues (2007). Upon examination of the male data it was evident that sex differences occurred in relation to TASTE and FREQ scores. Males were found to score the taste of high fat foods higher than females and reported consuming high fat foods more frequently than the females. Previously men have been found to consume a higher percentage of fat than females (Goldberg & Strycker, 2002). Males achieved lower scores for dietary fat restraint; this is perhaps unsurprising since males generally achieve low scores on dietary restraint scales (e.g. Klem, Klesges, Bene & Mellon, 1990). These data suggest that differences between males and females in fat intake and preference may warrant further investigation.

The FPQ© was also found to have good internal consistency suggesting that the items contained within the subscales were unidimensional. Ledikwe et al (2007) tested the reliability and validity of the measure via a series of experiments and found that the measure had good test-retest correlations suggesting good stability and reliability, and the experiments found that measures of fat intake correlated with TASTE and FREQ scores. In the current studies this was not directly examined in the current and further test of the reliability and validity of this scale in a UK population is recommended. This could be achieved by examining relationships between direct food intake, the frequency of consumption of high fat foods and the subscales of the FPQ. Despite this, positive correlations were observed between DIFF scores and dietary restraint (as measured by the TFEQ) indicative of convergent validity (Ledikwe et al., 2007).

Due to the observed limitations of examining dietary fat preference via sensory and hedonic testing (Geiselman et al., 1998; Ledikwe et al., 2007), the FPQ remains a useful and straightforward measure of preference for dietary fat but like all measures it is not without limitations. If a food set contained 2 foods items (a high fat and a low fat option) and only one of these was reported as "ever eaten" the subsequent questions relating to this food item (i.e. indications of tasting better and eaten more often) were included in the scoring. This is also highlighted as a limitation by the original authors although the scoring instructions suggest including these responses (Ledikwe et al., 2007). Despite this the inclusion of such responses may reflect problems with the scoring. It is further recommended that future utility of this measure in a UK population exclude or provide an alternative food group for question 2 (relating to bagel consumption) as this question did not successfully reflect intake of fat or fat preference in this population.

7.5.2 Predictors of Fat Preference

7.5.2.1 Eating Behaviour

Eating behaviour, specifically the Restrict scale from the TFEQ (Stunkard & Messick, 1985) was found to be a good predictor of preference for dietary fats. Examination of the TASTE subscale suggested that Restraint was found to be negatively related to the taste of the high fat foods. This suggests that high scores in Restraint were associated with low preference for the taste of high fat foods. Following this, over 30% of the variance in FREQ scores was found to be explained by Restraint scores. A negative relationship between FREQ and Restraint suggested that high scores in Restraint were associated with low frequency of consumption of high fat foods. These findings accord with Ledikwe and colleagues (2007), and provide further support for the Restraint Theory (Herman & Polivy, 1975). Increases in Dietary Restraint have been frequently found to be related to decreases in fat intake (Van Strein & Van de Laar, 2008); restrained eaters tend to choose low-fat or fat-free options over regular-fat products (Tuschl, Laessle, Platte & Pirke, 1990; Alexander & Tepper, 1995; Kanarek, Ryu & Przypek, 1995).

The Restraint scale from the TFEQ measures the extent to which individuals restrict their caloric intake in order to maintain their desired body weight (Stunkard & Messick, 1985). Similar to this the DIFF subscale of the FPQ (Ledikwe et al., 2007) represents a dietary restraint construct specific to fat preference. Due to these similarities it was expected that these constructs would be related. Restraint was found to a good predictor of dietary fat restraint (DIFF subscale); these constructs were found to positively correlate in the current study in line with previous findings (Ledikwe et al., 2007). Restrained eaters often avoid or restrict their consumption of high fat or regular-fat containing foods in favour of low-fat or fat-free alternatives (Tuschl et al., 1990; Alexander & Tepper, 1995).

7.5.2.2 Body Mass

Body mass index (BMI) scores were also entered into the regression models as a predictor of preference for dietary fats. Previously Ledikwe and colleagues (2007) found that fat preference scores were not associated with BMI. They describe this in terms of demand characteristics, suggesting that obese individuals or those with high BMI scores were more likely to select the low-fat options as they were deemed to be "healthier". Social desirability effects are a problem in self-report measures, including those which directly examine dietary habits (Kristal, Andrilla, Koepsell, Diehr & Cheadle, 1998). Despite this the current study found that BMI significantly predicted frequency of consumption of high fat foods and dietary fat restraint confirming results from elsewhere (Davis et al., 2006).

7.5.2.3 Personality

Dietary fats are thought to be detected by textural, olfactory and taste mechanisms. Though the taste effects are thought to be subtle preliminary evidence suggests individual variability in preference for dietary fats (Mattes, 2005). Previous explorations of personality variables as possible predictors of fat preference have been limited to 2 studies (Elfhag & Erlanson-Abertsson, 2006; Davis et al., 2007). Fat study B sought to explore individual differences specific to temperamental personality and preference for dietary fat. However, personality was generally found to be a poor predictor of preference for the taste of high fat foods and for the frequency of consumption of these food types. Fear of Uncertainty (HA2), a lower facet of harm avoidance), was found to significantly predict taste preference and consumption of high fat foods when added to the regression model at step 2. Despite this, HA2 did not significantly increase the level of explanation (adjusted R^2) of dietary fat preference. Further examination of the coefficients suggested that dietary fat restraint was weakly related to Attachment (RD3). However, again, the addition of this personality factor did not significantly increase the level of explanation (adjusted R^2). This suggests that personality factors did not have an additive effect on the model over and above cognitive factors and BMI. This suggests that in terms of preference for dietary fats cognitive factors may override personality factors, confirming Elfhag and Erlanson-Abertsson's (2006) findings.

7.5.3 Conclusion

Fat study A has successfully provided UK normative data, including male data, for the FPQ (Ledikwe et al., 2007) which is useful for comparison purposes and is not currently available elsewhere. Despite this further validation of this scale in a UK population is recommended, particularly along side studies which explore intake of dietary fat, such as diary studies. Fat study B confirmed previous research indicating that fat preference seems to be a product of eating behaviour, particularly Restraint rather than personality. However Harm Avoidance was found to weakly predict preference for dietary fat in terms of taste and frequency of consumption, although the amount of variance explained by Harm Avoidance was small. Personality factors did not significantly add the level of explanation provided by the regression models developed to explain fat preference.

Chapter 8

Overall Summary of Findings

8.1 Overview

This chapter provides an overall summary of all the studies reported in the thesis. A précis of each study is given as a reminder of the aims of each study, and the findings. The following chapter then presents a general discussion of the theoretical implications, limitations and future directions of this research.

8.2 Summary of Findings

8.2.1 Self-reported taste preference and temperament

The significant personality predictors of taste preference for study 1, 2, and 3. Study 1 (described in Chapter 4) examined self-reported reflective taste preference for 6 taste domains (sweet, salty, bitter, sour, umami and spicy) are summarised in table 8.1. Relationships between self-reported liking for these tastes and temperament traits were explored using visual analogue and self-report questionnaires respectively. Overall this study found that between 2-9% of the variance in taste preference, measured by liking scales, could be explained by different combinations of the personality variables depending on the specific taste. Temperamental personality traits were found to be weakly to moderately related to self-report measures of liking.

Table 8.1: Summary of findings for study 1, 2 and 3: Descriptions of significant predictors of liking for each taste by study

Taste	Study 1 (usual ratings)	Study 2 (taste samples)	Study 3
Sweet	Unassertive and shy in females (HA3). Dependent on emotional support from others In females (RD4). Bold, outgoing in males (HA3-). Independent and self-sufficient in males (RD4-).	Extravagant (NS3). Attached, sensitive to rejection (RD3).	*Usual sweet* Attached, sensitive to rejection (RD3) Inactive and unreliable (PER-). *Sweet tooth* Unassertive and shy (HA3). Inactive and unreliable (PER-). Sentimental and sympathetic (RD1). *Preferred Drink* Reflective (NS2-). Low energy and tired (HA4).
Salty	Organised and systematic (NS4-). Unassertive and shy (HA3). Low energy and tired (HA4). Inactive and unreliable (PER-). Sentimental and sympathetic (RD1).	Organised and systematic (NS4-). Reserved, controlled and restrained (NS3-).	*(not measured)*
Umami	Resistant to try new things, conventional (NS1-). Confident, calm, secure (HA2-). Attached, sensitive to rejection (RD3).	Reflective (NS2-). Attached, sensitive to rejection (RD3).	*(not measured)*

Note: (-) denote negative associations between the taste and the personality predictor

Table 8.1 continued.

Taste	Study 1 (usual ratings)	Study 2 (taste samples)	Study 3
Bitter	Reflective (NS2-). Confident, calm, secure (HA2-). Highly energetic and dynamic (HA4-). Self contained and detached (RD3-).	Attached, sensitive to rejection (RD3).	*(not measured)*
Sour	Highly energetic and dynamic (HA4-). Self contained and detached (RD3-).	Seek thrills, excitement and adventure (NS1). Positive-thinking, optimistic (HA1-). Tense and anxious in unfamiliar circumstances (HA2).	*Usual* Quick tempered and disorderly (NS4). Confident, calm, secure (HA2-).
Spicy	Seek thrills, excitement and adventure (NS1). Controlled and restrained (NS3-). Detached, disinterest in social relationships (RD3-).	*not significant*	*(not measured)*

Note: (-) denote negative associations between the taste and the personality predictor

Sweet tastes were found to be highly liked across the sample. As differences between males and females were observed in relation to both the personality and sweet liking measures, a regression model was developed to examine the associations between sex, sweet liking and personality. In females high scores in RD4 (a subscale of Reward Dependence described as needing emotional support) were significantly associated with high ratings of sweet liking. Similarly high scores of HA3 (unassertive and shy traits) in females were significantly related to high scores of sweet taste liking. The opposite pattern was found in males; significant negative relationships were found between scores of RD4 and sweet taste, and also HA3 and sweet taste. High salt liking was significantly predicted by high scores of HA3, which was found to the best temperament predictor of salty taste preference. High scores on the NS4 and NS2, subscales of Novelty Seeking, were also found to be significantly related to salt liking. This suggests that individuals who rated themselves as impulsive and disorderly tended to rate salty tastes with high liking. Self-reported liking for bitter and sour tastes was found to be low across the sample, and negative associations were noted with most temperament subscale scores. In particular high scores on all subscales of Reward Dependence and Harm Avoidance were found to be negatively related to bitter and sour liking; individuals achieving high scores on these subscales did not appear to like bitter and sour tastes.

Umami liking was found to be best predicted by NS1 (exploratory excitability) and RD3 (attachment). The liking scale for this measure was labelled “artificially enhanced” which may, in retrospect, have influenced the ratings in terms of social desirability. In a sense this was unavoidable; the term “umami” would not have held meaning for the participants as the term is not commonly used in everyday language. Previous investigations have not examined umami taste preference and personality, therefore comparisons cannot be made with previous research. Spicy tastes were best predicted by high scores in NS1 (exploratory excitability) in line with predictions and previous findings which have also linked spicy food liking and outgoing traits (Kish & Donnenworth, 1972; Logue & Smith, 1986; Ventramaiah & Baby Devaki 1990).

Conclusions from study 1 suggested that while there appeared to be weak correlations between taste and temperament, perhaps descriptors of taste domains were problematic and elicited different meanings for different individuals particularly in terms of umami and bitter descriptors. In light of this study 2 aimed to extend these findings by investigating individual differences in taste preference for real-food samples (pasta and sauce) specifically developed to represent each taste dimension, in order to provide 'real' measures of taste.

8.2.2 Individual differences in 'real' taste preference

Using food samples to represent the six tastes dimensions resulted in improvements in all models with the exception of spicy tastes. The variance in taste preference explained by temperament produced stronger models in most cases, for example variation in sweet taste preference explained by personality increased from 6% (study 1) to 9% (study 2), and sour increased from 6.2% to 10%. Liking for the sweet taste sample was best predicted by high scores in NS3, PER and RD3. This suggested that there were significant associations between those rating themselves as highly extravagant, persistent and hardworking, and also highly attached, with high scores of liking for the sweet taste sample. Liking for the salty taste sample was best predicted by low scores of NS3 and NS4. These relationships were negative, suggesting that low scores of extravagance and disorderliness were significantly associated with high scores of salt liking. Sour taste preference was predicted by subscales of Harm Avoidance. Low scores on HA1 (positive optimists), and high scores on HA2 (tense and anxious) and HA4 (low energy and tired) subscales were associated with high liking scores for the sour taste sample. Liking scores for the bitter taste sample were predicted by RD3 (highly attached and warm). Liking scores for umami taste sample were best predicted by NS2 (impulsive and temperamental) and RD3 (highly attached). The regression model for the spicy taste sample was found to be non significant; spicy taste preference was not significantly predicted by any of the temperament predictors.

Study 2 also explored relationships between temperament and characteristics of eating behaviour. Dietary restraint was the weakest of these models. The best predictor of dietary restraint was RD4; high scoring on this subscale, which describes individuals as dependent on others for emotional support and approval, were positively related to high scores on the restraint subscale. The regression model for Hunger suggested that high scores on both RD3 (highly attached individuals) and HA4 (low energy, tired individuals) were the best predictors of perceived hunger. Disinhibition scores were best predicted by Harm Avoidance and Reward Dependence temperaments, particularly HA3, RD1 and RD4. This suggested that individuals who agreed that they were highly unassertive and shy, who were also highly sentimental and sympathetic, and were dependent on others, self-rated themselves as being highly disinhibited eaters.

Study 2 further revealed important relationships between taste and temperament, and using taste samples proved successful in improving the models of best fit in most cases. The models developed to explain the variance in sweet and sour liking by the temperament predictors were the strongest, and confirmed early findings (study 1). The inclusion of the TFEQ added to the findings; relationships between characteristics of eating behaviour (restraint, disinhibition and hunger) and temperament were confirmed. Due the strong models developed to explain variation in both sweet and sour preference, these relationships were explored further in the following study.

8.2.3 Individual differences in glucose and sour taste solutions (lemon drinks)

Study 3 was developed to further examine sweet and sour liking using aqueous solutions (lemon drinks), as these are used widely and effectively within sensory evaluation studies. The TFEQ was also included as study 2 revealed interesting relationships linking characteristics of eating behaviour with temperament traits. Study 3 took measures of usual sour liking, usual sweet liking and self-rated sweet-tooth, as well as 3 measures for each solution (drinks were rated for sourness, sweetness and liking). In line with study 2 usual sour liking was rated very low, and usual sweet liking was rated very high. Sweet tooth ratings followed a similar pattern to usual sweet liking, and sex differences occurred with females rating their usual sweet liking and sweet-tooth as significantly higher compared to males. Overall liking for the taste samples increased as glucose content increased to 20g per 100 ml, liking decreased at 30g per 100 ml, representing an inverted U pattern. Sweet ratings followed a similar pattern, but further increased with greater glucose content. Compared to sweetness ratings, sourness scores followed a reverse pattern; sourness started very high at 0g per 100ml and then dropped as glucose content increased. This was interesting as sour levels remained constant across the samples. Further analysis of the taste sample measures revealed an interaction between sour and sweet, which influenced liking scores. The interaction of other tastes with sweetness intensities has been previously examined; at high intensities sweetness tends to suppress other basic tastes (Keast & Breslin, 2002), including sour tastes which are often found to be suppressed by increased sweet concentrations (Pelletier, Lawless & Horne, 2004).

Usual sour liking was found to be related to high scores of NS4 (disorderliness and quick tempered traits), and also low scores of HA2 (confident, calm, secure traits). These reflected similar findings to study 1 and study 2. Usual sweet liking was found to be best predicted by high scores of RD3 (Attachment) and low scores of Persistent (pragmatists). These findings further confirm findings relating to usual sweet liking found in study 2. High scores of HA3 (unassertive and shy traits) also accounted for some of the variance in usual sweet liking in line with study 1. High scores of sweet-tooth were also associated with high scores of HA3, suggesting that unassertive and shy traits were related to sweet tooth ratings. Persistence was also negatively related to sweet tooth rating much like usual sweet liking, suggesting that hardworking, persistent traits were associated with low sweet tooth rating and low usual sweet liking. The drink chosen as the overall preferred drink by the majority of the sample contained 20g of glucose per 100ml. Overall liking for this drink was best predicted by NS3 and HA4. This suggested that extravagant and unrestrained, and also low energy and tired traits were significantly associated with high liking for this sample drink.

The associations between characteristics of eating behaviour and temperament were further tested in this study, producing some consistent findings with study 2. Dietary restraint was best predicted by low scores of NS1 (conventional-types with little need to seek novel stimulation), high scores of HA1 (pessimistic worries) and high scores of HA3 (unassertive and shy traits). Restraint was also predicted by high scores of NS3 (extravagance), in line with study 2. Disinhibition was also predicted by high scores of NS3, although this was not supported by study 2. In addition high scores of NS2 and RD1 were included in the model of best fit for disinhibition providing support for the findings of study 2. This suggests that excitable, dramatic and temperamental traits, and also sentimental, sympathetic and understanding traits, were associated with disinhibited eating characteristics. Hunger scores were related to low scores of HA3 (bold, forward and outgoing traits) and low scores of NS2 (reflective, focussed and analytical traits). High scores of HA4 (low energy, tired traits) were also found to predict hunger scores in line with study 2. Considering the physiological mechanisms that influence the hunger response, the fact that low energy traits were found to predict feelings of hunger and the behavioural consequences reflected by high scores on the Hunger subscale was unsurprising.

8.2.4 Individual differences in fat preference

Highly sweet foods have a high density of calories, and as over consumption of high calorie dense food leads to weight gain and obesity it is unsurprisingly that preference for highly sweet tastes has elicited much interest. With the recent discovery of receptors on the tongue which react to free fatty acids, taste preference for fat has also received research interest, particularly in light of the rapid increase in obesity in countries where food which is highly calorie dense is cheap and highly palatable. Consequently fat studies A and B explored preference for the taste of and frequently of consumption of high dietary fats.

Fat study A produced UK normative data for the FPQ© (Ledikwe et al., 2007) and tested the reliability of this scale in a UK population. Male normative data was produced which is not available elsewhere, and proved useful in the examination of sex differences in preference for high fat foods. The scale was found to be reliable in a UK population and the subscales were found to be unidimensional. It is recommended that future research employing the FPQ© test the validity of the scale by examining actual dietary fat intake, this could be achieved using diary studies alongside the administration of the FPQ©. Relationships with the subscales of the TFEQ were also explored and similar relationships were revealed to those found by Ledikwe and colleagues (2007). Dietary restraint was found to be negatively correlated with taste preference for high fat foods and frequency of intake of high fat foods, suggesting that high scores of restraint were related with low preference for high fat tastes and low intake of high fat. Elfhag and Erlanson-Albertsson (2006) also found that fat preference was better explained by characteristics of eating behaviour, particularly dietary restraint, rather than personality traits directly.

Fat study B further explored the possibility that individual differences in temperament and characteristics of eating behaviour could predict preference for the taste and frequency of intake of high-calorie dense foods. Emerging evidence suggests that there is individual variability in the detection of fat (Mattes, 2005), therefore this study examined taste preference for high dietary fats. As well as examining the influence of temperament and characteristics of eating behaviour the study also explored BMI as a predictor of taste preference for, and intake of high dietary fat foods. This study confirmed previous research indicating that fat preference seems to be predicted by BMI and eating behaviour, particularly cognitive dietary restraint rather than personality. In their study Ledikwe and colleagues (2007) did not find relationships between BMI and preference of frequency of intake of high fat foods, this may be because their sample was obese. Fat study B found that BMI was negatively related to intake of high fat foods and positively related to restraint (specific to dietary fats). This suggests that as BMI increase, frequency of intake of high fat foods compared to low fat foods decreases, and as BMI scores increase so does restraint for dietary fats. This is not supported by the existing literature which shows that obese individuals report liking high-fat foods more so than lean individuals (Drewnowski et al., 1985; Mela &

Sacchetti, 1991). A weak relationship was found between scores of harm avoidance and preference for dietary fat in terms of taste and frequency of consumption, although this did not contribute a significant additive effect above that of dietary restraint.

Chapter 9

General Discussion

9.1 Overview

This final chapter provides a general discussion of the theoretical implications of the research programme, bringing together the findings of the study chapters. The overall aims of the thesis were to examine individual differences in taste preference using a biological model of temperament in a non-clinical population. Previously studies developed to examine taste and personality have been few in number, in light of this the thesis has taken an exploratory approach. It was expected that since temperament has been found to influence general eating behaviour, it may also be an important factor involved in the process of food selection, particularly taste which is considered to be a fundamental predictor of food selection. Limitations of the research and future directions are discussed towards the end of this chapter.

