Understanding Ideation in Autism

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Declaration

I hereby declare that:

1. I have not been enrolled for another award of the University, or other academic or professional organisation, whilst undertaking my research degree.

2. None of the material contained in the thesis has been used in any other submission for an academic award.

3. I am aware of and understand the University's policy on plagiarism and certify that this thesis is my own work. The use of all published or other sources of material consulted have been properly and fully acknowledged.

4. The work undertaken towards the thesis has been conducted in accordance with the SHU Principles of Integrity in Research and the SHU Research Ethics Policy.

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Abstract

Background

Autism spectrum disorder or Autism is a neurodevelopmental disorder that presents with deficiencies in three domains: social functioning, communication and stereotyped behaviour. As a result of these deficits many people with autism access health and social care services. The rate of people diagnosed with autism continues to rise therefore, to meet the demand on services it is important that functional impairments in autism are well understood.

This professional doctorate project arose from my observations of autistic children in clinical practice who appeared to be experiencing particular types of functional challenges as a result of ideational difficulties. A literature search framed ideation as a cognitive process that enables humans to form ideas. The purpose of this research is to expand what is known about autistic ideation.

Method

A scoping review confirmed that ideation in autism is deficient. The literature led to hypotheses about how the cognitive functions required for ideation might link to differences in autistic functioning. The scoping review provided the basis for the study.

The study aimed to understand better the relationship between cognitive functioning (memory and attention), autistic traits and ideation and to explore the uniqueness of these relationships in autism compared to controls.

A quasi-experimental investigation was conducted using a non-randomised sample of 20 autistic adult male participants and 20 well-matched controls. Standardised and norm-referenced tests of ideation, autistic traits and executive functions produced comparative data suitable for quantitative examination.

Results

The results suggest there is a relationship between attention and ideation in people with and without autism. Statistically significant results indicate that memory function relates to ideation abilities. More specifically, these results indicate a relationship between verbal memory, prospective memory and ideation. However, uniquely to the autistic group, a relationship was also found between visual memory and ideation. In both groups a relationship was found between immediate recall and ideation. Also uniquely to the autistic group however, a further relationship between delayed recall and delayed recognition and ideation was found.

The statistically significant results indicate a relationship between the degree of autistic traits and ideational abilities. Results showed a relationship between imagination autistic traits and ideation in non-autistic participants only. Similarly, whilst the results provide a positive signal that there is a relationship between attention-switching traits and ideation, only the non-autistic group reached statistical significance.

Finally, when looking at the methods used by the participants to generate ideas, the results suggested that the severity of autistic traits related to repetitive ideational responses. However, only in the non-autistic group did results show a relationship between the degree of autistic traits and the chaining of answers (linking next answer to the proceeding answer) despite the autistic group chaining more ideational responses.

By evaluating the result of the scoping review, quasi experimental study, and wider literature,

a new suggested pathway was formed outlining the potential areas of deficit that could contribute to poor ideation. This involved the consideration of cognitive sub processes, namely association and visuospatial planning in ideation. The impact of ideational difficulties was discussed in line with autistic traits and the impact this could have on daily function.

Conclusion

This study supports the concept that ideation in autism differs from ideation in neurotypical people and that there is a link between memory and attention function and abilities in ideation. This study indicates that ideational abilities relate to the severity of autistic traits. This research contributes to professional knowledge by increasing the theoretical understanding of ideation in autism. It offers guidance for future research and informs a set of clinical recommendations.

Acknowledgements

I wish to acknowledge and thank all the staff involved in the Professional Doctorate programme for their support and encouragement. In particular I would like to recognise the commitment from my supervisory team, Dr Hilary Piercy and Dr Jon Painter. I would like to acknowledge my colleague Dr Sushie Dobbinson, for her patience, support and encouragement. Finally, a thank you to the participants for their time and effort.

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CHAPTER 1: BACKGROUND

1.1 Introduction

This introductory chapter begins with the rationale for the research. The rationale includes an insight into my professional background and the experiences that triggered my interest in ideation, which provided the starting point for the research. Following this, the chapter offers a brief background on autism.

1.2 The rationale for initiating the study

Sam held the hoop, just looking at it. With no apparent sensory stimulation gains, this toy served a minimal purpose in play or learning for Sam. This was a typical response when he was given a novel item. However, this little boy could recite patterns of numbers, be it car registration plates, phone numbers, or barcodes, seemingly well beyond the capabilities of many adults. Sam was like many autistic children[1] I had seen in therapy, who often appeared to lack the ability to form ideas to use items and their bodies.