9.2 Theoretical Implications

9.2.1 Temperament and Taste

An illustrative representation of the consistent findings relating to taste observed across the studies is provided in figure 9.1. The diagram shows that 3 lower facets were found to consistently predict taste; tastes defined as innately liked (sweet, salty and umami) were the only tastes to be consistently predicted by temperament across the studies. Sweet and umami taste preference were linked to temperaments underpinned by the behavioural inhibition and maintenance systems, while salty preference was linked to low scores of NS underpinned by activity in the behavioural activation system. Preference for the taste of high fats was weakly predicted by low scores of HA2; although this relationship did not significantly add to the amount of variance explained.

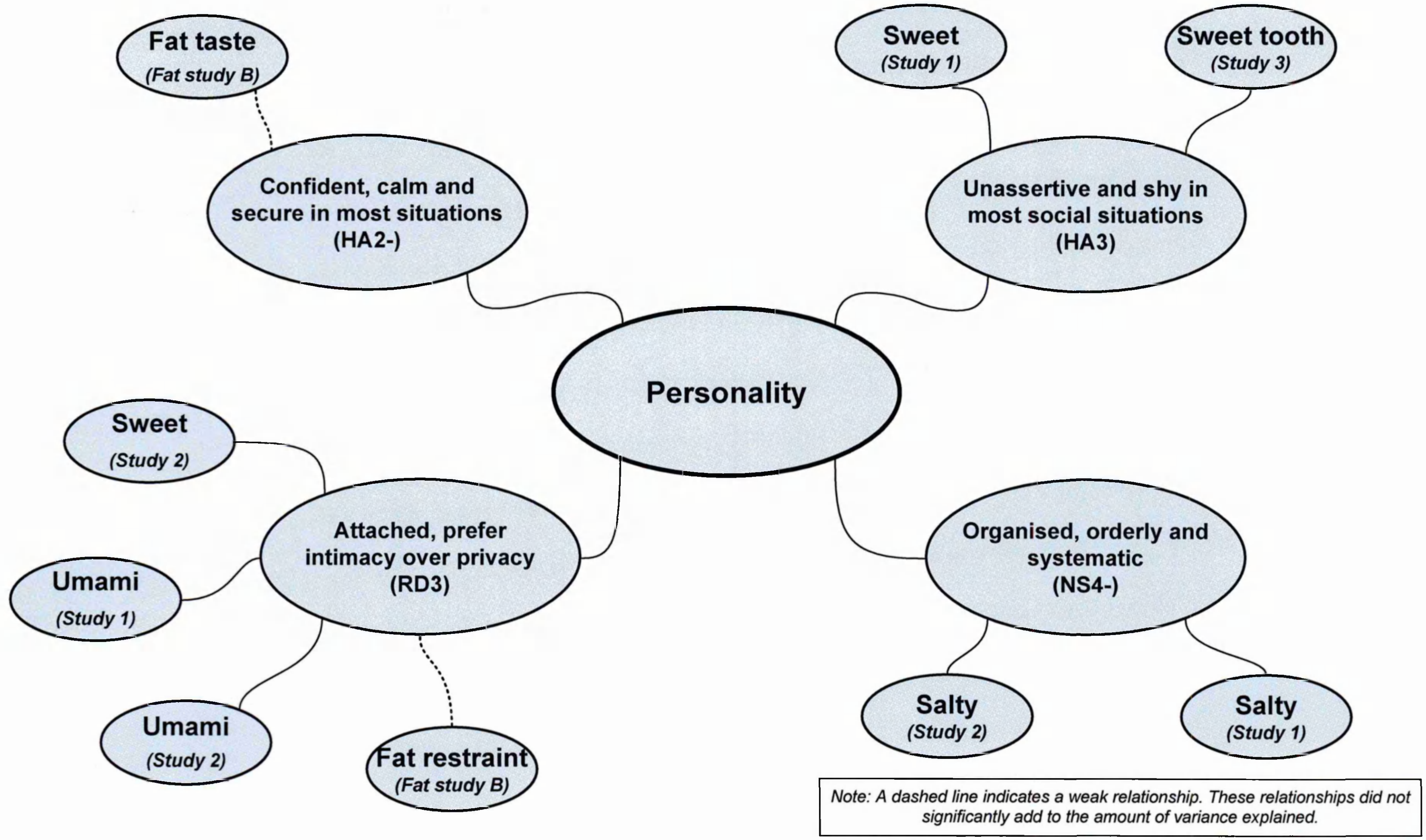

Figure 9.1: Illustrative representative showing consistent personality predictors of taste

9.2.1.1 Behavioural Activation System

Novelty seeking (NS) is a heritable tendency towards intense excitement, response to novel stimuli and cues for potential rewards. This leads to the exploratory pursuit of rewards and avoidance of punishment. Novelty seeking traits are thought to reflect variation in behavioural activation or incentive motivation. Dopamine is the principle neurotransmitter implicated in the stimulus-response in this system. Gray's (1973) Reward Sensitivity Theory (RST) describes a Behavioural Activation System (BAS) which serves to activate goal-directed behaviour. Individuals high in BAS tendencies are quick to seize opportunities; they are driven by rewards and motivated to seek out rewards. Traits such as novelty seeking and extraversion are explained in relation to such a behavioural activation system which is explained in terms of incentive motivation in which a neuro-anatomical network and neurotransmitters underpin the processing of this incentive motivation (Depue & Collins, 1999). Individual differences in the functioning of this network result from variation in the ventral tegmental area DA projections, which are involved in incentive motivation (Depue & Collins, 1999).

It was expected that preference for sweet tastes and tastes domains whereby liking is acquired (such as spicy, sour and bitter) would be predicted by scores of NS. However, this was not the case. In studies 1 and 2 preference for salty tastes were consistently predicted by low scores of NS4 describing individuals as organised, orderly and systemic. It was predicted that preference for innately liked tastes would be explained by less-out going traits, particularly high scores of RD and HA. Previous research examining relationships between personality and salt preference have focused on salt intake as opposed to hedonic liking, finding that high salt intake was predicted by extraversion and low salt intake was predicted by neuroticism (Shepherd et al., 1985; 1986a; 1986b). Salt intake was not measured across the studies reported in the thesis; therefore direct comparisons cannot be made, although salt intake and salt preference are likely to be related (Shepherd & Farleigh, 1986). Despite this much of salt intake is not in the control of the consumer due to the salt content in much processed foods, also salt requirements change due to dehydration needs which may well have an impact upon preference and taste acuity.

Although the findings in the thesis are not consistent with these previous findings related to salt intake and personality (Shepherd et al., 1985; 1986a; 1986b), they were similar across study 1 and 2 suggesting that low scores of Novelty seeking are associated with high salt liking. In this way salt preference can be attributed to variation in the brain's activation system; individuals expressing high salt preference exhibit goal-seeking behaviour which is underpinned by the transmission of DA (Depue & Collins, 1999).

9.2.1.2 Behavioural Inhibition System

Harm avoidance is described as the heritable tendency to respond intensively to signals of aversive stimuli (Cloninger, 1987; 1994). High scorers of HA learn to inhibit behaviour to avoid punishment and novelty, reflecting variation in the behavioural inhibition system in which serotonin (5-HT) is the principal neurotransmitter. Gray (1973) proposed that motivation and emotion maybe central to underlying trait dimensions. His construct of Behavioural Inhibition System (BIS) closely relates to HA; inhibited traits and intense responses to aversive stimuli are explained in terms of activation of the behavioural inhibition system. Moderately high scores of HA are characterised by inhibition and tension under normal circumstances, frequent worrying, easily tiring and needing extra rest, suffering from emotional stress and slow to recuperate after physical activity and minor illness (Cloninger, 1987). In the current research HA3 was found to predict liking for sweet tastes and for sweet tooth scores. Conceptually individuals who fear uncertainty are perhaps unable to inhibit or avoid their preference for highly sweet tastes. Previously individual differences in sweet liking have been related to out-going traits (Stone & Pangborn, 1990) and novelty seeking in alcoholics (Kampov-Polevoy and colleagues, 1997, 1998, 2004). Given that sweet taste liking has been shown to be innately liked and present from birth (Steiner 1974; Steiner 1977; Cowart 1981), it is unsurprising that sweet taste is universally liked. All studies reported here found high mean liking scores for sweet tastes. Hedonic response to sweet taste has been shown to be related to elevated sensitivity to the mood altering effects of sweet foods (Kampov-Polevoy, Alterman et al., 2005).

The consumption of carbohydrates (CHO) and calorie dense foods have shown to increase mood (Corisa & Spring, 2008). As 5-HT is implicated in mood and depression (Hirschfield, 2000), theoretically associations between high scores of HA associated and high sweet liking may be attributed to the stress and mood elevating consequences that follow self-administration of these foods high in CHO (Wurtman 1984, 1986). Individuals with high scores of HA show characteristics of avoidance and inhibition. This may explain why these individuals tend to prefer the innately liked sweet tastes, as opposed to tastes that are innately disliked such as bitter and sour; preference for these tastes are thought to be acquired through learning processes and exposure (Steiner et al., 2001), and so require some degree of behavioural activation or approach behaviour most likely underpinned by DA.

High scores of HA have been found in anorexic and bulimic patients (Kleifield et al., 1993, 1994; Brewerton et al., 1993; Bulik et al., 1998). These clinical subgroups, particularly bulimia nervosa patients and those inclined to engage in binge eating, have a higher hedonic response to the taste of more concentrated sucrose solutions than controls, and subsequently have high sweet liking scores (Franko et al., 1994; Greeno et al., 2000). In addition they display high sweet food preference during binges (Shaye, 1989). Consumption of foods high in CHO increase tryptophan transport and 5-HT turnover. In the studies presented here sweet preference was also associated with HA but in normal eaters. It may be speculated that preference for highly sweet tastes may reflect attempts to alleviate mood and stress with increased 5-HT activity. This may also suggest that individuals with high scores of HA are more susceptible to develop eating disorders and engage in binge eating (Waller et al., 1993), particularly in terms of highly sweet foods.

Preference for the taste of high fat foods was also significantly predicted by HA. As both sweet and fat tastes were significantly predicted by HA, this suggests that there is an association with the behavioural response to increased serotonin activity in the inhibition system with the taste of calorie-dense foods such as sugars and fats. This may be attributable to the theory of hedonic hunger discussed in more detail in section 9.2.5. Importantly, these findings strengthen the evidence for individual different factors in eating behaviour which may lead to over-consumption of palatable foods; if individual differences in taste preference exist, there are likely to be important individual differences in food choice and consumption.

9.2.1.3 Behavioural Maintenance System

Sweet liking was also found to be consistently predicted by scores of RD3, a lower facet of Reward Dependence. Reward-dependent traits are thought to reflect variation in the brain's maintenance system. This system is thought to be involved in the acquisition of conditioned signals of reward or relief from punishment (Cloninger, 1987). Noradrenalin (NA) in the major neurotransmitter underpinning this system, and is known to be involved in learning and memory of new paired associations. As CHO consumption increases serotonin and noradrenalin (Wurtman & Wurtman, 1995), it is likely that the pairing of sweet tastes with mood-uplifting response could lead to a conditioned reward signal in these individuals. Less out-going personality types, characterised by high scores of RD (and HA), tend to achieve high scores on the food neophobia measure, suggesting a lack of willingness to try and consequently, like novel and unusual foods, and flavours (Pliner & Melo 1997). Theoretically, this may suggest that less out-going personality traits such as those traits associated with RD, are more inclined to prefer innate tastes such as sweetness, compared to acquired tastes. Indeed the findings of the current research would suggest this; scores of RD consistently predicted high scores of liking for sweet and umami tastes. In addition these individuals were found to have high scores of fat restraint, suggesting that although they liked the taste of high fat foods they tended to avoid consuming foods high in fat.

Umami taste preference is also thought to be innately liked, neonates are found to respond with a gusto-facial reflex suggestive of an innate response to umami (Steiner, 1987; Bellisle, 1999). As individual differences in terms of personality and associations with taste preference for umami have not previously been investigated the examination of these variables was exploratory. However as adding glutamate to food has been shown to increase the perceived saltiness of the food (Prescott 2004) and due to the innate taste responses to umami, it was expected that a similar patterns of results would be observed as salty taste preference. Umami liking was found to be consistently predicted by RD3, a lower facet of Reward Dependence describing highly attached individuals. As outlined above, highly palatable foods tend to be over-consumed and eaten regardless of homeostatic hunger (hedonic hunger). Umami is associated with the flavour-enhancer MSG often added to foods to increase the palatability (Bellisle, 1999). Theoretically, individual differences in preference for umami tastes could also be attributed to the concept of hedonic hunger. Furthermore in light of the relationship between preference for these tastes and RD, individual differences in preference for umami may reflect variation in the behavioural maintenance system.

9.2.2 Wanting and Liking

In appetite and eating behaviour a current viewpoint explains over consumption in terms of non-homeostatic or reward mechanisms. This view has been supported by neurobiological findings and animal models implicating the mesolimbic dopamine system (Berridge, 1996). This approach explains eating behaviour in terms of two independent processes, motivational (wanting) and affective (liking).

The DA system is involved in reward anticipation (O'Doherty et al., 2002) and incentive motivation (Berridge, 1996). Robinson and colleagues (2005) found that DA was not necessary for liking or learning about rewards, rather it was necessary for wanting or seeking rewards during goal-directed behaviour. Finlayson et al (2007) argue that wanting and liking may have an explicit and implicit component in terms of levels of processing. They describe implicit wanting as a motivational expression of reward attribution, and explicit wanting as a conscious desire or subjective feelings of intent or desire. Implicit liking in terms of unconscious affect and explicit liking as subjective feelings of orosensory pleasure (Finlayson et al., 2007).

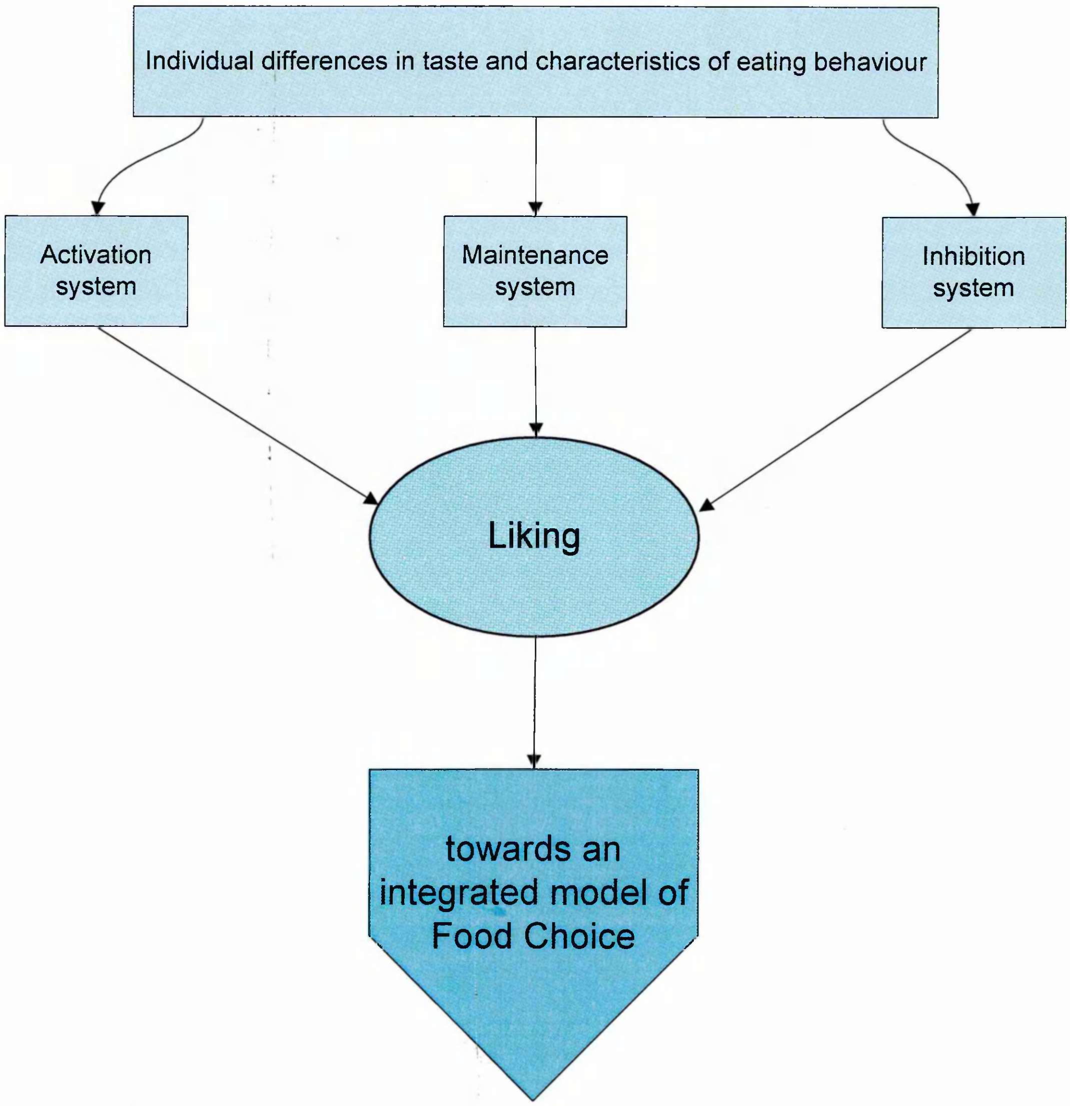

Figure 9.2: Schematic representation of the individual variability in the temperament systems and liking

In this way the current research programme has examined individual differences in explicit liking rather than explicit wanting, finding that individual differences in explicit liking for the tested taste domains can be explained by variation in the behavioural inhibition system (underpinned by 5-HT) and the behavioural maintenance system (underpinned by NA). This seems particularly apparent for the innately liked tastes sweet and umami, and to some extent high fats. Figure 9.2 shows a schematic representation of the likely systems involved in explicit liking based on the findings of this research. Of course the processes underlying the control of the expression of human eating habits in terms of implicit wanting and liking processes are more complex, and have previously been hampered by a lack of operationalised measures. Computer-based procedures designed to assess implicit and explicit wanting and liking in humans are in development (Finlayson et al., 2007; Finlayson, King & Blundell, 2008). Using VAS hedonic measures for photographic food stimuli and a forced-choice task Finlayson and colleagues have successfully shown that wanting and liking are separate psychological processes which can individually influence food preference (Finlayson et al., 2008). Future research investigating individual differences in explicit liking could adopt such a technique. As there is a paucity of research examining individual differences in implicit wanting and liking, Finlayson and colleagues computer-based procedure may also be useful for exploring these implicit psychological processes which are also thought to underpin food preferences.

9.2.3 Temperament and Characteristics of Eating Behaviour

As well as the exploration of taste preference and personality all studies presented here (with the exception of study 1 examining individual differences in self-reported usual taste preference) examined relationships between personality and characteristics of eating behaviour using the TFEQ (see table 9.1 for a summary of the consistent findings). Generally lower facets of Reward Dependence and Harm Avoidance were found to significantly predict all characteristics of eating behaviour, although some facets of Novelty Seeking were also included in some models but were negatively correlated. Previously restraint has been found to be influenced by neuroticism and conscientiousness, specifically cautious individuals with low self-esteem were found to have high levels of dietary restraint confirming some of the present findings (Heaven et al., 2001). A lack of assertiveness and embitterment has also been linked to dietary restraint (Elfhag, 2005), which does not concur with the present findings. Low self esteem is thought to be a prerequisite for the onset of eating disorders and it is suggested that low self-esteem increases sensitivity towards societal pressures of the "ideal" body (particularly in women), and consequently increased susceptibility to restrained eating (Silverstone 1992; Button et al., 1996).

Table 9.1: Consistent relationships between personality and characteristics of eating behaviour

Characteristics of eating behaviour	*Personality predictors (descriptions)*
Restraint	Resistant, no need for novel stimulation (NS1-).
	Pessimistic worries – anticipate harm and failure (HA1).
	Bold, forward, not shy with strangers (HA3-).
	Dependent on emotional support and approval from others (RD4).
	Extravagant with money and energy (NS3).
Disinhibition	Extravagant with money and energy (NS3).
	Bold, forward, not shy with strangers (HA3-).
	Sentimental, sympathetic, understanding (RD1).
	Less energy than others, easily tired (HA4).
	Dependent on emotional support and approval from others (RD4).
Hunger	Reflective, analytical and focused (NS2-).
	Pessimistic worries – anticipate harm and failure (HA1).
	Bold, forward, not shy with strangers (HA3-).
	Less energy than others, easily tired (HA4).
	Attached, prefer intimacy over privacy (RD3).

Note: (-) denote negative associations

Disinhibition was predicted by a combination of novelty seeking subscales, reward dependence and harm avoidance. Impulsivity has been linked to various aspects of abnormal eating, particularly bulimia (Penas-Lledo et al., 2002) and binge-eating disorder (Nasser, Gluck & Geiliebater, 2004). Recently the disinhibition scale has been linked to impulsivity, suggesting that a tendency to overeat is characteristic of impulsive personalities (Yeomans, Leitch & Mobini, 2008). The present findings suggest that bold, extravagant traits are linked with disinhibited eating, lending some support to the existing literature. Previously aspects of neuroticism, reward dependence and harm avoidance have also been found to be good predictors of disinhibition (van Strien et al., 1985; Gendall et al., 1998; Elfhag, 2005; van den Bree et al., 2006; Provencher et al., 2008). High harm avoidance is also found in bulimic patients who alternately binge and purge (Kleifield et al, 1993; Brewerton, Hand & Bishop, 1993; Waller et al., 1991; Waller, 1993).

The susceptibility to hunger scale appears to be the least researched and least discussed dimension of eating behaviour measured by the TFEQ, particularly in relation to personality predictors. This may be explained by high intercorrelations observed between hunger and disinhibition and also low internal consistency of this domain compared to the restraint and disinhibition subscales (Shearin et al., 1994). Previously, harm avoidance has been found to be a good predictor of susceptibility to hunger (Gendall et al., 1998; van den Bree et al., 2006), in line with the current findings. Other studies have also found less out-going and unassertive traits linked with high scores on the hunger subscale (Elfhag, 2005; Provencher et al., 2008).

Both perceived hunger and disinhibition were predicted by high scores of Fatigability (HA4), suggesting that individuals, who are susceptible to feelings of hunger (non-homeostatic) and tend to eat beyond satiety, are easily fatigued and are characteristically low in energy. Homeostatic hunger may result in low energy and fatigability at a physiological level. However, this research suggests that cognitive susceptibility to feelings of hunger and a drive to eat beyond calorie-need are related to individual differences in fatigability at the trait level. There has been a tendency for study of the physiological controls of feeding and the cognitive processes involved in eating behaviour to be polarised; an integrated approach is required to fully understand how cognitive processes and physiological controls of eating work together to influence intake (Higgs, 2005). The findings from the current research should be investigated further by examining individual variation in the cognitive and the physiological processes involved in hunger and over-eating, and the extent to which these may be influenced by personality traits.

9.2.4 Fat Preference

Previous research examining relationships between personality and fat preference are sparse; only two studies were found whilst reviewing the literature (Davis et al., 2006; Elfhag & Erlanson-Albertsson, 2006). The examination of individual differences in dietary fat study (fat study B) sought to examine personality predictors of preference for high fat foods, as well as characteristics of eating behaviour and BMI. It was found that personality predictors did not significantly add to the variance explained in fat preference, rather preference for high fat foods (taste preference and frequency of consumption) were found to relate to low scores of dietary restraint and BMI. Elfhag and Erlanson-Albertsson (2006) also concluded that fat preference was a product of dietary restraint; further finding no clear relationships between personality and fat preference.

These findings suggest that the cognitive processing of dietary restrictive eating behaviour override individual personality traits as predictors of fat preference. Instead low preference for high fats could represent a decline in taste preference after cognitive appraisal of the calorie-dense properties, rather than a decline in actual taste preference for fats. Previous conclusions also suggest that restrained eaters characteristically avoid or reduce their consumption of high fat foods compared to unrestrained eaters (Tushl, 1990; Alexander & Tepper, 1995). Typically, women with high scores of cognitive dietary restraint choose foods lower in fat and energy than those with low dietary restraint (Rideout et al., 2004). Due to the societal discourse surrounding high fat foods being "bad" and individual attempts to suppress and maintain desired body weight, individuals with high scores of restraint may cognitively suppress their liking for fats in order to avoid weight gain. Cognitive factors have previously shown to have a significant impact on consumption in restrained eaters; given information about the energy content of food significantly effects the amount of food eaten compared to unrestrained individuals (Chapelot, Pasquet, Apfelbaum, & Fricker, 1995). Laboratory studies that examine intake of dietary fat in restrained eaters found that foods labelled high-fat are consumed and chosen less often than foods labelled low-fat (Tuorila et al., 2001).

In this way because participants in our study were asked to select which food from a high or low fat option tasted better and which they consumed more often, lends support to the involvement of cognitive factors in restrained eaters food choice; given information about a food influences the food chosen in this group. The development of a series of experiments that examine individual differences in food choice and the impact of food labelling on food choice, whilst controlling for explicit cognitive factors could be achieved using an Implicit Association Test (Greenwald et al., 1998), or a similar procedure to that developed by Finlayson et al (2007, 2008). Implicit Association Tests are useful in this respect because they measure implicit attitudes via an automatic evaluation of stimuli without the participants' awareness (Greenwald et al., 1998), by-passing explicit attitudes and cognitions.

9.2.5 Hedonic Hunger and Liking

The orosensory qualities of foods are strong motivators in eating behaviour (Lowe & Butryn, 2007). The reward value of highly palatable foods can override internal signals of satiety influencing hedonic hunger, whereby palatable foods are consumed in spite of homeostatic hunger but due to the orosensory reward value. This may explain why calorie-dense foods typically with high fat and sugar content are over-consumed, particularly in developed countries where these are widely available and fairly inexpensive. Theoretically, it is evolutionarily adaptive to consume calorie-dense foods when they are available. Historically energy-dense foods were in short supply and so these foods would have been consumed when available in order to increase energy stores. In modern developed societies, these foods are readily-available and cheap; the over-consumption of energy-dense foods to maintain and build up energy levels is not necessary unless the energy stores are reduced through expenditure such as exercise. Mela (2006) suggests that it is the combination of motivation to consume energy-dense foods and the orosensory qualities of foods that are the likely causes of over-consumption and hedonic liking. Pleasure derived from the hedonic qualities, particularly taste, are implicated in raising levels of obesity (Yeomans, 2008). Although it is unclear whether obesity and fat taste sensitivity are related (Synder & Bartoshuk, 2008); this certainly warrants further study.

In order to further understand the causes of obesity a logical progression would include the examination of the factors that influence hedonic hunger and subsequent food choice. Hetherington and Rolls (2008) confirm that the difficulty and challenge for future research is to successfully demonstrate how energy-dense foods influence obesity. They suggest that new approaches are required that include studying energy-dense food intake in naturalistic settings increasing the ecological validity. This is particular important given the environmental factors that also influence over-consumption.

The current research has indicated that individual difference factors play an important role in this process in terms of taste. The findings suggest that preference for the taste of highly palatable and calorie-dense foods can be explained, in part, by individual differences in temperament, particularly traits associated with activity in the brain's inhibition and maintenance systems. Cognitive processing is also implicated in eating behaviour; dietary restraint was found to be related to the low preference for dietary fats. Future research may seek to examine these factors further taking volume of consumption of highly palatable foods into account, as well as other orosensory factors that influence flavour; hedonic evaluations of food rely on a complex interplay between many sensory components not just taste (Prescott, 1999).

9.2.6 Models of Food Choice

The existing literature surrounding eating and the previous attempts to model the process of food choice clearly demonstrate the complexity of this behaviour (Shepherd & Sparks, 1994). Existing models of food choice outline three key aspects in this process; the food, the person and the environment. Many of the models fail to include individual difference factors in terms of personality and temperament. The current research has demonstrated that individual differences in temperament are important predictors of the cognitive processes of eating behaviour and liking, particularly in terms of highly palatable foods (sweet, umami, and fat tastes). Up to 17% of the variance in cognitive characteristics of eating behaviour and up to 20% of the variance in taste preference examined experimentally could be attributed to individual differences in temperament. In some cases the amount of variance was much smaller, although in light of the number of other mediating influences in this process such as lifestyle, background, culture and religion, along with practical research design issues, these findings contribute a significant addition to understanding the process of food choice. Other studies have also found small amounts of variance in eating behaviour explained by temperament and personality, arguing that complex behaviours such as eating tend to be influenced by a variety of factors each explaining small proportions of the variation (van den Bree et al., 2006; Yeo et al., 1997; Elfhag & Morey, 2007).

Earlier in this chapter the associations between taste and temperament, and characteristics of eating behaviour and temperament, were explained in relation to the brain's reward, inhibition, and maintenance systems. It is important to recognise that these relationships form part of a larger food choice process which include a diversity of determinants (see section 1.2.1), many of which, have been studied in depth elsewhere. Despite this, taste remains a primary reinforcer in this process and previous attempts to link individual differences in taste have not been forthcoming. The findings from this research programme suggest that individual differences factors are important in this process and should feature in models of food choice. Traditionally a large diversity of disciplines such as biology, physiology and the sensory sciences, have sought to uncover answers relating to food choice. These disciplines have yielded many findings, but have tended to study isolated factors in this process. As observed in this research and elsewhere, often associations between variables influencing diet and eating behaviour are small (van den Bree et al., 2006), but nevertheless, important. Köster (2003, 2009) suggests that full understandings of the complexity of the food choice process are hampered by "isolated mono-disciplinary" (Köster, 2009, pp.71) and recommends that a multi-disciplinary approach is adopted in future research which specifically require insights from a psychological perspective. Such links could lead to a fully integrated model of food choice with data relating to the many interacting factors involved in this process. This research programme has started to do this by taking an individual differences approach from a psychobiological perspective, in order to examine taste preference and cognitive eating behaviour that are thought to influence food choice.

9.3 Limitations and Problems

9.3.1 Sex Differences

The research programme set out to examine relationships between taste preference, characteristics of eating behaviour and temperament in normal eaters, therefore it was important that both males and females be represented in the study samples. The intention was to develop a generalised explanation for the individual differences in these behaviours in a non-clinical population. In spite of this, sex differences relating to these variables were noted in all studies. Due to a lack of statistical power it was not possible to examine these differences in detail. Observations made from the existing literature indicate that the majority of studies investigating eating behaviour tend to employ solely female sample. It is recommended that future research examining individual differences in normal eating behaviour take these sex differences into account and ensure that male participants are more fairly represented. This is problematic as females are known to more readily engage in research, particularly psychological research, than males (Cooper, Baumgardner & Strathman, 1991). Despite this, it is essential that these sex differences are further explored if progress in understanding the food choice process in normal eaters is to be achieved.

9.3.2 Measures of Taste

Study 1 relied on self-reported measures of taste preference for the six taste domains (sweet, salty, sour, bitter, umami and spicy). An existing method of testing this many taste domains across a single food sample could not be found elsewhere. This method warrants development; testing taste preference across a number of foods over a number of days is the ideal method, although this may suffer logistical difficulties (i.e. time-consuming, and costly). Measures of self-report food intake are thought to be less reliable than measured intakes due to underreporting (Mertz et al., 1991; Hill & Prentice, 1995). Subjective measures of liking have been criticised for creating biased estimations of optimal palatability particularly when related to subsequent intake (Finlayson et al., 2007), but this may not mean that measures of taste liking will be equally unreliable. Snoek and colleagues (2004) defend their use of brief exposure taste tests by defining them as measures of "reflective, conscious, rationalised liking" (pp.830). The comparison of the self-reported taste measures and the measure of liking for the taste samples in study 2 did suggest that self-reported taste reflected 'real' taste preference for the test foods, although the strength of the relationships between these measures were moderate. Adopting Snoek and colleagues definition of liking in relation to measures of brief exposure tests may be appropriate for the studies reported here. However, it is clear that the effectiveness of self-reported taste measures requires further investigation; testing preference for a range of foods with varied concentrations and variety of taste intensities could be compared with self-report measures.

The method chapter outlined the difficulties researchers face when conducting studies involving sensory evaluation. Using raw substances to evaluate taste has proved problematic, often resulting in decreased palatability (Beauchamp & Pearson 1991), study 2 developed real-food taste samples that represented 6 taste dimensions that were palatable and similar in texture and appearance. A study seeking to examine liking ratings of these 6 taste domains and temperament could not be found elsewhere and so the development of the taste samples proved challenging. It was important that the taste samples represented 'real' food in order to increase the ecological validity of the study, an opposed to using pure tastants which may not have reflected 'real' consumption and preference. Pasta and sauce was chosen as this has proved to be a effective vehicle for manipulating palatability previously (Yeomans, 1997). After the pilot study these food-samples they were deemed to be palatable and the taste dimensions were distinct but not over-powering.

The measures of taste were assessed across the studies using visual analogue hedonic scales. For some of the taste measures, particularly the acquired tastes which are not universally liked such as bitter, using a graphic ideal-to-relative scale may improve the measurement of preference for these tastes. Very low liking scores were observed for the bitter food sample used in study 2. This might suggest that these low scoring taste samples were unpalatable or it could reflect universal dislike of the taste. It was also suspected that negative expectancy effects may have influenced the ratings of this sample; pasta is not expected to taste bitter, and foods that are not normally bitter may be perceived as “bad” or off. This raises questions for the use of a single food to test taste preference across a range of taste dimensions. Using multiple foods manipulated by a range of intensities of each taste dimension may overcome these problems in future.

The introduction of graphic ideal-to-relative scales rather than liking scales could further improve the acceptability of the taste samples, particularly in the development of the taste samples through the pilot studies. Shepherd and Farleigh (1986) used these to develop individual ideal salt concentrations for a tomato soup and found this method produced accurate representations of individual taste preference for salt. However, this type of method can only be realistically applied to small sample sizes as it involves the sensory evaluation of a number of concentrations on a number of occasions (over 7 days in Shepherd and Farleigh’s study).

Although self-report measures are often criticised, there are advantages in utilising these measures in research of this nature. Food preference questionnaires are useful in that they can measure a larger variety of food preferences than sensory tests allow. In this sense, future studies examining individual difference variables in taste and food preference may consider such measures as they provide a wider insight into preferences in general. However, taste preferences do not necessarily predict general food preferences and vice versa (Drewnowski, 1997). For example, preferences for sweet or salty taste samples do not necessarily predict preference for sweet or salty foods (Connor et al., 1988). Although there are mixed findings within the literature; elsewhere self-reported preferences were found to predict sensory evaluation of similar foods, although sensory evaluation did tend to be lower than self-reported scores (Weaver & Britten, 2001). As study 3 (sweet and sour drink solutions) showed pairing tastes can make unpalatable food more palatable, suggesting that the interaction of tastes has a significant impact upon overall liking.

A further problem with sensory testing and self-rated measures of food preferences do not always accurately predict real-life food consumption and food purchase (Meiselman, Waterman & Symington, 1974). This is a real problem within the eating behaviour and appetite research environment, yet alternative methods which aim to accurately assess food and taste preferences are not forthcoming. In order to increase the ecological validity of measures of food preferences and intake the development of effective measures in fundamental. Methods such as diary studies are thought to provide accurate measures of intake but are not without their limitations; a high level of social desirable responding and inaccurate responding are suspected with this method, and this method may not be fully representative of the individuals' food selection habits (Reed, Bachmanov, Beauchamp, Tordoff & Price, 1997). Köster (2009) argues that as a discipline Psychology has a lot to offer in terms of the development of new appropriate measures which achieve further understanding of this complex behaviour. He posits that the development of a more real-life approach is warranted, employing methods which study real eating behaviour in real settings.

9.3.2.1 Language

Examining individual differences in taste preference for the 6 taste domains explored in study 1 and 2 indicate that the language used in these studies may have influenced subsequent rating scores. This was particularly noted in relation to the umami taste dimension. As the word umami may be unfamiliar to the lay

person the term "artificially enhanced" was employed to assess reflective umami liking. Mean scores for self-rated “artificially-enhanced” liking were low compared to the taste sample measure used in study 2 to represent umami. This suggests that the descriptor used may have influenced the ratings for usual taste preference for this taste dimension. Societal discourse surrounding food has a strong impact upon individual cognitions surrounding the perceived healthiness and acceptability of foods. Wiggins (2004) posits that language surrounding food can be distinguished between 2 different components; affective and cognitive. The affective component relates to the sensory, feelings and emotions experienced in response to food (e.g. ‘tastes great’), and the cognitive component relates to attitudes and beliefs about the food (e.g. ‘good for you’). These concepts are effectively applied to food marketing and advertising (Cantin & Dube, 1999; Dube & Cantin, 2000). In this way rating “artificially-enhanced” taste liking may evoke cognitions of non-healthy and unnatural resulting in low ratings. The ratings for the umami taste sample, however, were much higher, suggesting that participants liked this taste domain more after tasting than indicated via their subjective ratings
Language may also have influenced ratings of sweet taste preference. Study 1 and 2 asked participants to rate their liking of sweet tastes. Study 3 (using sweet and sour drink solutions) additionally asked participants to self-rate “sweet tooth”. The amount of variance explained by sweet tooth increased (compared to usual sweet liking) suggesting that idea of having a sweet tooth may hold more meaning to participants. The appropriateness of the descriptors of taste dimensions warrants further investigation in order to develop effective measures of taste, particularly self-reported taste preference.

9.3.3 Measures of Fat

As discussed in chapter 2, measuring preference for fat is also problematic. Selecting an appropriate food to use in studies using sensory evaluation to investigate preference and liking for dietary fats has proven challenging due to the complex role fat plays in the diet and across different foods. This led to the development of the FPQ© (Ledikwe et al., 2007) which aimed to measure taste preference and frequency of consumption of dietary fat across a number of foods, and was used in fat study A and B for this reason. Previously this instrument has not been used in a UK population and some changes were made to make the FPQ© to reflect food sets representative of UK diets. Using a self-rated measure to investigate fat preference proved useful as it meant that a range of food could be considered, giving a more accurate representation of preference for dietary fat in general rather than specifically in terms of one food with varied fat contents. Despite this the FPQ is not without limitations. There are some problems with the scoring instructions of the FPQ as outlined by Ledikwe and colleagues (2007). This was apparent when respondents indicated that they had not eaten one of the foods within a food set but had eaten the other, for example, if respondents indicated that they had eaten full-fat ice cream and subsequently indicated that this tasted better then low-fat but they indicated they had not eaten low-fat ice cream, this was counted in the totalling of the TASTE scoring. This may have resulted in some inaccuracies in the preference scores. Some aspects of the scoring of this measure need to be reviewed.

Furthermore since actual intake of dietary fat was not measured in fat study A and B, comparisons and further validity cannot be ascertained in terms of actual consumption of dietary fat. Future studies should aim to measure intake of dietary fat via diary records or through controlled laboratory studies, or ideally both. The authors of the FPQ further recommend that future studies should examine comparisons with the FPQ measures and laboratory methods of assessing preference for dietary fat (Ledikwe et al., 2007), although this may be challenging due to the original difficulties outlined with the assessment of dietary fat using food stimuli. Further investigation of the validity and reliability of the measure is also warranted in male populations, to assess the generalisability of the measure across the sexes.

9.3.4 Eating Behaviour

The TFEQ (Stunkard & Messick, 1985) was chosen because of the reliability and validity of the measure and also due to the previous results implicating relationships between the subscales and temperament (see section 2.3.1, Chapter

2). Certain items from the scale were viewed as problematic in terms of their age-appropriateness. In particular, item 25 (from the Disinhibition subscale) ask participants to decide if their weight has fluctuated in the last 10 years. For younger participants, particularly first year students enrolled on a course straight after leaving school, responses to this item do not take into account puberty and physical growth which would have taken place in those last 10 years. As the majority of the samples included undergraduate students, a large proportion aged between 18-21 years, this item was excluded from the analysis as it was not felt to reflect a true representation of Disinhibition in these participants. A number of studies using the TFEQ with student populations do not mention whether this item was removed. Future studies employing student samples should take this into account. The reliability of this measure in males also warrants further investigation; the constructs of restraint and disinhibition do not appear to reflect cognitive eating behaviours in normal male eaters.

9.3.5 Measures of Temperament

A biological model of temperament was employed throughout the research programme due to previous observations linking eating behaviour, particularly disordered eating behaviour, and temperament. Clinical subgroups are found to have high scores of Harm Avoidance (Brewerton et al., 1993; Bulik et al., 2000; Kleifield et al., 1994). Although Cloninger's model (1987) has been widely applied to clinical subgroups it has not been widely used in normal populations, nor used to examine relationships with taste preference. In light of the sparse literature examining eating behaviour and taste preference in populations of normal eaters, direct comparisons with the current findings could not always be achieved. Instead comparisons with other studies have been made, these frequently employ the Big 5 and Eysenck's model which include measures of character as well as temperament. Although intercorrelations between these different measures suggest some underlying similarities, these relationships have only been explored at the major dimension level and not at the lower facet level (Zuckerman et al., 1991; Zuckerman & Cloninger, 1996). Recently the International Personality Item Pool (IPIP: Goldberg et al., 2006) has been developed which draws on a number of well-known models of personality and has been rigorously tested on large samples across many countries, and has excellent validity and reliability. As this is now available in the public domain it is becoming more widely used; future studies examining individual differences will benefit from the resource.

Further investigation of the validity and reliability of Cloninger's measure of temperament in a UK population is warranted, as there are obvious cultural differences between the UK and US (Otter et al., 1995; Stewart et al., 2004). Perhaps the development of a UK version of the measure would be more appropriate, this has occurred in many other countries to great success (for example, Finland, Denmark, France, Spain, see Miettunen et al., 2004 and 2008).