This research topic was identified through my clinical practice as an occupational therapist. Occupational therapy involves the assessment of occupational challenges to understand, treat and improve people's functional challenges. In most cases, occupational therapy assessments use skill analysis or activity analysis to determine what skills are required for a task and to identify what skills are problematic.

[1] Throughout this thesis, the wording places autism first, i.e., autistic person, not person with autism. This aligns with the neurodiversity movement, guidance from the National Autistic Society and the consensus from a study on the UK autism community (Kenny et al., 2016). However, I appreciate this is not the view of everyone and apologise for any offence caused.

I have worked as an occupational therapist with autistic adults and children for over 18 years. During these observational assessments, I became aware of how often this difficulty with ideation occurred, specifically with autistic patients. I have skills in identifying dyspraxia[2] through my qualifications in sensory integration practice. It occurred to me that this pattern of maladaptive behaviours was in keeping with the symptomology of ideational dyspraxia, a term first coined by Dr Jean Ayres to describe children who cannot interact effectively with objects or their environment because they do not have the 'idea' of what to do or how to do it (Ayres, 1972). Combining my clinical observations and Ayres' work on ideation prompted me to think about the role of ideation in autism and provided the basis for this thesis. As a starting point, I will outline autism in relation to the clinical context of this study. Chapter 2 will then address ideation.

1.3 Introduction to Autism

1.3.1 What is autism?

The latest Diagnostic and Statistical Manual of Mental Disorders (DSM 5) and International Classification of Disability (ICD-11) inform that Autism Spectrum Disorder (also referred to as ASD and autism) is a diagnostic label applied to a group of neurodevelopmental conditions. Autism is characterised by persistent deficits in reciprocal social interaction and social communication and a range of restricted, repetitive, and inflexible patterns of behaviour, interests or activities (American Psychiatric Association, 2013; World Health Organization, 2019). These deficits are known as autistic traits (Constantino et al., 2009; Kamio et al., 2013; Stewart & Austin, 2009; Wakabayashi et al., 2006). Autism, in most

[2] Dyspraxia, also known as developmental co-ordination disorder (DCD), is a common disorder that affects movement and co-ordination (NHS, 2022).

cases, becomes apparent during the first five years of life and continues into adulthood (World Health Organization, 2019). A British-based study of more than 7 million children reported that 1 in 57 children in the UK are autistic; this figure is significantly higher than reported in previous studies, reflecting that autism diagnoses are on the rise (Roman-Urrestarazu et al., 2021).

Theories of autism that seek to explain the condition's causes and understand its nature can be broadly categorised as biological, psychological, or social.

1.3.1.1 A biological basis of autism

There remains much debate about the biological factors affecting autism. Environmental and genetic influences have both been found. Environmental research has investigated potential ecological causes, including the preservatives used in vaccines, diet, and environmental pollutants (Landrigan et al., 2020; Wing & Potter, 2002). However, evidence in this field has not been consistent enough to confirm any environmental factors as a cause of autism (Landrigan et al., 2020; Lawler et al., 2004). Similarly, despite vast amounts of research, no single gene or gene pattern has been deemed responsible for the cause of autism (Howlin & Asgharian, 1999; Masi et al., 2017). While genetic research continues, the focus on autism causality is multi-modal and across fields wider than genetics (Rutter et al., 2003a; Tordjman et al., 2017).

A key focus in biological research is neurological abnormalities. A recent systematic review of neurology in autism concluded that autistic individuals were significantly more likely than the general population to exhibit epilepsy, microcephaly, hydrocephalus, cerebral palsy, migraine/headache, and congenital nervous system abnormalities. However,

observed patterns of neurological abnormalities have lacked consistency, preventing robust conclusions on this being linked to autism causality (Pan et al., 2021).

Another area of neurological research focuses on understanding the neural underpinnings of sensory processing in autism (for example- Gonthier 2016, Green 2016, Leekam 2007, Rehbein & Herrmann, 2020). Marco and colleagues reviewed the literature on neurophysiological responses in the sensory systems of autistic participants (Marco et al., 2011). They concluded that 'neurophysiologic profiles of sensory processing in autism might serve as valuable biomarkers for diagnosing and monitoring therapeutic interventions for autism and reveal potential strategies and target brain regions for therapeutic interventions' (Marco et al., 2011). This study reported that differences in sensory processing might be responsible for the core features of autism, including language delay (auditory processing) and difficulty with reading emotion from faces (visual processing) (Marco et al., 2011). Other authors have also noted deficits in autism sensory processing and have linked this to various other difficulties experienced by autistic people, including motor problems, sensory-integration problems, inertia, sensory overload, apraxia, dyspraxia, echolalia, mutism, behaviour disorder, and catatonia (Bristol et al., 1996; Dhossche, 2004; Donnellan,. et al., 2013; Donnellan, et al., 2013; Endow, 2006; Filipek et al., 2000; Gernsbacher et al., 2008; Goldman et al., 2009; Gonthier et al., 2016; Jansiewicz et al., 2006; Leekam, et al., 2007; Markram & Markram, 2010; McCray et al., 2014; O'connor, 2012; Rehbein & Herrmann, 2020; Thye et al., 2018; Tomchek & Dunn, 2007).

1.3.1.2 Psychological autism theories

Psychological autism research has mainly focused on explaining cognitive differences in autism. Theories include the Theory of Mind, Central Coherence Theory and Executive Function (Baron-Cohen, 2000; Green et al., 2020; Jarrold, C. et al., 2000).

Theory of mind (TOM) is the ability to attribute mental states to oneself and others. TOM is described as a critical function in social interaction as it enables understanding of others and thus supports the ability to pre-empt others' behaviour. This theory aims to explain the behavioural symptoms of autism, for example, social inappropriateness (Jarrold, C. et al., 2000). In addition to psychological research, biological studies i.e., Castelli et al., (2002) support this theory.

Central Coherence Theory also aims to explain cognitive differences in autism. Also known as the Weak Central Coherence Theory (WCC), this theory focuses on an inability to 'see the whole picture', noting that autistic people often focus on parts of visual or auditory stimuli (Vanegas & Davidson, 2015).

Executive functions are processed within the frontal cortex and include but are not limited to planning, inhibition, flexibility, and working memory (Hughes, Claire, 2002). Executive Function Theory seeks to explain autistic deficits, assuming that faults occur within executive functioning (Yeung, Michael & Chan, 2020). However, whilst autism research on executive function predominantly found weaknesses, strengths were also noted (Geurts, . et al., 2004; Geurts, . et al., 2020a; Yeung, Michael & Chan, 2020; Zhang, . et al., 2020). Additionally, this theory may be limited because of the lack of understanding about executive dysfunction and autistic traits. This is partly because of the diversity of executive function within the autism population and because these patterns of function are not exclusive to autism (Geurts, et al., 2020a; Ozonoff, . et al., 1991).

1.3.1.3 Social autism theories

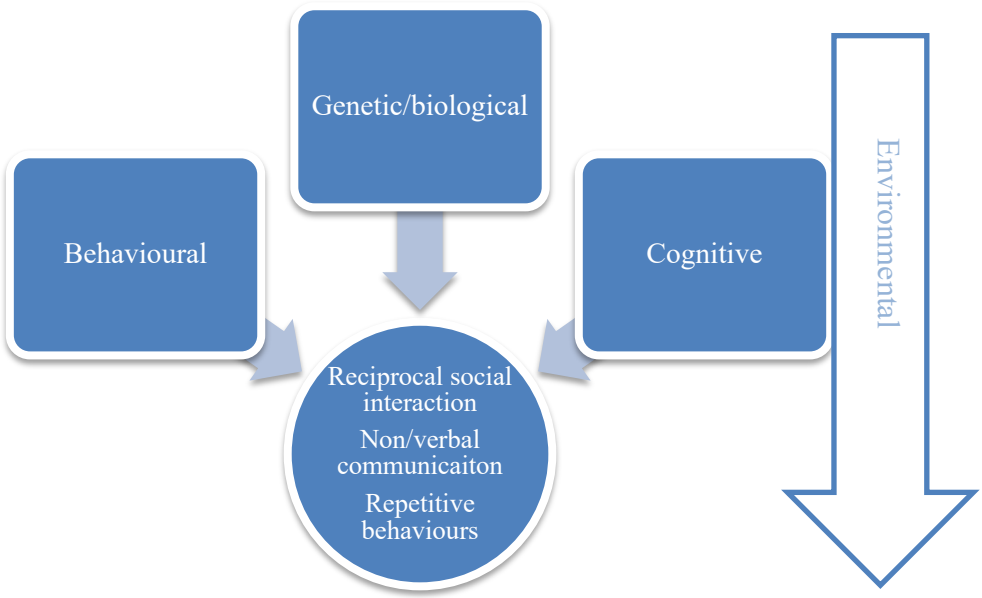
Much autism research has been about understanding the cause. However, it is recognised that understanding autistic traits and their impact on a person is also essential. Social theories look at how social/psychosocial effects are likely to impact a person's autistic traits, for example, poorly adapted work environments resulting in sensory processing difficulties at work or the social construct of appropriate and inappropriate behaviour and the socialisation barriers this may impose (Richardson et al., 2018). The social model reflects the importance of viewing the individual as an expert on their autism; it also supports the neurodiversity movement – viewing autistic people as divergent, not disabled (Richardson et al., 2018; Woods, 2017). The social model serves as a reminder that cognitive functions in autism could be different, not necessarily deficient and that autism research needs to look holistically at presenting challenges and the potential causes of autism. In social models of autism, it is posited that autism does not necessarily require treatment; instead, it should be supported by social adjustments and accommodations (Woods, 2017). Having said that, many coexisting conditions, i.e., executive dysfunction and anxiety, are amenable to interventions that improve functioning.