Generally it has been observed that relationships between personality and other behaviours are weak to moderate in strength (Nisbett & Ross, 1980). Mischel (1968) termed this the personality coefficient. Personality traits are reported to be reliable and consistent predictors of health behaviour but again the observed relationships are often reported to be moderate in strength (Booth-Kewley & Vickers, 1994). The few studies that have explored associations between diet and personality, and eating behaviour and personality have also found weak correlations. For example, Yeo and colleagues (1997) found relationships between personality and the consumption of salt, fat and fibre ranging from 0.10 to 0.18, and similarly Elfhag and Morey (2007) found relationships between personality and eating behaviour ranging from 0.07 to 0.48. The studies reported in the thesis are of no exception; relationships between taste and personality, and between eating behaviour and personality resulted in weak correlations. Taking this into consideration this raises questions in terms of the validity and the use of generalised models used to examine individual differences when reports of weak trends can be made in a general sense and little can be said in terms of individual behaviour. However, these weak associations could be due to the variety of other factors involved in this complex process.

9.3.6 Body Mass Index (BMI)

The use of BMI as a measure of obesity and weight is often criticised for not taking body composition and body shape into account. It has been found to be a poor predictor of body fatness in students (Arroyo et al., 2004) and the universal categories of BMI are designed to suit the UK and the US, but are not necessarily appropriate for all ethnic groups (Deurenberg, 2001). Despite this it is still widely used and alternative measures such as the use of body impedance scales are not widely reported in the eating behaviour and appetite literature at present. It is important to consider the use of more accurate measures of weight and obesity such as an assessment based on body fat percentage and BMI which takes age and sex into account (Deurenberg, 2001), or the use of body impedance scales, which are recommended for future research.

9.3.7 Sample Selection

The main objective of the research programme was to explore individual differences in taste preference in normal eaters. Other studies in the field investigating individual differences in eating behaviour have restricted their samples to clinical populations (i.e. obese populations), women and students; samples which are not necessarily representative of "normal eaters". As the research programme was interested in "normal" eating it was important that males were represented within the samples and also, that the sample selection drew upon wide populations representative of a variety of socioeconomic backgrounds and age. As the intention was that the samples selected for the studies within the thesis would be drawn for a wide population, parents from a local school, office workers, local professionals and students were invited to participate in the studies (with their prior permission). Although this selection process did result in a mix of individuals in terms of age and occupation, the uptake of participation was poor resulting in undergraduates forming the majority of the samples and so wide representation of normal eaters can not be ensured.

9.3.8 Analysis

Since previous attempts to examine individual differences specific to temperament are few in number, the research programme has been exploratory in nature. This has resulted in specific challenges in relation to statistical analysis. A number of avenues have been visited but problems have been encountered in most cases. For example, canonical correlational analysis was considered but due to the way in which this procedure combines variables this was not thought to be appropriate because the taste domains in the earlier studies represented unique constructs. It was intended that Structural Equation Modelling (SEM) could be applied to the data in study 4b, but due to weak correlations between variables and the number of correlations the predicted model did not converge. This may relate to the problem outlined in section 9.3.5 relating to weak correlations often observed between personality and health behaviours. It is recommended that future research of this nature should examine fewer variables and adopt a modelling approach, if possible, to maximise statistical power, encompassing the exploration of fewer measures of taste and personality variables.

9.4 Future Directions

Variation in behavioural inhibition was found to predict high scores of sweet and umami taste preference, and that preference for salt could be explained by variation in the behavioural reward system. These findings need to be further explored using studies which examine eating in the context of the everyday eating environment; this would strengthen the ecological validity of these findings. The research programme also found that interactions between sweet and sour increase the palatability of a test drink. In real eating environments taste domains do not occur in isolation, rather they interact to influence flavour. Future research investigating taste should seek to develop taste samples which reflect interactions between tastes and consider how certain tastes can mask unpalatable tastes effecting ratings of liking, as study 3 has shown. Future studies beyond the thesis will seek the assistance of the food companies to develop improved taste samples. In light of the difficulties relating to the taste samples used in the present research subsequent studies will use novel foods which accurately reflect the taste domains under investigation, with the primary purpose of strengthening the current findings with more rigorous methods. The impact of other orosensory factors involved in sensory perception should also be considered, as hedonic evaluations of food rely on a complex interplay between smell, mouth-feel and appearance as well as taste. Brief exposure taste measurement may not accurately reflect true taste preference, therefore measurement of taste liking needs to be developed to consider taste preference across a range of foods and time points that reflect real experiences of eating.

Future examination of the impact of individual difference factors in wanting and liking certainly require research attention, as previous studies examining individual difference factors in these processes are few in number. Adopting a computer-based procedure such as the Implicit Association Test (Greenwald et al., 1998) or the procedure outlined by Finlayson et al (2007; 2008) alongside real-food testing may achieve this. These methods have shown that implicit automatic evaluations can be tested effectively (Greenwald et al., 1998), and that wanting and liking are separate processes which independently contribute to food preferences (Finlayson et al., 2007, 2008). A proposed future study that could strengthen the current findings will seek to investigate individual differences in explicit liking for highly palatable foods using images rather than words. This will explore the cognitive processes and individual difference factors involved in the food choice.

In terms of fat preference cognitive factors were found to explain variance in fat preference above personality traits. Yet personality and characteristics of eating behaviour (measured by the TFEQ) are also related suggesting that personality variables are involved in this process to some extent. Future research should certainly examine these relationships further, and employing a modelling approach may illustrate that the relationship between fat preference and personality may be indirectly related or mediated by co-factors. Additionally, research examining fat preference using the FPQ© in a UK population should validate this measure more thoroughly by examining fat consumption as well as self-reported fat preference.

In order to fully develop understandings of the process of food choice an integrated approach is required. Köster (2003, 2009) indicates that traditionally the examination of the factors influencing food choice have been studied in isolation. Due to the complexity of this process the examination of all the factors involved is the ideal approach, though perhaps unrealistic. Instead a multi-disciplinary approach is warranted which seeks to build upon models of food choice to provide a fuller picture of this complex process.

9.5 Applications

The consistent findings from this thesis demonstrate that individual variation in the behavioural maintenance system and the behavioural inhibition systems have a significant impact upon explicit liking specific to taste preference for highly palatable tastes. The findings of the thesis therefore, have implications for behaviour change and health messages and the development of diet interventions should be tailored to reflect these individual differences. The thesis further demonstrates that individuals respond differently towards food in terms of both the cognitive processes, and so are likely to respond differently to health messages surrounding diet which further suggests that health messages and behaviour change related to food choice should be developed to reflect these individual differences. Tailoring treatment towards individuals may improve the successful outcome of such programmes. For example those high in harm avoidance are more likely to respond positively to messages that express the risks of overeating of fats and sugars as these individuals tend to inhibit their behaviour to avoid harm or punishment, therefore highlighting the risks involved in overconsumption is more likely to have an effect on their behaviour than offering incentives. These types also require more reassurance and encouragement than most people, which should be taken into account when developing treatment plans. Whereas individuals high in novelty seeking are likely to respond positively to reward and are quick to engage in whatever is new or unfamiliar, therefore taking a different approach with these individuals is more likely to show success in diet interventions if they are novel and offer rewards. The applications of the thesis warrant further exploration after replication of the findings.

9.6 Concluding Comments

This research programme set out to examine relationships between individual difference predictors and a range of taste dimensions. As taste is a primary reinforcer in food liking it has a significant impact on food choice. Overall, important relationships were found which linked taste preference and temperament. The studies presented also add to, and strengthen the existing literature linking characteristics of eating behaviour, particularly measures of restraint and disinhibition, with temperament. Preference and consumption of dietary fats are suggested to be a product of cognitive eating behaviour, particularly restraint, rather than personality. Large amounts of variance in taste preference were not expected to be explained by personality; however the studies presented here do imply that temperamental personality variables are involved in this process, and should feature in models of food choice.

The contribution of this research to the study of human eating behaviour has demonstrated that individual difference factors play an important and understudied role in taste liking and subsequent food choice in normal eaters (non-clinical). This has implications for behaviour change and health messages which could be tailored to reflect these individual differences. The consistent findings from this thesis demonstrate that individual variation in the behavioural maintenance system (underpinned by NA) and the behavioural inhibition system (underpinned by 5-HT) have a significant impact upon explicit liking specific to taste preference for highly palatable tastes such as sugars, umami tastes and to some extent dietary fats. In this way these findings contribute new knowledge to the eating behaviour literature; previous examinations of individual differences in taste have concentrated on clinical populations or focused on reward mechanisms and traits underpinned by dopamine activity.

The thesis further demonstrates that individuals respond differently towards food in terms of both the cognitive processes and individual variation in inhibition and incentive motivation, and so are likely to respond differently to health messages surrounding diet. Future research should consider individual difference factors as fundamental contributors to human eating behaviour, and not treat these as nuisance variables as they so often are (Stevens, 1996).

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List of Appendices

Appendix 1 – Pilot Data for the Fat Study using taste samples

Sample A - Total Greek Strained Yogurt (full fat)

F27	M33	F38	M36	M45	F58	F29	F31	F23	
79	62	77	58	40	84	94	38	59	Creaminess
69	50	67	38	17	50	62	67	54	Pleasantness
76	76	92	76	27	89	95	72	57	Smoothness
89	74	84	75	62	84	95	68	92	Thickness
30	65	40	6	9	37	7	35	29	Sweetness
67	60	60	6	18	33	8	42	8	Bitterness
57	61	58	72	83	67	70	26	83	Sourness
5	11	14	6	17	69	2	22	22	Saltiness
59	17	73	78	39	80	83	35	61	Fattiness

Sample B - Tesco brand Healthy Living Crème Fraiche (low fat)

F27	M33	F38	M36	M45	F58	F29	F31	F23	
52	59	64	52	54	46	69	76	67	Creaminess
21	42	37	5	23	50	94	21	66	Pleasantness
87	57	83	55	65	52	95	70	87	Smoothness
64	48	36	54	69	45	47	17	69	Thickness
18	28	31	7	20	32	24	12	77	Sweetness
63	78	64	7	24	37	9	83	9	Bitterness
73	82	67	82	62	48	11	73	8	Sourness
5	55	63	6	17	47	0	59	12	Saltiness
40	24	50	50	37	23	65	69	78	Fattiness

Sample C - Total 0% Yoghurt (Low fat)

F27	M33	F38	M36	M45	F58	F29	F31	F23	
46	40	52	64	52	35	60	67	33	Creaminess
34	38	70	46	38	32	56	75	48	Pleasantness
72	45	76	47	32	56	53	60	48	Smoothness
74	63	40	58	70	55	57	73	29	Thickness
40	10	30	6	25	41	11	40	31	Sweetness
60	72	27	48	30	48	3	10	29	Bitterness
65	76	53	62	68	80	53	10	46	Sourness
5	64	50	7	10	36	0	3	35	Saltiness
45	72	12	69	36	31	56	19	44	Fattiness

Sample D - Tesco brand Crème Fraiche (full fat)

F27	M33	F38	M36	M45	F58	F29	F31	F23	
87	35	82	80	68	50	80	74	76	Creaminess
55	37	59	7	60	27	5	14	20	Pleasantness
85	65	79	70	64	61	83	79	63	Smoothness
87	58	50	52	60	47	85	79	90	Thickness
37	30	25	6	27	36	3	45	76	Sweetness
16	80	50	47	17	35	1	31	2	Bitterness
18	72	44	65	29	40	46	82	17	Sourness
16	47	61	9	16	24	1	29	27	Saltiness
83	19	63	70	33	32	50	84	76	Fattiness

Appendix 2 - Background measures for study 1

Sheffield Hallam University

Instructions

This study is related to taste preference and individual differences.

Please complete the following questionnaire in the order presented. Please answer the questions as honestly as possible. All responses will remain confidential. Please complete the personal code box at the top of the page (for example you could use the first 2 initials of your mother's maiden name followed by your house number). This code will be unique to you; you will not be identifiable in the data set.

Please take care to complete all pages.

If you would like further information about this study please feel free to contact Catherine Day (Psychology Section, Sheffield Hallam University). Email: [redacted] or by phone on [redacted].

About You

1. Please state your age .... years

2. Sex Female ☐ Male ☐

3. Do you smoke? Yes ☐ No ☐

4. Please state your occupation: ....

5. How much alcohol do you drink per week?
   ....glasses of wine
   ....half pints beer/lager/cider
   ....pub measures of spirits
   ....Alco pops

About Your Health and Diet

6. Are you in good health at the present time? Yes ☐ No ☐

7. Are you at present attending a doctor or hospital for any reason?
   Yes ☐ No ☐

If yes, please specify ....

8. Are you currently on medication? Yes ☐ No ☐
   If yes, please specify

....

9. Are you now or have you in the past taken any medication to control or stabilise a condition (e.g. insulin for diabetes or ventolin for asthma)?

Yes ☐ No ☐

If yes, please specify ....

10. In the last 12 months have you undergone any operation or hospital treatment, or had a serious accident?

Yes ☐ No ☐

If yes, please specify ....

11. Do you suffer any long-term limiting illness or any other health conditions?

Yes ☐ No ☐

If yes, please specify ....

12. How often do you exercise per week? NB. One session of exercise is equivalent to 20 minutes brisk walking; this may include walking as part of your daily routine.

Regularly (2 or more times a week) ☐ Once a week ☐ Twice a month ☐ Occasionally (Less than twice month) ☐ Never - I don't exercise ☐

13. Do you suffer any food allergies and/or food intolerances? Yes ☐ No ☐

If yes please specify ....

14. Do you suffer any health problems that affect your diet? e.g. diabetes etc.

Yes ☐ No ☐

If yes please specify ....

15. Are you currently pregnant or have you recently had a baby (i.e. within the last year)?

Yes ☐ No ☐

If yes, has this had an effect on your taste preferences or have you "gone off" any particular tastes or foods?
Please specify ....

16. Does anything else affect your sense of taste or smell that has not been mentioned so far?

Yes ☐ No ☐

If yes, please specify ....

Appendix 3 - Hierarchical regression models for of taste (criterion) by personality and sex (non significant models)

Regression: Salty

Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.316[a]	.100	.065	25.72476	.100	2.867	13	337	.001
2	.356[b]	.126	.059	25.80261	.027	.831	12	325	.619

a. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence

b. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence, Zha3xsex, Zns2xsex, Zrd1xsex, Zha4xsex, Zns1xsex, Zns3xsex, Zrd4xsex, Zpersistencexsex, Zns4xsex, Zha1xsex, Zrd3xsex, Zha2xsex

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	24665.559	13	1897.351	2.867	.001[a]
	Residual	223014.1	337	661.763		
	Total	247679.7	350			
2	Regression	31302.904	25	1252.116	1.881	.007[b]
	Residual	216376.8	325	665.775		
	Total	247679.7	350			

a. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence

b. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence, Zha3xsex, Zns2xsex, Zrd1xsex, Zha4xsex, Zns1xsex, Zns3xsex, Zrd4xsex, Zpersistencexsex, Zns4xsex, Zha1xsex, Zrd3xsex, Zha2xsex

c. Dependent Variable: I usually like salty tastes

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	45.863	8.677		5.286	.000
	NS1 Exploratory excitability vs stoic rigidity	-.560	.873	-.040	-.642	.521
	NS2 Impulsiveness vs Reflection	1.451	.759	.113	1.911	.057
	NS3 Extravagence vs Reserve	.950	.846	.064	1.123	.262
	NS4 Disorderliness vs Regimentation	-1.859	.758	-.149	-2.452	.015
	HA1 Anticipatory worry vs uninhibited optimism	-.324	.706	-.032	-.459	.647
	HA2 Fear of Uncertainity vs Confidence	-.904	.971	-.067	-.931	.353
	HA3 Shyness with strangers vs Gregariousness	2.508	.863	.188	2.907	.004
	HA4 Fatigability & Asthenia vs Vigor	-2.059	.629	-.194	-3.275	.001
	RD1 Sentimentality vs Insensitivity	3.299	1.228	.155	2.686	.008
	Persistence	-1.286	.714	-.100	-1.801	.073
	RD3 Attachment vs Detachment	.248	.620	.025	.399	.690
	RD4 Dependence vs Independence	.469	1.177	.025	.399	.690
	Dummy coding sex	-4.709	3.367	-.081	-1.398	.163
2	(Constant)	46.392	9.420		4.925	.000
	NS1 Exploratory excitability vs stoic rigidity	-.476	.898	-.034	-.530	.596
	NS2 Impulsiveness vs Reflection	1.431	.785	.111	1.822	.069
	NS3 Extravagence vs Reserve	.788	.865	.053	.910	.363
	NS4 Disorderliness vs Regimentation	-1.625	.781	-.131	-2.081	.038
	HA1 Anticipatory worry vs uninhibited optimism	-.501	.728	-.050	-.688	.492
	HA2 Fear of Uncertainity vs Confidence	-.940	1.001	-.069	-.940	.348
	HA3 Shyness with strangers vs Gregariousness	2.538	.874	.190	2.903	.004
	HA4 Fatigability & Asthenia vs Vigor	-1.851	.650	-.175	-2.846	.005
	RD1 Sentimentality vs Insensitivity	3.148	1.249	.148	2.521	.012
	Persistence	-1.212	.738	-.094	-1.642	.102
	RD3 Attachment vs Detachment	.211	.640	.021	.330	.742
	RD4 Dependence vs Independence	.322	1.198	.017	.269	.788
	Dummy coding sex	-4.818	3.484	-.083	-1.383	.168
	Zns1xsex	-.411	1.709	-.015	-.241	.810
	Zns2xsex	-.046	1.715	-.002	-.027	.979
	Zns3xsex	1.589	1.539	.063	1.032	.303
	Zns4xsex	-3.864	1.756	-.143	-2.200	.029
	Zha1xsex	-.183	2.032	-.007	-.090	.928
	Zha2xsex	-.968	2.020	-.037	-.479	.632
	Zha3xsex	-.416	1.723	-.016	-.242	.809
	Zha4xsex	-.068	1.648	-.003	-.042	.967
	Zrd1xsex	1.352	1.525	.053	.886	.376
	Zpersistencexsex	-2.355	1.577	-.090	-1.493	.136
	Zrd3xsex	-1.267	1.613	-.052	-.785	.433
	Zrd4xsex	-.975	1.642	-.038	-.594	.553

a. Dependent Variable: I usually like salty tastes

Regression: Spicy

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.281[a]	.079	.043	26.27644	.079	2.214	13	337	.009
2	.361[b]	.131	.064	25.99201	.052	1.618	12	325	.085

a. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence

b. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence, Zha3xsex, Zns2xsex, Zrd1xsex, Zha4xsex, Zns1xsex, Zns3xsex, Zrd4xsex, Zpersistencexsex, Zns4xsex, Zha1xsex, Zrd3xsex, Zha2xsex

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	19877.050	13	1529.004	2.214	.009[a]
	Residual	232682.1	337	690.451		
	Total	252559.2	350			
2	Regression	32994.164	25	1319.767	1.954	.005[b]
	Residual	219565.0	325	675.585		
	Total	252559.2	350			

a. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence

b. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence, Zha3xsex, Zns2xsex, Zrd1xsex, Zha4xsex, Zns1xsex, Zns3xsex, Zrd4xsex, Zpersistencexsex, Zns4xsex, Zha1xsex, Zrd3xsex, Zha2xsex

c. Dependent Variable: I usually like spicy tastes

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	68.100	8.863		7.684	.000
	NS1 Exploratory excitability vs stoic rigidity	2.215	.891	.157	2.485	.013
	NS2 Impulsiveness vs Reflection	.602	.776	.046	.776	.438
	NS3 Extravagence vs Reserve	-1.472	.864	-.098	-1.704	.089
	NS4 Disorderliness vs Regimentation	-.533	.774	-.042	-.688	.492
	HA1 Anticipatory worry vs uninhibited optimism	.150	.722	.015	.208	.835
	HA2 Fear of Uncertainity vs Confidence	.100	.992	.007	.101	.920
	HA3 Shyness with strangers vs Gregariousness	.170	.881	.013	.193	.847
	HA4 Fatigability & Asthenia vs Vigor	-.926	.642	-.087	-1.443	.150
	RD1 Sentimentality vs Insensitivity	.689	1.255	.032	.549	.583
	Persistence	.499	.729	.039	.684	.495
	RD3 Attachment vs Detachment	-.690	.634	-.068	-1.089	.277
	RD4 Dependence vs Independence	-.506	1.202	-.026	-.421	.674
	Dummy coding sex	-8.864	3.440	-.150	-2.577	.010
2	(Constant)	71.520	9.489		7.537	.000
	NS1 Exploratory excitability vs stoic rigidity	2.254	.905	.160	2.490	.013
	NS2 Impulsiveness vs Reflection	.502	.791	.039	.634	.527
	NS3 Extravagence vs Reserve	-1.569	.872	-.104	-1.800	.073
	NS4 Disorderliness vs Regimentation	-.666	.787	-.053	-.847	.398
	HA1 Anticipatory worry vs uninhibited optimism	-.111	.734	-.011	-.152	.879
	HA2 Fear of Uncertainity vs Confidence	.027	1.008	.002	.027	.979
	HA3 Shyness with strangers vs Gregariousness	.394	.881	.029	.448	.655
	HA4 Fatigability & Asthenia vs Vigor	-.955	.655	-.089	-1.458	.146
	RD1 Sentimentality vs Insensitivity	.918	1.258	.043	.730	.466
	Persistence	.680	.743	.052	.914	.361
	RD3 Attachment vs Detachment	-.993	.645	-.098	-1.539	.125
	RD4 Dependence vs Independence	-.290	1.206	-.015	-.241	.810
	Dummy coding sex	-10.095	3.509	-.171	-2.877	.004
	Zns1xsex	1.606	1.721	.057	.933	.352
	Zns2xsex	-.615	1.727	-.023	-.356	.722
	Zns3xsex	.198	1.550	.008	.128	.898
	Zns4xsex	-.934	1.769	-.034	-.528	.598
	Zha1xsex	-3.808	2.047	-.139	-1.861	.064
	Zha2xsex	-1.287	2.035	-.049	-.632	.528
	Zha3xsex	2.024	1.736	.076	1.166	.244
	Zha4xsex	1.487	1.660	.054	.895	.371
	Zrd1xsex	1.268	1.536	.050	.825	.410
	Zpersistencexsex	2.425	1.589	.092	1.526	.128
	Zrd3xsex	-4.062	1.625	-.164	-2.500	.013
	Zrd4xsex	2.202	1.654	.085	1.331	.184

a. Dependent Variable: I usually like spicy tastes

Regression: Bitter

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.382[a]	.146	.113	20.56786	.146	4.428	13	337	.000
2	.405[b]	.164	.100	20.71733	.018	.596	12	325	.845

a. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence

b. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence, Zha3xsex, Zns2xsex, Zrd1xsex, Zha4xsex, Zns1xsex, Zns3xsex, Zrd4xsex, Zpersistencexsex, Zns4xsex, Zha1xsex, Zrd3xsex, Zha2xsex

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	24351.473	13	1873.190	4.428	.000[a]
	Residual	142563.5	337	423.037		
	Total	166915.0	350			
2	Regression	27422.427	25	1096.897	2.556	.000[b]
	Residual	139492.5	325	429.208		
	Total	166915.0	350			

a. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence

b. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence, Zha3xsex, Zns2xsex, Zrd1xsex, Zha4xsex, Zns1xsex, Zns3xsex, Zrd4xsex, Zpersistencexsex, Zns4xsex, Zha1xsex, Zrd3xsex, Zha2xsex

c. Dependent Variable: I usually like bitter tastes

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	39.961	6.938		5.760	.000
	NS1 Exploratory excitability vs stoic rigidity	.375	.698	.033	.537	.592
	NS2 Impulsiveness vs Reflection	-1.214	.607	-.115	-2.000	.046
	NS3 Extravagence vs Reserve	1.053	.676	.086	1.557	.120
	NS4 Disorderliness vs Regimentation	.851	.606	.083	1.404	.161
	HA1 Anticipatory worry vs uninhibited optimism	-.232	.565	-.028	-.411	.681
	HA2 Fear of Uncertainity vs Confidence	-.083	.777	-.007	-.106	.915
	HA3 Shyness with strangers vs Gregariousness	-.123	.690	-.011	-.178	.859
	HA4 Fatigability & Asthenia vs Vigor	-1.062	.503	-.122	-2.112	.035
	RD1 Sentimentality vs Insensitivity	.135	.982	.008	.138	.891
	Persistence	1.015	.571	.096	1.778	.076
	RD3 Attachment vs Detachment	-1.313	.496	-.159	-2.647	.008
	RD4 Dependence vs Independence	-.610	.941	-.039	-.648	.517
	Dummy coding sex	-9.795	2.692	-.205	-3.638	.000
2	(Constant)	39.961	7.563		5.283	.000
	NS1 Exploratory excitability vs stoic rigidity	.349	.721	.030	.483	.629
	NS2 Impulsiveness vs Reflection	-1.202	.631	-.114	-1.907	.057
	NS3 Extravagence vs Reserve	1.116	.695	.091	1.606	.109
	NS4 Disorderliness vs Regimentation	.734	.627	.072	1.170	.243
	HA1 Anticipatory worry vs uninhibited optimism	-.178	.585	-.022	-.305	.761
	HA2 Fear of Uncertainity vs Confidence	-.214	.803	-.019	-.266	.791
	HA3 Shyness with strangers vs Gregariousness	-.092	.702	-.008	-.131	.896
	HA4 Fatigability & Asthenia vs Vigor	-.923	.522	-.106	-1.767	.078
	RD1 Sentimentality vs Insensitivity	.011	1.003	.001	.011	.991
	Persistence	.960	.592	.091	1.620	.106
	RD3 Attachment vs Detachment	-1.199	.514	-.145	-2.332	.020
	RD4 Dependence vs Independence	-.720	.962	-.046	-.749	.455
	Dummy coding sex	-9.453	2.797	-.197	-3.380	.001
	Zns1xsex	1.159	1.372	.051	.845	.399
	Zns2xsex	.439	1.377	.020	.319	.750
	Zns3xsex	-1.427	1.236	-.069	-1.155	.249
	Zns4xsex	.054	1.410	.002	.038	.969
	Zha1xsex	.050	1.631	.002	.031	.975
	Zha2xsex	-.264	1.622	-.012	-.163	.871
	Zha3xsex	-.380	1.383	-.018	-.274	.784
	Zha4xsex	.541	1.323	.024	.409	.683
	Zrd1xsex	1.565	1.225	.075	1.278	.202
	Zpersistencexsex	-1.930	1.266	-.090	-1.524	.128
	Zrd3xsex	.976	1.295	.048	.754	.452
	Zrd4xsex	-1.354	1.318	-.064	-1.027	.305

a. Dependent Variable: I usually like bitter tastes

Regression: Sour

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.294[a]	.086	.051	22.74145	.086	2.451	13	337	.003
2	.346[b]	.120	.052	22.72762	.034	1.034	12	325	.417

a. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence

b. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence, Zha3xsex, Zns2xsex, Zrd1xsex, Zha4xsex, Zns1xsex, Zns3xsex, Zrd4xsex, Zpersistencexsex, Zns4xsex, Zha1xsex, Zrd3xsex, Zha2xsex

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	16478.280	13	1267.560	2.451	.003[a]
	Residual	174287.5	337	517.174		
	Total	190765.8	350			
2	Regression	22888.724	25	915.549	1.772	.014[b]
	Residual	167877.1	325	516.545		
	Total	190765.8	350			

a. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence

b. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence, Zha3xsex, Zns2xsex, Zrd1xsex, Zha4xsex, Zns1xsex, Zns3xsex, Zrd4xsex, Zpersistencexsex, Zns4xsex, Zha1xsex, Zrd3xsex, Zha2xsex

c. Dependent Variable: I usually like sour tastes

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	48.105	7.671		6.271	.000
	NS1 Exploratory excitability vs stoic rigidity	-.107	.772	-.009	-.139	.890
	NS2 Impulsiveness vs Reflection	-.121	.671	-.011	-.180	.857
	NS3 Extravagence vs Reserve	-.359	.748	-.027	-.480	.631
	NS4 Disorderliness vs Regimentation	.983	.670	.090	1.467	.143
	HA1 Anticipatory worry vs uninhibited optimism	.201	.624	.023	.323	.747
	HA2 Fear of Uncertainity vs Confidence	-.790	.859	-.066	-.920	.358
	HA3 Shyness with strangers vs Gregariousness	.058	.763	.005	.076	.939
	HA4 Fatigability & Asthenia vs Vigor	-1.154	.556	-.124	-2.077	.039
	RD1 Sentimentality vs Insensitivity	1.096	1.086	.059	1.009	.314
	Persistence	.890	.631	.079	1.410	.159
	RD3 Attachment vs Detachment	-1.448	.548	-.164	-2.641	.009
	RD4 Dependence vs Independence	-.499	1.040	-.030	-.480	.632
	Dummy coding sex	-4.656	2.977	-.091	-1.564	.119
2	(Constant)	53.160	8.297		6.407	.000
	NS1 Exploratory excitability vs stoic rigidity	.089	.791	.007	.113	.910
	NS2 Impulsiveness vs Reflection	-.239	.692	-.021	-.345	.730
	NS3 Extravagence vs Reserve	-.547	.762	-.042	-.718	.473
	NS4 Disorderliness vs Regimentation	.965	.688	.088	1.403	.162
	HA1 Anticipatory worry vs uninhibited optimism	.192	.642	.022	.300	.764
	HA2 Fear of Uncertainity vs Confidence	-1.096	.881	-.092	-1.244	.214
	HA3 Shyness with strangers vs Gregariousness	.136	.770	.012	.177	.860
	HA4 Fatigability & Asthenia vs Vigor	-.989	.573	-.106	-1.726	.085
	RD1 Sentimentality vs Insensitivity	.785	1.100	.042	.714	.476
	Persistence	.820	.650	.073	1.262	.208
	RD3 Attachment vs Detachment	-1.485	.564	-.169	-2.635	.009
	RD4 Dependence vs Independence	-.900	1.055	-.054	-.853	.394
	Dummy coding sex	-5.294	3.068	-.103	-1.725	.085
	Zns1xsex	1.559	1.505	.064	1.036	.301
	Zns2xsex	.085	1.510	.004	.057	.955
	Zns3xsex	-1.288	1.356	-.059	-.951	.343
	Zns4xsex	-2.237	1.547	-.094	-1.446	.149
	Zha1xsex	-1.119	1.789	-.047	-.625	.532
	Zha2xsex	-.389	1.779	-.017	-.219	.827
	Zha3xsex	.649	1.518	.028	.428	.669
	Zha4xsex	1.510	1.452	.064	1.040	.299
	Zrd1xsex	-.868	1.343	-.039	-.646	.519
	Zpersistencexsex	-2.259	1.389	-.099	-1.626	.105
	Zrd3xsex	-.471	1.421	-.022	-.331	.741
	Zrd4xsex	-.706	1.446	-.031	-.488	.626

a. Dependent Variable: I usually like sour tastes

Regression: Umami

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.272[a]	.074	.038	26.72068	.074	2.072	13	337	.015
2	.332[b]	.110	.042	26.67447	.036	1.097	12	325	.361

a. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence

b. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence, Zha3xsex, Zns2xsex, Zrd1xsex, Zha4xsex, Zns1xsex, Zns3xsex, Zrd4xsex, Zpersistencexsex, Zns4xsex, Zha1xsex, Zrd3xsex, Zha2xsex

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	19235.233	13	1479.633	2.072	.015[a]
	Residual	240616.3	337	713.995		
	Total	259851.5	350			
2	Regression	28605.134	25	1144.205	1.608	.035[b]
	Residual	231246.4	325	711.527		
	Total	259851.5	350			

a. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence

b. Predictors: (Constant), Dummy coding sex, HA3 Shyness with strangers vs Gregariousness, Persistence, NS3 Extravagence vs Reserve, NS2 Impulsiveness vs Reflection, RD1 Sentimentality vs Insensitivity, HA4 Fatigability & Asthenia vs Vigor, RD4 Dependence vs Independence, NS4 Disorderliness vs Regimentation, NS1 Exploratory excitability vs stoic rigidity, RD3 Attachment vs Detachment, HA1 Anticipatory worry vs uninhibited optimism, HA2 Fear of Uncertainity vs Confidence, Zha3xsex, Zns2xsex, Zrd1xsex, Zha4xsex, Zns1xsex, Zns3xsex, Zrd4xsex, Zpersistencexsex, Zns4xsex, Zha1xsex, Zrd3xsex, Zha2xsex

c. Dependent Variable: I usually like artifically enhanced tastes

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	32.915	9.013		3.652	.000
	NS1 Exploratory excitability vs stoic rigidity	-2.475	.907	-.173	-2.730	.007
	NS2 Impulsiveness vs Reflection	.805	.789	.061	1.021	.308
	NS3 Extravagence vs Reserve	-.053	.878	-.003	-.060	.952
	NS4 Disorderliness vs Regimentation	.632	.787	.050	.803	.422
	HA1 Anticipatory worry vs uninhibited optimism	-.214	.734	-.021	-.292	.771
	HA2 Fear of Uncertainity vs Confidence	-1.764	1.009	-.127	-1.749	.081
	HA3 Shyness with strangers vs Gregariousness	1.009	.896	.074	1.126	.261
	HA4 Fatigability & Asthenia vs Vigor	1.003	.653	.092	1.536	.126
	RD1 Sentimentality vs Insensitivity	-1.392	1.276	-.064	-1.091	.276
	Persistence	-.759	.742	-.058	-1.024	.307
	RD3 Attachment vs Detachment	1.332	.644	.129	2.067	.039
	RD4 Dependence vs Independence	1.533	1.222	.078	1.254	.211
	Dummy coding sex	1.336	3.498	.022	.382	.703
2	(Constant)	42.741	9.738		4.389	.000
	NS1 Exploratory excitability vs stoic rigidity	-2.598	.929	-.181	-2.797	.005
	NS2 Impulsiveness vs Reflection	1.176	.812	.089	1.448	.149
	NS3 Extravagence vs Reserve	-.226	.895	-.015	-.253	.800
	NS4 Disorderliness vs Regimentation	.481	.808	.038	.596	.552
	HA1 Anticipatory worry vs uninhibited optimism	-.031	.753	-.003	-.041	.967
	HA2 Fear of Uncertainity vs Confidence	-2.083	1.034	-.150	-2.014	.045
	HA3 Shyness with strangers vs Gregariousness	.911	.904	.067	1.008	.314
	HA4 Fatigability & Asthenia vs Vigor	1.000	.672	.092	1.487	.138
	RD1 Sentimentality vs Insensitivity	-1.830	1.291	-.084	-1.418	.157
	Persistence	-.800	.763	-.061	-1.049	.295
	RD3 Attachment vs Detachment	1.071	.662	.104	1.619	.106
	RD4 Dependence vs Independence	1.243	1.238	.063	1.004	.316
	Dummy coding sex	-1.070	3.601	-.018	-.297	.766
	Zns1xsex	-1.562	1.767	-.055	-.884	.377
	Zns2xsex	-2.116	1.773	-.078	-1.194	.233
	Zns3xsex	-.539	1.591	-.021	-.339	.735
	Zns4xsex	2.494	1.816	.090	1.373	.171
	Zha1xsex	-1.892	2.100	-.068	-.901	.368
	Zha2xsex	-2.475	2.088	-.093	-1.186	.237
	Zha3xsex	2.229	1.781	.083	1.251	.212
	Zha4xsex	-.337	1.704	-.012	-.198	.843
	Zrd1xsex	-1.364	1.577	-.053	-.865	.388
	Zpersistencexsex	-1.846	1.631	-.069	-1.132	.258
	Zrd3xsex	.349	1.668	.014	.209	.835
	Zrd4xsex	-.272	1.698	-.010	-.160	.873

a. Dependent Variable: I usually like artifically enhanced tastes

Appendix 4

Full Hierarchical Regression Model for Sweet scores (criterion) by personality and sex predictors (model 1) and with interaction variables (model 2)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.251[a]	.063	.027	24.15803	.063	1.736	13	337	.052
2	.356[b]	.126	.059	23.74970	.064	1.974	12	325	.026

a. Predictors: (Constant), Zscore: Dummy coding sex, Zscore: HA3 Shyness with strangers vs Gregariousness, Zscore: Persistence, Zscore: NS3 Extravagence vs Reserve, Zscore: NS2 Impulsiveness vs Reflection, Zscore: RD1 Sentimentality vs Insensitivity, Zscore: HA4 Fatigability & Asthenia vs Vigor, Zscore: RD4 Dependence vs Independence, Zscore: NS4 Disorderliness vs Regimentation, Zscore: NS1 Exploratory excitability vs stoic rigidity, Zscore: RD3 Attachment vs Detachment, Zscore: HA1 Anticipatory worry vs uninhibited optimism, Zscore: HA2 Fear of Uncertainity vs Confidence

b. Predictors: (Constant), Zscore: Dummy coding sex, Zscore: HA3 Shyness with strangers vs Gregariousness, Zscore: Persistence, Zscore: NS3 Extravagence vs Reserve, Zscore: NS2 Impulsiveness vs Reflection, Zscore: RD1 Sentimentality vs Insensitivity, Zscore: HA4 Fatigability & Asthenia vs Vigor, Zscore: RD4 Dependence vs Independence, Zscore: NS4 Disorderliness vs Regimentation, Zscore: NS1 Exploratory excitability vs stoic rigidity, Zscore: RD3 Attachment vs Detachment, Zscore: HA1 Anticipatory worry vs uninhibited optimism, Zscore: HA2 Fear of Uncertainity vs Confidence, Zha3xsex, Zns2xsex, Zrd1xsex, Zha4xsex, Zns1xsex, Zns3xsex, Zrd4xsex, Zpersistencexsex, Zns4xsex, Zha1xsex, Zrd3xsex, Zha2xsex

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13168.087	13	1012.930	1.736	.052[a]
	Residual	196676.8	337	583.611		
	Total	209844.8	350			
2	Regression	26529.093	25	1061.164	1.881	.007[b]
	Residual	183315.8	325	564.048		
	Total	209844.8	350			

a. Predictors: (Constant), Zscore: Dummy coding sex, Zscore: HA3 Shyness with strangers vs Gregariousness, Zscore: Persistence, Zscore: NS3 Extravagence vs Reserve, Zscore: NS2 Impulsiveness vs Reflection, Zscore: RD1 Sentimentality vs Insensitivity, Zscore: HA4 Fatigability & Asthenia vs Vigor, Zscore: RD4 Dependence vs Independence, Zscore: NS4 Disorderliness vs Regimentation, Zscore: NS1 Exploratory excitability vs stoic rigidity, Zscore: RD3 Attachment vs Detachment, Zscore: HA1 Anticipatory worry vs uninhibited optimism, Zscore: HA2 Fear of Uncertainity vs Confidence

b. Predictors: (Constant), Zscore: Dummy coding sex, Zscore: HA3 Shyness with strangers vs Gregariousness, Zscore: Persistence, Zscore: NS3 Extravagence vs Reserve, Zscore: NS2 Impulsiveness vs Reflection, Zscore: RD1 Sentimentality vs Insensitivity, Zscore: HA4 Fatigability & Asthenia vs Vigor, Zscore: RD4 Dependence vs Independence, Zscore: NS4 Disorderliness vs Regimentation, Zscore: NS1 Exploratory excitability vs stoic rigidity, Zscore: RD3 Attachment vs Detachment, Zscore: HA1 Anticipatory worry vs uninhibited optimism, Zscore: HA2 Fear of Uncertainity vs Confidence, Zha3xsex, Zns2xsex, Zrd1xsex, Zha4xsex, Zns1xsex, Zns3xsex, Zrd4xsex, Zpersistencexsex, Zns4xsex, Zha1xsex, Zrd3xsex, Zha2xsex

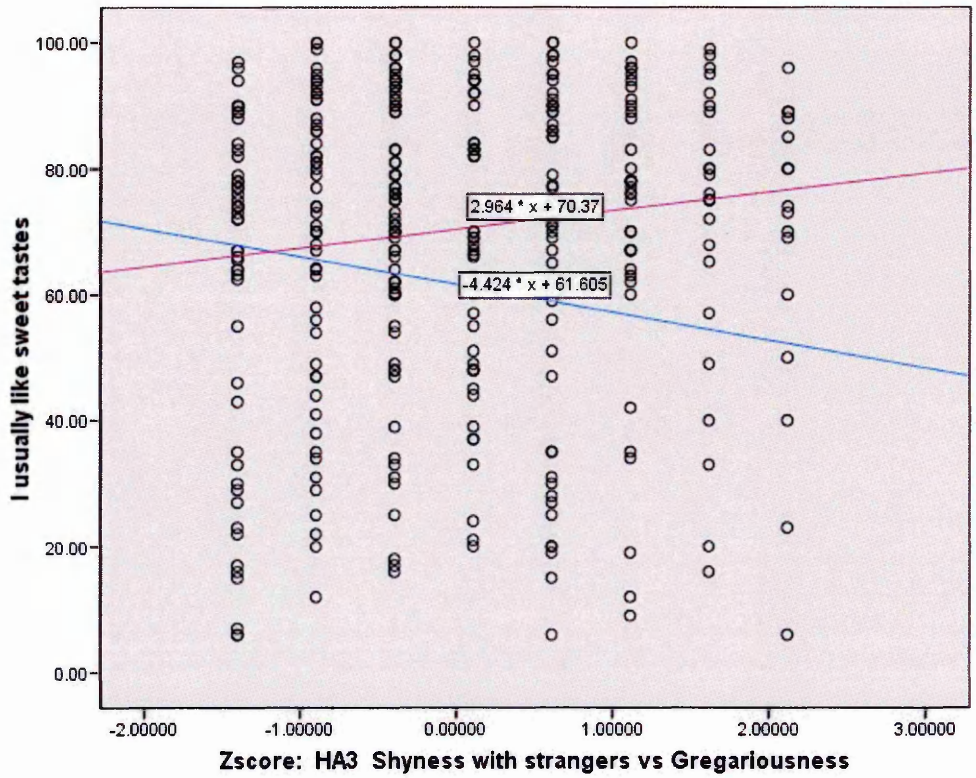
c. Dependent Variable: I usually like sweet tastes

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	68.149	1.289		52.849	.000
	Zscore: NS1 Exploratory excitability vs stoic rigidity	-2.927	1.558	-.120	-1.879	.061
	Zscore: NS2 Impulsiveness vs Reflection	.105	1.476	.004	.071	.943
	Zscore: NS3 Extravagence vs Reserve	-.619	1.417	-.025	-.437	.662
	Zscore: NS4 Disorderliness vs Regimentation	1.973	1.521	.081	1.297	.195
	Zscore: HA1 Anticipatory worry vs uninhibited optimism	.832	1.754	.034	.474	.636
	Zscore: HA2 Fear of Uncertainity vs Confidence	-.526	1.786	-.022	-.295	.768
	Zscore: HA3 Shyness with strangers vs Gregariousness	.839	1.610	.034	.521	.603
	Zscore: HA4 Fatigability & Asthenia vs Vigor	.984	1.481	.040	.664	.507
	Zscore: RD1 Sentimentality vs Insensitivity	-1.224	1.440	-.050	-.850	.396
	Zscore: Persistence	-1.189	1.389	-.049	-.856	.392
	Zscore: RD3 Attachment vs Detachment	2.210	1.541	.090	1.434	.152
	Zscore: RD4 Dependence vs Independence	.553	1.534	.023	.360	.719
	Zscore: Dummy coding sex	3.886	1.442	.159	2.695	.007
2	(Constant)	67.804	1.396		48.562	.000
	Zscore: NS1 Exploratory excitability vs stoic rigidity	-2.639	1.572	-.108	-1.679	.094
	Zscore: NS2 Impulsiveness vs Reflection	.629	1.496	.026	.420	.675
	Zscore: NS3 Extravagence vs Reserve	-.489	1.421	-.020	-.344	.731
	Zscore: NS4 Disorderliness vs Regimentation	2.016	1.536	.082	1.313	.190
	Zscore: HA1 Anticipatory worry vs uninhibited optimism	.295	1.773	.012	.166	.868
	Zscore: HA2 Fear of Uncertainity vs Confidence	-.149	1.803	-.006	-.083	.934
	Zscore: HA3 Shyness with strangers vs Gregariousness	.796	1.599	.033	.498	.619
	Zscore: HA4 Fatigability & Asthenia vs Vigor	.714	1.502	.029	.475	.635
	Zscore: RD1 Sentimentality vs Insensitivity	-.542	1.435	-.022	-.378	.706
	Zscore: Persistence	-.713	1.407	-.029	-.507	.613
	Zscore: RD3 Attachment vs Detachment	1.831	1.558	.075	1.175	.241
	Zscore: RD4 Dependence vs Independence	.940	1.530	.038	.614	.539
	Zscore: Dummy coding sex	3.998	1.462	.163	2.734	.007
	Zns1xsex	-1.540	1.573	-.060	-.979	.328
	Zns2xsex	-.644	1.578	-.026	-.408	.684
	Zns3xsex	2.272	1.416	.098	1.604	.110
	Zns4xsex	-1.286	1.617	-.052	-.796	.427
	Zha1xsex	-2.062	1.870	-.083	-1.103	.271
	Zha2xsex	-2.264	1.859	-.095	-1.218	.224
	Zha3xsex	3.369	1.586	.139	2.124	.034
	Zha4xsex	1.084	1.517	.044	.715	.475
	Zrd1xsex	.818	1.404	.035	.582	.561
	Zpersistencexsex	2.121	1.452	.088	1.461	.145
	Zrd3xsex	-1.721	1.485	-.076	-1.159	.247
	Zrd4xsex	4.342	1.511	.184	2.873	.004

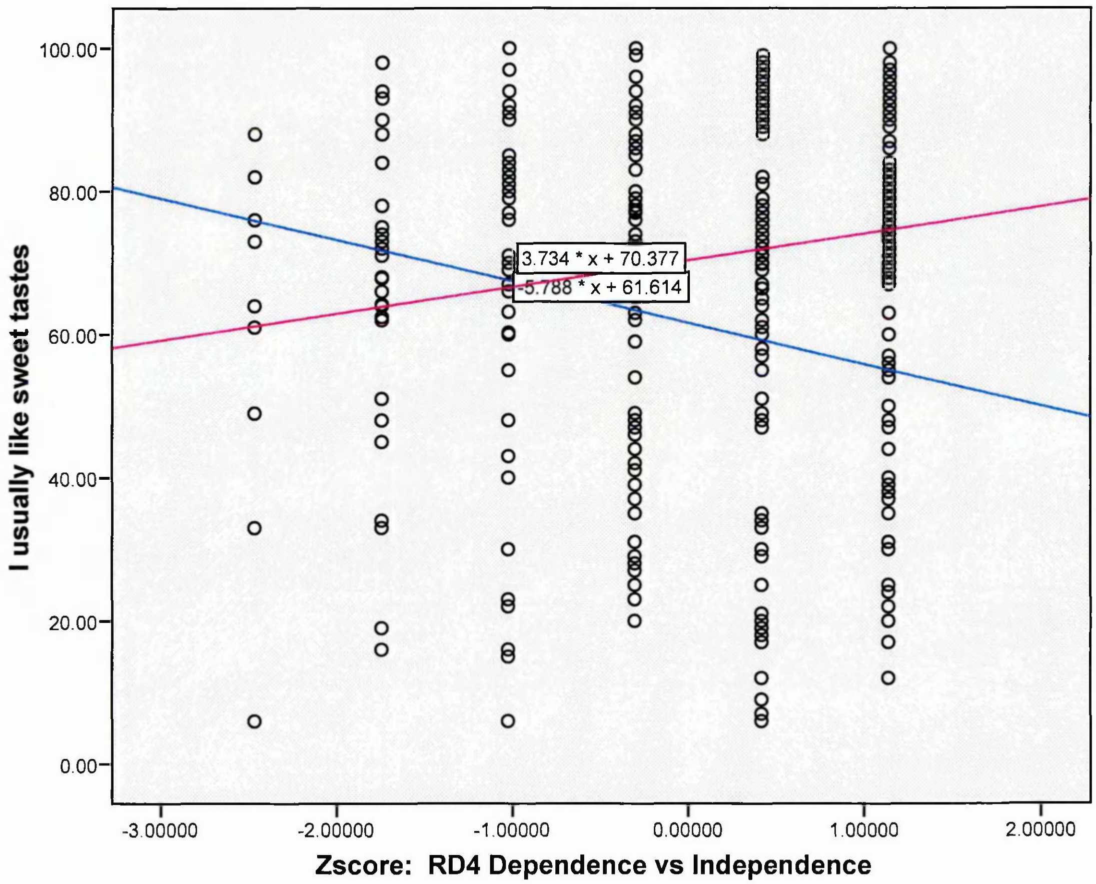
a. Dependent Variable: I usually like sweet tastes

Scatter Graph: Sweet liking by scores of HA3, showing line of best fit for males and females



Note: The pink line refers to female scores and the blue line refers to male scores

Scatter Graph: Sweet liking by scores of RD4, showing line of best fit for males and females



Note: The pink line refers to female scores and the blue line refers to male scores

Appendix 5 - Study 2 Consent and Nutritional Information

You have volunteered to take part in a piece of post-graduate research at Sheffield Hallam University which will be conducted by Catherine Day. This study is concerned with individual differences in taste preference. The experiment requires that you consume small amounts of lemon-flavoured drinks. For all nutritional information about the content of the drinks please study the information overleaf before deciding to take part. If for any reason you do not wish to consume any of the listed ingredients you are free to leave now. **If you have any food allergies or diet related problems you will be advised not to take part.**

Confidentiality

All data recorded from this study will be kept confidential. You will be asked to fill out a unique identification code which will used to match up your completed questionnaires and test trial results but will not be asked to put your name on any questionnaires or task sheets. Your identity will not be revealed in the written report. The researcher will have the only access to the data collected from this study.

Right to withdraw

If you have any objections now or later decide to withdraw from the study you are free to do so without giving the researcher or anyone else reason for doing so.

Contacts and Questions

You are free to ask any questions now if you wish. However if after the study you think of any further questions you wish to discuss feel free to contact me on [redacted] or by email [redacted]

Consent

I have thoroughly read the information above and studied the nutritional information overleaf. I feel that my questions regarding the study have been answered and that I have adequate information about the study.

- ☐ I am a non-smoker
- ☐ I do not suffer any food allergies or intolerances to the listed foods
- ☐ I do not have any health problems that affect my diet i.e. diabetes
- ☐ I, therefore, give my full consent to take part in the study.

Please complete the following personal identification code. The code should consist of the first 2 letters of your mother's maiden name, followed by the day of your birthday, followed by your house number (or first 2 digits of your house number if it is 3 or more digits long), for example SH1222. This code will be unique to you; you will not be identifiable.

CODE: ☐☐☐☐☐☐ Date: ....

Nutritional Information

The following information has been taken from the food packaging used in this study. Please study it carefully and let the researcher know if you have any food allergies or food intolerances.

The following foods may be included:

	Quantity per participant
Pasta	10g
Tinned tomatoes	60ml
Angostura bitters	4 drops
Tabasco	4 drops
Salt	0.83g
Lemon juice	3.33ml
Monosodium glutamate	1.66g
Olive oil	0.38ml
Oregano	trace
Glucose	3.33g

Ingredients

Pasta Bows: Durum wheat semolina

Tinned tomatoes: Organic tomatoes, tomato juice

Angostura bitters: Water, alcohol, spices, natural aromas, sugar, colorant: caramel E150a.

Glucose: dextrose monohydrate

Tabasco: fully aged red peppers, high grain all-natural vinegar and salt

Other ingredients: sea salt, lemon juice, monosodium glutamate, oregano and olive oil.

Appendix 6

Matrix for ingredient quantities for study 2 based on participant number

People	400g Tins of Tomato	Desert Spoons of Oil	Herbs	Grams of Tomato Sauce	Pasta Shells
1	1	2	1	35	7
2	1	2	1	70	14
3	1	2	1	105	21
4	1	2	1	140	28
5	1	2	1	175	35
6	1	2	1	210	42
7	1	2	1	245	49
8	1	2	1	280	56
9	1	2	1	315	63
10	2	4	2	350	70
11	2	4	2	385	77
12	2	4	2	420	84
13	2	4	2	455	91
14	2	4	2	490	98
15	2	4	2	525	105
16	2	4	2	560	112
17	2	4	2	595	119
18	2	4	2	630	126
19	2	4	2	665	133
20	2	4	2	700	140

Appendix 7 - Screening and background measures for study 2

CODE: ☐☐☐☐☐☐

Screening Questionnaire

The purpose of the following questionnaire is to assess your suitability to the study and to provide the researcher with some background information about you, your health and your habits. Please answer the questions as honestly as possible. All responses will be kept confidential.

About You

1. Please state your age .... years

2. Sex Female ☐ Male ☐

3. Do you smoke? Yes ☐ No ☐

4. Please state your occupation: ....

5. How much alcohol do you drink each week?

   ....glasses of wine

   ....half pints beer/lager/cider

   ....pub measures of spirits

   ....Alco pops

About Your Health

6. Are you in good health at the present time? Yes ☐ No ☐

7. Are you at present attending a doctor or hospital for any reason?

   Yes ☐ No ☐

   If yes, please specify ....

8. Are you currently on medication? Yes ☐ No ☐

   If yes, please specify ....

9. Are you now or have you in the past taken any medication to control or stabilise a condition (e.g. insulin for diabetes or ventolin for asthma)?

   Yes ☐ No ☐

   If yes, please specify ....

10. In the last 12 months have you undergone any operation or hospital treatment, or had a serious accident?

    Yes ☐ No ☐

    If yes, please specify ....

11. Do you suffer any long-term limiting illness or any other health conditions?

Yes ☐ No ☐

If yes, please specify ....

12. How often do you exercise per week? NB. One session of exercise is equivalent to 20 minutes brisk walking, this may include walking as part of your daily routine.

Regularly (2 or more times a week) ☐ Once a week ☐ Twice a month ☐ Occasionally (Less than twice month) ☐ Never - I don't exercise ☐

13. Do you suffer any food allergies and/or food intolerances? Yes ☐ No ☐

If yes please specify ....

14a. In particular do you have a wheat allergy? Yes ☐ No ☐

14b. Do you have any sensitivity to artificial flavour enhancers, for example monosodium glutamate?

Yes ☐ No ☐

15. Do you suffer any health problems that affect your diet? e.g. diabetes etc.

Yes ☐ No ☐

If yes please specify ....

About Your Diet

16a. Do you have any dietary restrictions? Yes ☐ No ☐

16b. If yes are these for religious or ethical reasons?

Religious ☐ Ethical ☐ Neither, please specify ....

17. How frequently do you add salt to your food after it is served?

Never ☐ 1-2 times per week ☐ About once a day ☐ With almost all meals ☐

18. How many times do you eat "fast food"?

Rarely ☐ Once a week ☐ 2-3 times per week ☐ 4+ times per week ☐

19. In what form do you most frequently purchase food or meal preparations?

Fresh ☐ Jarred sauces ☐ Canned or frozen reduced salt, sugar and fat ☐ Canned, frozen or dry with sauces and/or seasonings ☐

Appendix 8 - Descriptions of the traits associated with high scores on the lower subscales of the Tridimensional Personality Questionnaire (TPQ)

Lower Subscales of the 4 major domains	Characteristics of high scorers
HA1 Anticipatory worry and pessimism vs. uninhibited	Pessimistic worries who tend to anticipate harm and failure (esp. in hazardous, unfamiliar or realistically difficult situations). Also happens in harmless situations. Also have difficulty getting over humiliating and embarrassing experiences.
HA2 Fear of Uncertainty	Cannot tolerate uncertainty or unfamiliar circumstances that are potentially dangerous. Often feel tense and anxious in unfamiliar circumstances (even when there is little to worry about). They rarely take risks, have difficulty adapting to change and prefer to stay quiet and inactive.
HA3 Shyness with strangers	Unassertive and shy in most social situations. Actively avoid meeting strangers because they lack confidence with people they do not know well. Usually unwilling to enter relationships with people they don't know unless given a strong guarantee of acceptance. Any initiative they may have is easily inhibited by unfamiliar people or situations.
HA4 Fatigability vs. Vigour	Appear to have less energy than most people. Often need naps or rest because they get tired easily. Recover more slowly than most from illness or stress.
NS1 Exploratory excitability vs. stoic rigidity	Enjoy exploring unfamiliar places and situations even if most people think it is a waste of time. "Sensation seekers". Get excited about new ideas and activities - tend to seek thrills, excitement and adventures. Easily bored. Intolerant of routine and monotony.

NS2 Impulsiveness vs. reflection	Excitable, dramatic, impressionistic and "temperamental". Act on momentary instincts and intuitive hunches. Distractible and short attention spans. Have difficulty staying focused.
NS3 Extravagance vs. Reserve	Extravagant with their money, energy and feelings. May impress others as gallant, flamboyant and unrestrained.
NS4 Disorderliness vs. Regimentation	Quick tempered and disorderly. They show and express anger outwardly when they don't get what they want. Prefer activities without strict rules and regulations. Do not like fixed routines and rules. they run away from whatever is frustrating, boring or uncomfortable (physically or psychologically).
RD1 Sentimentality	Sentimental, sympathetic, understanding individuals who tend to be deeply moved by sentimental appeals. Show their emotions easily in front of others.
RD3 Attachment vs. detachment	Prefer intimacy over privacy. Like to discuss their feelings and experiences openly. Form warm and lasting social attachments. Sensitive to rejection.
RD4 Dependence vs. independence	Dependent on emotional support and approval from others. Care deeply how others regard them. Reluctant to make decisions or do things on their own. Easily hurt by criticism and disapproval. Very sensitive to social cues and highly responsive to social pressure.
Persistence (RD2 or PER)	Industrious, hard-working, persistent and stable despite frustration and fatigue. Ambitious over-achievers who are willing to make major sacrifices to be a success. Perfectionist and workaholic.

Appendix 9 - Study 2 Debriefing

Debriefing

You have just taken part in a study with aims to look at the relationship between taste preference of raw tastes and personality. The taste samples you have consumed each contained one of the 6 raw tastes; spicy, sweet, salty, bitter, sour and Unami (or artificially enhanced flavour in this case monosodium glutamate). Previous research has found that clinical populations such as obese and eating disordered individuals show preference for particular tastes. Research in non-clinical populations is limited in this area. I plan to look at your usual taste ratings and compare these with the results of your real taste ratings. I also plan to see if there are any relationships between personality types and taste ratings.

If you have any questions about the nature of the study or my research in general please do not hesitate to ask them now. If however you wish to ask any questions at a later date please contact me by email or telephone, my details are available on your consent form.

Thank you again for taking part.

Appendix 10 - Consent Form for Study 3

Sheffield Hallam University
SHARPENS YOUR THINKING

Consent Form

You have volunteered to take part in a post-graduate research study at Sheffield Hallam University which will be conducted by Catherine Day. This study is concerned with individual differences in taste preference. You will be asked to consume and rate small amounts of lemon-flavoured drinks containing lemon juice, glucose and mineral water. You will also be required to complete questionnaires relating to eating behaviour and personality. **If you have any food allergies or diet related problems you will be advised not to take part.**

Confidentiality

All data recorded from this study will be kept confidential. You will be asked to fill out a unique identification code which will be used to match up your completed questionnaires and test trial results but will not be asked to put your name on any questionnaires or task sheets. Your identity will not be revealed in the written report. The researcher will have the only access to the data collected from this study.

Right to withdraw

If you have any objections now you are free to withdraw from the study without giving the researcher or anyone else reason for doing so. You also have the right to withdraw your data within 7 days of participation.

Contacts and Questions

You are free to ask any questions now if you wish. However if after the study you think of any further questions feel free to contact me on [redacted] or by email [redacted]

Consent

I have thoroughly read the information above. I feel that my questions regarding the study have been answered and that I have adequate information about the study.

- ☐ I am a non-smoker
- ☐ I do not suffer any food allergies or intolerances to the listed foods
- ☐ I do not have any health problems that affect my diet (i.e. diabetes, hypoglycaemia etc)
- ☐ I, therefore, give my full consent to take part in the study.

Please complete the following personal identification code. The code should consist of the first 2 letters of your mother's maiden name, followed by the day of your birthday, followed by your house number (or first 2 digits of your house number if it is 3 or more digits long), for example SH2557. This code will be unique to you; you will not be identifiable.

CODE: ☐☐☐☐☐☐ Date: ....

Appendix 11 – Background measures for Study 3

Background Questionnaire

About You

1. Age: ____________ 2. Sex: Male Female

3. Please state your occupation: ______________________________

4. Please give your height (feet/Inches): ____________ 5. Weight (stone/pound): ___________

Your Health

6. Are you in good health at the present time? Yes No

7. Are you currently taking any medication and/or undergoing treatment that affects your diet or taste?

If yes please specify: ______________________________

8. Do you have any health problems that affect your diet? Yes No

9. Do you smoke? Yes No

10. Are you pregnant or have recently had a baby (within the last year)?

Yes No

If yes, has this affected your taste or have you gone off any foods? Yes No

Please specify: ______________________________

Your Diet

11. On average how much alcohol do you consume per week (please state quantity)?

Glasses of wine (small, 125 ml): _________Spirits (pub measures): _________

Half Pints (strong, 5% or above): ____________Half Pints (normal strength): _______________

Alco-pops: __________ Other, please state: ______________________________

12. Do you have any dietary restrictions e.g. vegan, vegetarian? Yes No

If yes, please specify: ______________________________

And for what reason? Ethical Religious Other

13. Are you currently on a diet? Yes No

☐ Calorie controlled Atkins Weight Watchers GI Slimming World

Other, please specify: ______________________________

14. Is there anything you exclude from your diet? Yes No

If yes, please specify: ______________________________

15. Do you have any food allergies and/or intolerances? Yes No

If yes, please specify: ______________________________

16. Does anything else affect your diet or taste not mentioned so far? Yes No

If yes, please specify: ______________________________

Appendix 12 – Matrix of ingredient quantity for Study 3 by number of participants and for each drink

People	Water (ml)	Lemon (ml)	Sample A	Sample B	Sample C	Sample D	Sample E
6	100	25	0	5	10	20	30
13	200	50	0	10	20	40	60
20	300	75	0	15	30	60	90
27	400	100	0	20	40	80	120
34	500	125	0	25	50	100	150
41	600	150	0	30	60	120	180
48	700	175	0	35	70	140	210
55	800	200	0	40	80	160	240
62	900	225	0	45	90	180	270
69	1000	250	0	50	100	200	300
76	1100	275	0	55	110	220	330
83	1200	300	0	60	120	240	360
90	1300	325	0	65	130	260	390
97	1400	350	0	70	140	280	420
104	1500	375	0	75	150	300	450

Appendix 13 – Debriefing for Study 3

Debriefing

You have just taken part in a study with aims to look at individual differences in preference for sour and sweet tastes. The taste samples you have consumed each contained varying intensities of glucose. Previous research has found that clinical populations such as obese and eating disordered individuals show preference for particular tastes. A previous study I conducted found that preference for sweet and sour tastes could be explained by certain personality traits, particularly those relating to novelty seeking and harm avoidance. Research in non-clinical populations is limited in this area.

If you have any questions about the nature of the study or my research in general please do not hesitate to ask them now. If however you wish to ask any questions at a later date please contact me by email or telephone, my details are available on your consent form.

Thank you again for taking part.

Appendix 14 – Point biserial correlations for each drink by liking, sour and sweet scores

Drink A

Correlations

		Preferred drink	Liking	Sour rating	Sweet rating
Preferred drink	Pearson Correlation	1.000	.199	-.222*	.182
	Sig. (2-tailed)		.067	.040	.094
	N	86.000	86	86	86
Liking	Pearson Correlation	.199	1.000	-.396**	.357**
	Sig. (2-tailed)	.067		.000	.001
	N	86	86.000	86	86
Sour rating	Pearson Correlation	-.222*	-.396**	1.000	-.359**
	Sig. (2-tailed)	.040	.000		.001
	N	86	86	86.000	86
Sweet rating	Pearson Correlation	.182	.357**	-.359**	1.000
	Sig. (2-tailed)	.094	.001	.001	
	N	86	86	86	86.000

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

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

Drink B

Correlations

		Preferred drink	Liking	Sour rating	Sweet rating
Preferred drink	Pearson Correlation	1.000	.268*	-.209	.240*
	Sig. (2-tailed)		.013	.054	.026
	N	86.000	86	86	86
Liking	Pearson Correlation	.268*	1.000	-.417**	.460**
	Sig. (2-tailed)	.013		.000	.000
	N	86	86.000	86	86
Sour rating	Pearson Correlation	-.209	-.417**	1.000	-.579**
	Sig. (2-tailed)	.054	.000		.000
	N	86	86	86.000	86
Sweet rating	Pearson Correlation	.240*	.460**	-.579**	1.000
	Sig. (2-tailed)	.026	.000	.000	
	N	86	86	86	86.000

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

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

Drink C

Correlations

		Preferred drink	Liking	Sour rating	Sweet rating
Preferred drink	Pearson Correlation	1.000	.235*	-.099	.104
	Sig. (2-tailed)		.029	.367	.339
	N	86.000	86	86	86
Liking	Pearson Correlation	.235*	1.000	-.415**	.485**
	Sig. (2-tailed)	.029		.000	.000
	N	86	86.000	86	86
Sour rating	Pearson Correlation	-.099	-.415**	1.000	-.434**
	Sig. (2-tailed)	.367	.000		.000
	N	86	86	86.000	86
Sweet rating	Pearson Correlation	.104	.485**	-.434**	1.000
	Sig. (2-tailed)	.339	.000	.000	
	N	86	86	86	86.000

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

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

Drink D

Correlations

		Preferred drink	Liking	Sour rating	Sweet rating
Preferred drink	Pearson Correlation	1.000	.318**	-.053	.161
	Sig. (2-tailed)		.003	.632	.140
	N	86.000	85	85	85
Liking	Pearson Correlation	.318**	1.000	-.365**	.389**
	Sig. (2-tailed)	.003		.001	.000
	N	85	85.000	85	85
Sour rating	Pearson Correlation	-.053	-.365**	1.000	-.393**
	Sig. (2-tailed)	.632	.001		.000
	N	85	85	85.000	85
Sweet rating	Pearson Correlation	.161	.389**	-.393**	1.000
	Sig. (2-tailed)	.140	.000	.000	
	N	85	85	85	85.000

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

Drink E

Correlations

		Preferred drink	Liking	Sour rating	Sweet rating
Preferred drink	Pearson Correlation	1.000	.089	.174	.097
	Sig. (2-tailed)		.414	.110	.375
	N	86.000	86	86	86
Liking	Pearson Correlation	.089	1.000	-.392**	.242*
	Sig. (2-tailed)	.414		.000	.025
	N	86	86.000	86	86
Sour rating	Pearson Correlation	.174	-.392**	1.000	-.356**
	Sig. (2-tailed)	.110	.000		.001
	N	86	86	86.000	86
Sweet rating	Pearson Correlation	.097	.242*	-.356**	1.000
	Sig. (2-tailed)	.375	.025	.001	
	N	86	86	86	86.000

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

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

Appendix 15 - Full multilevel model developed to explain the relationship and interaction of scores of sweet and sour

Information Criteria[a]

-2 Restricted Log Likelihood	3861.889
Akaike's Information Criterion (AIC)	3869.889
Hurvich and Tsai's Criterion (AICC)	3869.985
Bozdogan's Criterion (CAIC)	3890.088
Schwarz's Bayesian Criterion (BIC)	3886.088

The information criteria are displayed in smaller-is-better forms.

a. Dependent Variable: Liking.

Type III Tests of Fixed Effects[a]

Source	Numerator df	Denominator df	F	Sig.
Intercept	1	78.340	703.503	.000
Drink	4	397.208	16.590	.000

a. Dependent Variable: Liking.

Covariance Parameters

Estimates of Covariance Parameters[a]

Parameter		Estimate	Std. Error	Wald Z	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Residual		218.048077	46.537958	4.685	.000	143.509445	331.301983
Sourrating	Variance	71.639376	33.293038	2.152	.031	28.811911	178.127726
Sweetrating	Variance	61.003360	30.302308	2.013	.044	23.042781	161.500035
Sourrating * Sweetrating	Variance	205.530939	57.112122	3.599	.000	119.219885	354.328198

a. Dependent Variable: Liking.

Estimates of Fixed Effects[b]

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	54.716117	2.800880	271.734	19.535	.000	49.201934	60.230300
[Drink=1]	-25.806656	3.807567	396.577	-6.778	.000	-33.292194	-18.321118
[Drink=2]	-19.626577	3.680143	408.954	-5.333	.000	-26.860934	-12.392219
[Drink=3]	-8.747330	3.580007	412.477	-2.443	.015	-15.784663	-1.709997
[Drink=4]	-.904531	3.456034	414.665	-.262	.794	-7.698062	5.889000
[Drink=5]	0[a]	0	.	.	.	.	.

a. This parameter is set to zero because it is redundant.

b. Dependent Variable: Liking.

Appendix 16 – Background measures taken for Study 4

Sheffield Hallam University
SHARPENS YOUR THINKING

Background Questionnaire

About You

1. Age: ___________ 2. Sex: Male Female

3. Please state your occupation: ______________________________

4. Please give your height (feet/Inches): ________5. Weight (stone/pound): __________

Your Health

6. Are you in good health at the present time? Yes No

7. Are you currently taking any medication and/or undergoing treatment that affects your diet or taste?

If yes please specify: ______________________________

8. Do you have any health problems that affect your diet? Yes No

9. Do you smoke? Yes No

10. Are you pregnant or have recently had a baby (within the last year)? Yes No

If yes, has this affected your taste or have you gone off any foods? Yes No

Please specify: ______________________________

Your Diet

11. On average how much alcohol do you consume per week (please state quantity)?

Glasses of wine (small, 125 ml): _______ Spirits (pub measures): _________

Half Pints (strong, 5% or above): _______ Half Pints (normal strength): ______

Alco-pops: ________ Other, please state: ______________

12. Do you have any dietary restrictions e.g. vegan, vegetarian? Yes No

If yes, please specify: ______________________________

And for what reason? Ethical Religious Other

13. Are you currently on a diet? Yes No

Calorie controlled Atkins Weight Watchers GI Slimming World

Other, please specify: ______________________________

14. Is there anything you exclude from your diet? Yes No

If yes, please specify: ______________________________

15. Do you have any food allergies and/or intolerances? Yes No

If yes, please specify: ______________________________

16. Does anything else affect your diet or taste not mentioned so far? Yes No

If yes, please specify: ______________________________

Appendix 17 – UK adapted version of the Fat Preference Questionnaire© (FPQ©)

Food Preference Questionnaire

Instructions: You will be presented with 19 sets of foods. For each set, please:

a. Indicate if you **have ever** eaten the foods by checking either Yes ☑ or No ☑ for each item.

b. Circle the number next to the food that you think **tastes better**, like this: Cake ---------- 1

c. Circle the number next to the food that you **eat more often**, like this: Bread --------- 2

Consider your *current* preferences when selecting which foods taste better and which foods you eat more often.

Assume that all foods have not been modified in calories, sugar, or fat, unless it is specifically stated otherwise.

---

1. Chocolate or boiled sweets

a. Have you ever eaten:

Chocolate? Yes ☐ No ☐

Boiled sweets? Yes ☐ No ☐

If you answered "No" for all of the items above, please go to Question 2.

b. Which food tastes better? (Circle one)

Chocolate ---------------------------- 1

Boiled sweets ------------------------------ 2

c. Which food do you eat more often? (Circle one)

Chocolate ---------------------------- 1

Boiled sweets -------------------------------- 2

I no longer eat any of these foods ------- 3

---

2. Bagel with Cream Cheese *or* Plain Bagel

a. Have you ever eaten:

Bagel with *regular* cream cheese, butter, or margarine? Yes ☐ No ☐

Bagel with *low-fat* cream cheese, butter, or margarine? Yes ☐ No ☐

Plain bagel? Yes ☐ No ☐

If you answered "No" for all of the items above, please go to Question 3.

b. Which food tastes better? (Circle one)

Bagel with *regular* cream cheese/butter/margarine --------- 1

Bagel with *low-fat* cream cheese/butter/margarine --- 2

Plain bagel -- 3

c. Which food do you eat more often? (Circle one)

Bagel with *regular* cream cheese/butter/margarine ---------	1
Bagel with *low-fat* cream cheese/butter/margarine ---	2
Plain bagel ---	3
I no longer eat any of these foods ----------------------------	4

3. Baked Potatoes *or* Chips

a. Have you ever eaten:

Baked potato with sour cream or butter?	Yes ☐	No ☐
Chips?	Yes ☐	No ☐
Baked potato with low-fat topping?	Yes ☐	No ☐
Plain baked potato?	Yes ☐	No ☐

If you answered "No" for all of the items above, please go to Question 4.

b. Which food tastes better? (Circle one)

Baked potato with sour cream or butter --	1
Chips ----------------------------------	2
Baked potato with low-fat topping --	3
Plain baked potato --------------------------	4

c. Which food do you eat more often? (Circle one)

Baked potato with sour cream or butter --	1
Chips ----------------------------------	2
Baked potato with reduced-fat topping --	3
Plain baked potato --------------------------	4
I no longer eat any of these foods -------	5

4. Full-fat Ice Cream *or* low-fat Ice Cream

a. Have you ever eaten:

Full-fat ice cream?	Yes ☐	No ☐
Low-fat ice cream?	Yes ☐	No ☐

If you answered "No" for all of the items above, please go to Question 5.

b. Which food tastes better? (Circle one)

Full-fat ice cream ---------------------------	1
Low-fat ice cream --------------------	2

c. Which food do you eat more often? (Circle one)

Full-fat ice cream ---------------------------	1
Low-fat ice cream --------------------	2
I no longer eat any of these foods -------	3

5. Cream Soups *or* Clear/low calorie soups

a. Have you ever eaten:

Cream soups?	Yes ☐	No ☐
Clear/low calorie soups?	Yes ☐	No ☐

If you answered "No" for all of the items above, please go to Question 6.

b. Which food tastes better? (Circle one)

Cream soups -------------------------------------	1
Clear soups --	2

c. Which food do you eat more often? (Circle one)

Cream soups -------------------------------------	1
Clear soups --	2
I no longer eat any of these foods ------------	3

6. Sautéed/Fried/Roasted Vegetables *or* Plain Steamed/Boiled Vegetables

a. Have you ever eaten: Sautéed or fried vegetables? Yes ☐ No ☐
Steamed/boiled vegetables? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 7.

b. Which food tastes better? (Circle one)
Sautéed or fried vegetables -------------------- 1
Plain steamed vegetables ---------------------- 2

c. Which food do you eat more often? (Circle one)
Sautéed or fried vegetables -------------------- 1
Plain steamed vegetables ---------------------- 2
I no longer eat any of these foods ------------ 3

---

7. Sandwiches with Mayonnaise *or* Sandwiches without Mayonnaise

a. Have you ever eaten: Sandwiches with *regular* mayonnaise? Yes ☐ No ☐
Sandwiches with *low-fat* mayonnaise? Yes ☐ No ☐
Sandwiches *without* mayonnaise? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 8.

b. Which food tastes better? (Circle one)
Sandwiches with *regular* mayonnaise -------- 1
Sandwiches with *low-fat* mayonnaise -- 2
Sandwiches *without* mayonnaise ------------- 3

c. Which food do you eat more often? (Circle one)
Sandwiches with *regular* mayonnaise -------- 1
Sandwiches with *low-fat* mayonnaise -- 2
Sandwiches *without* mayonnaise ------------- 3
I no longer eat any of these foods ------------ 4

---

8. Full-fat Cheese *or* Low-fat Cheese

a. Have you ever eaten: Full-fat cheese? Yes ☐ No ☐
Low-fat cheese? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 9.

b. Which food tastes better? (Circle one)
Full-fat cheese ------------------------------------ 1
Low-fat cheese ---------------------------- 2

c. Which food do you eat more often? (Circle one)
Full-fat cheese ------------------------------------ 1
Low-fat cheese ---------------------------- 2
I no longer eat any of these foods ------------ 3

---

9. Toast with butter/margarine or toast with low-fat spread

a. Have you ever eaten: Toast butter/margarine? Yes ☐ No ☐
Toast with *low-fat* margarine? Yes ☐ No ☐
Toast *without* butter/margarine? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 10.

b. Which food tastes better? (Circle one)

Toast with *regular* butter/margarine	1
Toast with *low-fat* margarine	2
Toast *without* butter/margarine	3

c. Which food do you eat more often? (Circle one)

Toast with *regular* butter/margarine	1
Toast with *low-fat* margarine	2
Toast *without* butter/margarine	3
I no longer eat any of these foods	4

---

10. Baked/Steamed/Grilled Fish *or* Fried Fish

a. Have you ever eaten: Baked, steamed or grilled fish? Yes ☐ No ☐
Fried fish? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 11.

b. Which food tastes better? (Circle one)

Baked, steamed, or grilled fish	1
Fried fish	2

c. Which food do you eat more often? (Circle one)

Baked, streamed, or grilled fish	1
Fried fish	2
I no longer eat any of these foods	3

---

11. Hamburger *or* Grilled Chicken Sandwich

a. Have you ever eaten: A hamburger? Yes ☐ No ☐
A grilled chicken sandwich? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 12.

b. Which food tastes better? (Circle one)

Hamburger	1
Grilled chicken sandwich	2

c. Which food do you eat more often? (Circle one)

Hamburger	1
Grilled chicken sandwich	2
I no longer eat any of these foods	3

---

12 Salad with Full-fat Dressing *or* Salad with low-fat Dressing

a. Have you ever eaten: Salad with *full-fat* dressing Yes ☐ No ☐
Salad with *low-fat* dressing? Yes ☐ No ☐
Salad without dressing Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 13.

b. Which food tastes better? (Circle one)

Salad with *full-fat* dressing	1
Salad with *low-fat* dressing	2
Salad without dressing	3

c. Which food do you eat more often? (Circle one)

Salad with *full-fat* dressing	1
Salad with *low-fat* dressing	2

Salad without dressing ------------------------ 3
I no longer eat any of these foods ------------ 4

---

13. Pasta with Tomato Sauce *or* Pasta with Cream/Cheese Sauce

a. Have you ever eaten: Pasta with tomato sauce? Yes ☐ No ☐
Pasta with cream or cheese sauce? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 14.

b. Which food tastes better? (Circle one)
Pasta with tomato sauce ------------------ 1
Pasta with cream or cheese sauce ------ 2

c. Which food do you eat more often? (Circle one)
Pasta with tomato sauce ------------------ 1
Pasta with cream or cheese sauce ------ 2
I no longer eat any of these foods ------- 3

---

14. Regular Cheese Pizza *or* Pizza with Extra Cheese or Meat (Pepperoni, Sausage, Salami, Bacon)

a. Have you ever eaten: Regular cheese pizza? Yes ☐ No ☐
Pizza with meat or extra cheese? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 15.

b. Which food tastes better? (Circle one)
Regular cheese pizza ---------------------- 1
Pizza with meat or extra cheese --------- 2

c. Which food do you eat more often? (Circle one)
Regular cheese pizza ---------------------- 1
Pizza with meat or extra cheese --------- 2
I no longer eat any of these foods ------- 3

---

15. Plain Raw Vegetables *or* Vegetables with Dip

a. Have you ever eaten: Plain raw vegetables? Yes ☐ No ☐
Vegetables with *reduced-fat* dip? Yes ☐ No ☐
Vegetables with *full-fat* dip? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 16.

b. Which food tastes better? (Circle one)
Plain raw vegetables ----------------------- 1
Vegetables with *reduced-fat* dip ---------- 2
Vegetables with *full-fat* dip ---------------- 3

c. Which food do you eat more often? (Circle one)
Plain raw vegetables ----------------------- 1
Vegetables with *reduced-fat* dip --------- 2
Vegetables with *full-fat* dip ---------------- 3
I no longer eat any of these foods ------- 4

---

16. Reduced-fat biscuits *or* Full-fat biscuits

a. Have you ever eaten: Reduced-fat biscuits? Yes ☐ No ☐
Full-fat biscuits? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 17.

b. Which food tastes better? (Circle one)

Reduced-fat biscuits	1
Full-fat biscuits	2

c. Which food do you eat more often? (Circle one)

Reduced-fat biscuits	1
Full-fat biscuits	2
I no longer eat any of these foods	3

17. Fried Chicken *or* Grilled/Baked Chicken

a. Have you ever eaten:

Fried chicken? Yes ☐ No ☐
Grilled or baked chicken? Yes ☐ No ☐

If you answered "No" for all of the items above, please go to Question 18.

b. Which food tastes better? (Circle one)

Fried chicken	1
Grilled or baked chicken	2

c. Which food do you eat more often? (Circle one)

Fried chicken	1
Grilled or baked chicken	2
I no longer eat any of these foods	3

18. Low-fat crisps or full-fat (normal) crisps

a. Have you ever eaten:

low-fat potato chips? Yes ☐ No ☐
Full-fat potato chips? Yes ☐ No ☐

If you answered "No" for all of the items above, please go to Question 19.

b. Which food tastes better? (Circle one)

Low-fat potato chips	1
Full-fat potato chips	2

c. Which food do you eat more often? (Circle one)

Low-fat potato chips	1
Full-fat potato chips	2
I no longer eat any of these foods	3

19. Skimmed Milk *or* Semi-skimmed Milk *or* Whole Milk

a. Have you ever eaten:

Skimmed milk? Yes ☐ No ☐
Semi-skimmed milk? Yes ☐ No ☐
Whole milk? Yes ☐ No ☐
Other, please specify:

If you answered "No" for all of the items above,
you are finished with the questionnaire.

b. Which food tastes better? (Circle one)

Skimmed milk	1
Semi-skimmed milk	2
Whole milk	3
Other	4

c. Which food do you eat more often? (Circle one)

Skimmed milk	1
Semi-skimmed milk	2
Whole milk	3
Other	4
I no longer eat any of these foods	5

Appendix 18 - Fat Preference Questionnaire© original version

Food Preference Questionnaire

Instructions: You will be presented with 19 sets of foods. For each set, please:

a. Indicate if you **have ever** eaten the foods by checking either Yes ☑ or No ☑ for each item.

b. Circle the number next to the food that you think **tastes better**, like this: Cake ------- 1

c. Circle the number next to the food that you **eat more often**, like this: Bread -------- 2

Consider your *current* preferences when selecting which foods taste better and which foods you eat more often.

Assume that all foods have not been modified in calories, sugar, or fat, unless it is specifically stated otherwise.

---

1. Chocolate Candy *or* Hard Candy

a. Have you ever eaten: Chocolate candy? Yes ☐ No ☐
Hard candy? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 2.

b. Which food tastes better? (Circle one)
Chocolate candy ---------------------------- 1
Hard candy ---------------------------------- 2

c. Which food do you eat more often? (Circle one)
Chocolate candy ---------------------------- 1
Hard candy ---------------------------------- 2
I no longer eat any of these foods ------- 3

---

2. Bagel with Cream Cheese *or* Plain Bagel

a. Have you ever eaten: Bagel with *regular* cream cheese, butter, or margarine? Yes ☐ No ☐
Bagel with *reduced-fat* cream cheese, butter, or margarine? Yes ☐ No ☐
Plain bagel? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 3.

b. Which food tastes better? (Circle one)
Bagel with *regular* cream cheese/butter/margarine --------- 1
Bagel with *reduced-fat* cream cheese/butter/margarine --- 2

Plain bagel -- 3

c. Which food do you eat more often? (Circle one)

Bagel with *regular* cream cheese/butter/margarine --------- 1
Bagel with *reduced-fat* cream cheese/butter/margarine --- 2
Plain bagel -- 3
I no longer eat any of these foods ----------------------------- 4

---

3. Baked Potatoes *or* French Fries

a. Have you ever eaten:

Baked potato with sour cream or butter? Yes ☐ No ☐
French fries? Yes ☐ No ☐
Baked potato with reduced-fat topping? Yes ☐ No ☐
Plain baked potato? Yes ☐ No ☐

If you answered "No" for all of the items above, please go to Question 4.

b. Which food tastes better? (Circle one)

Baked potato with sour cream or butter -- 1
French fries ---------------------------------- 2
Baked potato with reduced-fat topping -- 3
Plain baked potato -------------------------- 4

c. Which food do you eat more often? (Circle one)

Baked potato with sour cream or butter -- 1
French fries ---------------------------------- 2
Baked potato with reduced-fat topping -- 3
Plain baked potato -------------------------- 4
I no longer eat any of these foods ------- 5

---

4. Full-fat Ice Cream *or* Reduced-fat Ice Cream

a. Have you ever eaten:

Full-fat ice cream? Yes ☐ No ☐
Reduced-fat ice cream? Yes ☐ No ☐

If you answered "No" for all of the items above, please go to Question 5.

b. Which food tastes better? (Circle one)

Full-fat ice cream --------------------------- 1
Reduced-fat ice cream -------------------- 2

c. Which food do you eat more often? (Circle one)

Full-fat ice cream --------------------------- 1
Reduced-fat ice cream -------------------- 2
I no longer eat any of these foods ------- 3

---

5. Cream Soups *or* Clear Soups

a. Have you ever eaten:

Cream soups? Yes ☐ No ☐
Clear soups? Yes ☐ No ☐

If you answered "No" for all of the items above, please go to Question 6.

b. Which food tastes better? (Circle one)

Cream soups ------------------------------------- 1
Clear soups -- 2

c. Which food do you eat more often? (Circle one)

Cream soups ------------------------------------- 1

Clear soups	2
I no longer eat any of these foods	3

6. Sautéed/Fried Vegetables *or* Plain Steamed Vegetables

a. Have you ever eaten: Sautéed or fried vegetables? Yes ☐ No ☐
Plain steamed vegetables? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 7.

b. Which food tastes better? (Circle one)

Sautéed or fried vegetables	1
Plain steamed vegetables	2

c. Which food do you eat more often? (Circle one)

Sautéed or fried vegetables	1
Plain steamed vegetables	2
I no longer eat any of these foods	3

7. Sandwiches with Mayonnaise *or* Sandwiches without Mayonnaise

a. Have you ever eaten: Sandwiches with *regular* mayonnaise? Yes ☐ No ☐
Sandwiches with *reduced-fat* mayonnaise? Yes ☐ No ☐
Sandwiches *without* mayonnaise? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 8.

b. Which food tastes better? (Circle one)

Sandwiches with *regular* mayonnaise	1
Sandwiches with *reduced-fat* mayonnaise	2
Sandwiches *without* mayonnaise	3

c. Which food do you eat more often? (Circle one)

Sandwiches with *regular* mayonnaise	1
Sandwiches with *reduced-fat* mayonnaise	2
Sandwiches *without* mayonnaise	3
I no longer eat any of these foods	4

8. Full-fat Cheese *or* Reduced-fat Cheese

a. Have you ever eaten: Full-fat cheese? Yes ☐ No ☐
Reduced-fat cheese? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 9.

b. Which food tastes better? (Circle one)

Full-fat cheese	1
Reduced-fat cheese	2

c. Which food do you eat more often? (Circle one)

Full-fat cheese	1
Reduced-fat cheese	2
I no longer eat any of these foods	3

9. Pancakes with Butter/Margarine *or* Pancakes without Butter/Margarine

a. Have you ever eaten: Pancakes with *regular* butter/margarine? Yes ☐ No ☐
Pancakes with *reduced-fat* margarine? Yes ☐ No ☐
Pancakes *without* butter/margarine? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 10.

b. Which food tastes better? (Circle one)

Pancakes with *regular* butter/margarine	1
Pancakes with *reduced-fat* margarine	2

	Pancakes *without* butter/margarine ----------- 3
c. Which food do you eat more often? (Circle one)	Pancakes with *regular* butter/margarine ----- 1
	Pancakes with *reduced-fat* margarine -------- 2
	Pancakes *without* butter/margarine ----------- 3
	I no longer eat any of these foods ------------- 4

10. Baked/Broiled/Grilled Fish *or* Fried Fish

a. Have you ever eaten: Baked, broiled or grilled fish? Yes ☐ No ☐
Fried fish? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 11.

b. Which food tastes better? (Circle one)	Baked, broiled, or grilled fish ------------------- 1
	Fried fish -- 2
c. Which food do you eat more often? (Circle one)	Baked, broiled, or grilled fish ------------------- 1
	Fried fish -- 2
	I no longer eat any of these foods ------------- 3

11. Hamburger *or* Grilled Chicken Sandwich

a. Have you ever eaten: A hamburger? Yes ☐ No ☐
A grilled chicken sandwich? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 12.

b. Which food tastes better? (Circle one)	Hamburger -- 1
	Grilled chicken sandwich ----------------------- 2
c. Which food do you eat more often? (Circle one)	Hamburger -- 1
	Grilled chicken sandwich ----------------------- 2
	I no longer eat any of these foods ------------- 3

12. Salad with Full-fat Dressing *or* Salad with Reduced-fat Dressing

a. Have you ever eaten: Salad with *full-fat* dressing Yes ☐ No ☐
Salad with *reduced-fat* dressing? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 13.

b. Which food tastes better? (Circle one)	Salad with *full-fat* dressing ---------------------- 1
	Salad with *reduced-fat* dressing --------------- 2
c. Which food do you eat more often? (Circle one)	Salad with *full-fat* dressing ---------------------- 1
	Salad with *reduced-fat* dressing --------------- 2
	I no longer eat any of these foods ------------- 3

13. Pasta with Tomato Sauce *or* Pasta with Cream/Cheese Sauce

a. Have you ever eaten: Pasta with tomato sauce? Yes ☐ No ☐
Pasta with cream or cheese sauce? Yes ☐ No ☐
If you answered "No" for all of the items above, please go to Question 14.

b. Which food tastes better? (Circle one)	Pasta with tomato sauce ------------------- 1
	Pasta with cream or cheese sauce ------ 2

c. Which food do you eat more often? (Circle one)

Pasta with tomato sauce	1
Pasta with cream or cheese sauce	2
I no longer eat any of these foods	3

14. Regular Cheese Pizza *or* Pizza with Meat (Pepperoni, Sausage, Salami, Bacon) or Extra Cheese

a. Have you ever eaten:

Regular cheese pizza?	Yes ☐	No ☐
Pizza with meat or extra cheese?	Yes ☐	No ☐

If you answered "No" for all of the items above, please go to Question 15.

b. Which food tastes better? (Circle one)

Regular cheese pizza	1
Pizza with meat or extra cheese	2

c. Which food do you eat more often? (Circle one)

Regular cheese pizza	1
Pizza with meat or extra cheese	2
I no longer eat any of these foods	3

15. Plain Raw Vegetables *or* Vegetables with Dip

a. Have you ever eaten:

Plain raw vegetables?	Yes ☐	No ☐
Vegetables with *reduced-fat* dip?	Yes ☐	No ☐
Vegetables with *full-fat* dip?	Yes ☐	No ☐

If you answered "No" for all of the items above, please go to Question 16.

b. Which food tastes better? (Circle one)

Plain raw vegetables	1
Vegetables with *reduced-fat* dip	2
Vegetables with *full-fat* dip	3

c. Which food do you eat more often? (Circle one)

Plain raw vegetables	1
Vegetables with *reduced-fat* dip	2
Vegetables with *full-fat* dip	3
I no longer eat any of these foods	4

16. Reduced-fat Cookies *or* Full-fat Cookies

a. Have you ever eaten:

Reduced-fat cookies?	Yes ☐	No ☐
Full-fat cookies?	Yes ☐	No ☐

If you answered "No" for all of the items above, please go to Question 17.

b. Which food tastes better? (Circle one)

Reduced-fat cookies	1
Full-fat cookies	2

c. Which food do you eat more often? (Circle one)

Reduced-fat cookies	1
Full-fat cookies	2
I no longer eat any of these foods	3

17. Fried Chicken *or* Grilled/Baked/Broiled Chicken

a. Have you ever eaten:

Fried chicken?	Yes ☐	No ☐
Grilled, baked, or broiled chicken?	Yes ☐	No ☐

If you answered "No" for all of the items above, please go to Question 18.

b. Which food tastes better? (Circle one)

Fried chicken	1

	Grilled, baked, or broiled chicken -------- 2
c. Which food do you eat more often? (Circle one)	Fried chicken -------------------------------- 1
	Grilled, baked, or broiled chicken -------- 2
	I no longer eat any of these foods ------- 3

---

18. Reduced-fat Potato Chips *or* Full-fat Potato Chips

a. Have you ever eaten:

Reduced-fat potato chips?	Yes ☐	No ☐
Full-fat potato chips?	Yes ☐	No ☐

If you answered "No" for all of the items above, please go to Question 19.

b. Which food tastes better? (Circle one)	Reduced-fat potato chips ----------------- 1
	Full-fat potato chips ------------------------ 2
c. Which food do you eat more often? (Circle one)	Reduced-fat potato chips ----------------- 1
	Full-fat potato chips ------------------------ 2
	I no longer eat any of these foods ------- 3

---

19. Skim Milk *or* Low-fat Milk *or* Whole Milk

a. Have you ever eaten:

Skim milk?	Yes ☐	No ☐
1% milk?	Yes ☐	No ☐
2% milk?	Yes ☐	No ☐
Whole milk?	Yes ☐	No ☐

If you answered "No" for all of the items above,
you are finished with the questionnaire.

b. Which food tastes better? (Circle one)	Skim milk ------------------------------------ 1
	1% milk -- 2
	2% milk -- 3
	Whole milk ----------------------------------- 4
c. Which food do you eat more often? (Circle one)	Skim milk ------------------------------------ 1
	1% milk -- 2
	2% milk -- 3
	Whole milk ----------------------------------- 4
	I no longer eat any of these foods ------- 5

Please go back over the questionnaire and be sure that you have answered every question.

Thank you for your participation.

Appendix 19 – Consent form for Study 4

Sheffield Hallam University
SHARPENS YOUR THINKING

Consent Form

This study is concerned with individual differences in eating behaviour. You will be asked to complete a questionnaire booklet containing a background questionnaire related to general health and diet; a personality questionnaire; and 2 eating behaviour questionnaires. Please follow the instructions of each of these in turn.

Confidentiality

All data recorded from this study will be kept confidential. You will be asked to fill out a unique identification code which will be used to match up your completed questionnaires. You will not be asked to put your name on any questionnaires. Your identity will not be revealed in any written reports. The researcher will have the only access to the data collected from this study.

Right to withdraw

If you have any objections now or later decide to withdraw from the study you are free to do so without giving the researcher or anyone else reason for doing so.

Contacts and Questions

If you wish to ask any questions or discuss any issues regarding this research please contact me by phone [redacted] or by email [redacted]

Consent

I have thoroughly read the information above. I give my full consent to take part.

Signature: .... Date: ....

Please complete the following personal identification code. The code should consist of the first 2 letters of your mother's maiden name, followed by the day of your birthday, followed by your house number e.g. SH1222). If you have taken part in any previous studies conducted by Catherine Day please use the same code. This code will be unique to you; you will not be identifiable. You will need to remember this code as you will require it again later.

CODE: | | | | | | |

Appendix 20 – Full Hierarchical Regression Models for the subscales of the FPQ (entered as criterions), with TFEQ subscales, BMI and TPQ subscales (entered as predictors)

Regression: TASTE subscale

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.281[a]	.079	.063	2.86580	.079	5.113	4	239	.001
2	.367[b]	.134	.073	2.85033	.056	1.217	12	227	.272

a. Predictors: (Constant), Total Hunger, BMI, Total Restraint, Total Disinhibition

b. Predictors: (Constant), Total Hunger, BMI, Total Restraint, Total Disinhibition, Extravagence (NS3), Sentimentality (RD1), Shyness with strangers (HA3), Persistence (RD2), Attachment (RD3), Exploratory excitability (NS1), Fatigability (HA4), Disorderliness (NS4), Dependence (RD4), Impulsiveness (NS2), Anticipatory worry (HA1), Fear of uncertainity (HA2)

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	167.967	4	41.992	5.113	.001[a]
	Residual	1962.865	239	8.213		
	Total	2130.832	243			
2	Regression	286.594	16	17.912	2.205	.006[b]
	Residual	1844.238	227	8.124		
	Total	2130.832	243			

a. Predictors: (Constant), Total Hunger, BMI, Total Restraint, Total Disinhibition

b. Predictors: (Constant), Total Hunger, BMI, Total Restraint, Total Disinhibition, Extravagence (NS3), Sentimentality (RD1), Shyness with strangers (HA3), Persistence (RD2), Attachment (RD3), Exploratory excitability (NS1), Fatigability (HA4), Disorderliness (NS4), Dependence (RD4), Impulsiveness (NS2), Anticipatory worry (HA1), Fear of uncertainity (HA2)

c. Dependent Variable: TASTE

Hierarchical regression model for TASTE (continued)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	21.429	1.175		18.237	.000
	BMI	-.030	.050	-.039	-.589	.556
	Total Restraint	-.133	.038	-.235	-3.519	.001
	Total Disinhibition	.110	.065	.138	1.701	.090
	Total Hunger	.048	.067	.056	.716	.475
2	(Constant)	20.397	1.893		10.774	.000
	BMI	-.022	.052	-.028	-.415	.679
	Total Restraint	-.122	.039	-.216	-3.095	.002
	Total Disinhibition	.107	.068	.134	1.565	.119
	Total Hunger	.042	.068	.049	.617	.538
	Exploratory excitability (NS1)	-.088	.123	-.054	-.718	.474
	Impulsiveness (NS2)	-.052	.109	-.036	-.482	.630
	Extravagence (NS3)	.169	.114	.103	1.476	.141
	Disorderliness (NS4)	.022	.104	.016	.214	.830
	Anticipatory worry (HA1)	-.055	.083	-.054	-.658	.511
	Fear of uncertainity (HA2)	-.241	.121	-.176	-1.990	.048
	Shyness with strangers (HA3)	.052	.117	.035	.449	.654
	Fatigability (HA4)	.091	.083	.078	1.099	.273
	Sentimentality (RD1)	-.019	.179	-.007	-.104	.917
	Persistence (RD2)	-.021	.092	-.015	-.229	.819
	Attachment (RD3)	.083	.083	.071	.999	.319
	Dependence (RD4)	.273	.164	.123	1.661	.098

a. Dependent Variable: TASTE

Regression: FREQ subscale

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.584[a]	.341	.330	2.74146	.341	30.932	4	239	.000
2	.616[b]	.380	.336	2.72975	.038	1.171	12	227	.305

a. Predictors: (Constant), Total Hunger, BMI, Total Restraint, Total Disinhibition

b. Predictors: (Constant), Total Hunger, BMI, Total Restraint, Total Disinhibition, Extravagence (NS3), Sentimentality (RD1), Shyness with strangers (HA3), Persistence (RD2), Attachment (RD3), Exploratory excitability (NS1), Fatigability (HA4), Disorderliness (NS4), Dependence (RD4), Impulsiveness (NS2), Anticipatory worry (HA1), Fear of uncertainity (HA2)

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	929.884	4	232.471	30.932	.000[a]
	Residual	1796.226	239	7.516		
	Total	2726.111	243			
2	Regression	1034.612	16	64.663	8.678	.000[b]
	Residual	1691.498	227	7.452		
	Total	2726.111	243			

a. Predictors: (Constant), Total Hunger, BMI, Total Restraint, Total Disinhibition

b. Predictors: (Constant), Total Hunger, BMI, Total Restraint, Total Disinhibition, Extravagence (NS3), Sentimentality (RD1), Shyness with strangers (HA3), Persistence (RD2), Attachment (RD3), Exploratory excitability (NS1), Fatigability (HA4), Disorderliness (NS4), Dependence (RD4), Impulsiveness (NS2), Anticipatory worry (HA1), Fear of uncertainity (HA2)

c. Dependent Variable: FREQ

Hierarchical regression model for FREQ (continued)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	23.089	1.124		20.541	.000
	BMI	-.154	.048	-.178	-3.178	.002
	Total Restraint	-.325	.036	-.508	-8.991	.000
	Total Disinhibition	.062	.062	.069	1.006	.315
	Total Hunger	.091	.064	.094	1.417	.158
2	(Constant)	22.580	1.813		12.453	.000
	BMI	-.151	.050	-.174	-3.003	.003
	Total Restraint	-.319	.038	-.499	-8.437	.000
	Total Disinhibition	.054	.065	.060	.824	.411
	Total Hunger	.086	.066	.089	1.319	.189
	Exploratory excitability (NS1)	-.063	.118	-.035	-.539	.590
	Impulsiveness (NS2)	.022	.104	.014	.216	.829
	Extravagence (NS3)	.131	.110	.070	1.196	.233
	Disorderliness (NS4)	.008	.100	.005	.076	.939
	Anticipatory worry (HA1)	.030	.080	.027	.382	.703
	Fear of uncertainity (HA2)	-.250	.116	-.161	-2.159	.032
	Shyness with strangers (HA3)	.017	.112	.010	.151	.880
	Fatigability (HA4)	.099	.079	.075	1.253	.212
	Sentimentality (RD1)	.221	.171	.076	1.293	.197
	Persistence (RD2)	-.074	.089	-.048	-.832	.406
	Attachment (RD3)	-.056	.079	-.043	-.710	.478
	Dependence (RD4)	.179	.157	.071	1.138	.256

a. Dependent Variable: FREQ

Regression: DIFF subscale

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.487[a]	.237	.225	2.30533	.237	18.604	4	239	.000
2	.517[b]	.267	.215	2.31909	.030	.764	12	227	.687

a. Predictors: (Constant), Total Hunger, BMI, Total Restraint, Total Disinhibition

b. Predictors: (Constant), Total Hunger, BMI, Total Restraint, Total Disinhibition, Extravagence (NS3), Sentimentality (RD1), Shyness with strangers (HA3), Persistence (RD2), Attachment (RD3), Exploratory excitability (NS1), Fatigability (HA4), Disorderliness (NS4), Dependence (RD4), Impulsiveness (NS2), Anticipatory worry (HA1), Fear of uncertainity (HA2)

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	395.495	4	98.874	18.604	.000[a]
	Residual	1270.177	239	5.315		
	Total	1665.672	243			
2	Regression	444.827	16	27.802	5.169	.000[b]
	Residual	1220.845	227	5.378		
	Total	1665.672	243			

a. Predictors: (Constant), Total Hunger, BMI, Total Restraint, Total Disinhibition

b. Predictors: (Constant), Total Hunger, BMI, Total Restraint, Total Disinhibition, Extravagence (NS3), Sentimentality (RD1), Shyness with strangers (HA3), Persistence (RD2), Attachment (RD3), Exploratory excitability (NS1), Fatigability (HA4), Disorderliness (NS4), Dependence (RD4), Impulsiveness (NS2), Anticipatory worry (HA1), Fear of uncertainity (HA2)

c. Dependent Variable: DIFF

Hierarchical regression model for DIFF (continued)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	8.340	.945		8.823	.000
	BMI	.124	.041	.183	3.047	.003
	Total Restraint	.192	.030	.384	6.317	.000
	Total Disinhibition	.048	.052	.068	.918	.360
	Total Hunger	-.043	.054	-.057	-.795	.427
2	(Constant)	7.817	1.540		5.075	.000
	BMI	.129	.043	.191	3.025	.003
	Total Restraint	.197	.032	.394	6.128	.000
	Total Disinhibition	.053	.055	.075	.954	.341
	Total Hunger	-.044	.056	-.058	-.794	.428
	Exploratory excitability (NS1)	-.025	.100	-.017	-.248	.805
	Impulsiveness (NS2)	-.075	.088	-.058	-.847	.398
	Extravagence (NS3)	.038	.093	.026	.407	.684
	Disorderliness (NS4)	.015	.085	.012	.174	.862
	Anticipatory worry (HA1)	-.085	.068	-.095	-1.258	.210
	Fear of uncertainity (HA2)	.009	.099	.008	.096	.924
	Shyness with strangers (HA3)	.035	.095	.027	.374	.709
	Fatigability (HA4)	-.008	.067	-.008	-.124	.901
	Sentimentality (RD1)	-.240	.145	-.105	-1.651	.100
	Persistence (RD2)	.052	.075	.043	.698	.486
	Attachment (RD3)	.139	.067	.135	2.064	.040
	Dependence (RD4)	.094	.134	.048	.701	.484

a. Dependent Variable: DIFF