Considering the social model of autism, this thesis aims to provide knowledge that enables a better understanding of ideation in autism. Throughout this research, strengths in autism ideation may appear, but it is also presumed that areas of difficulty will be identified. Accepting the view that autism itself is not a condition that requires treatment however, by enabling a better understanding of ideational function and sharing this knowledge, the autistic community and the research community can choose how to use that knowledge most helpfully to the individual or groups.

1.3.2 Autism model adopted for this study

Anderson-Chavarria(((2021) reviewed autism models and measured the impact the models have on autistic people. This review confirmed that the causal model by (Roth & Rezaie, 2011) supports the uniqueness of each autism diagnosis and the acceptance that multiple factors in autism could affect ideation. The causal model shows the complex interplay between genetic, biological, cognitive and behavioural functions in autism (Aitken, 2011) (Figure 1). This model also supports the use of this research in clinical practice by emphasising that whilst autism may not be preventable or curable, the challenges for the autistic person can be considered multi-faceted.

Figure 1 Causal Model of Autism



1.3.3 Further rationale for the study- supporting autism in health care

As this is a professional doctorate in health, it is necessary to consider autism in the context of health care. Whilst it is accepted that autism is heterogeneous and not everyone with

autism will require intervention, it is a reasonable assumption that many autistic people, at some point, will need support and/or intervention from health and/or social care services (Hume et al., 2021). Interventions may directly relate to traits, i.e., from speech and language therapy, but also to comorbid conditions such as anxiety. Historically, the lack of understanding about autism has led to poor quality services and a lack of support.

Over the past ten years, programmes such as Transforming Care Delivery have informed the development of health and care services. However, access to services and support for people with autism is still inadequate (Care Quality Commission, 2020). Transforming Care Delivery is supported by NHS England, the Department of Health, the Local Government Association, the Association of Adult Social Services, the Care Quality Commission, and Health Education England. The programme aims to develop services for people with learning disabilities and/or autism and highlights the need for research to boost evidence-based interventions (NHS England/LGA/ADASS, 2015). The National Institute for Clinical Excellence (NICE) has developed two guidelines for health and social care services. For adults, they produced 'The Autistic Spectrum Disorder in Adults: Diagnosis and Management (National Institute for Health and Care Excellence, 2021) 'Autistic Spectrum Disorder in Under 19's: Recognition, referral, and Diagnosis' (National Institute for Health and Care Excellence, 2017). Both guidelines provide limited guidance on intervention types, duration, and frequency. This is possibly because of the lack of understanding about the condition and the fact that autism presents differently in everyone (Lundin et al., 2021).

Publications on clinical support for autism include: 'The European Society of Child and Adolescence Practice Guidance for autism' (Fuentes et al., 2021) and 'Evidence-based Practices for children, youth, and young adults with Autism', produced by the Frank Porter

Graham Child Development Institute, National Clearinghouse on Autism Evidence and The Practice Review Team (Hume et al., 2021). These publications go some way in cataloguing interventions for autism. However, despite over 60 years of research, considerable gaps in knowledge still exist, limiting evidence-based interventions for the challenges caused by traits and comorbid conditions (Fombonne et al., 2009; Fuentes et al., 2021; Keyes et al., 2012; Sam et al., 2021).

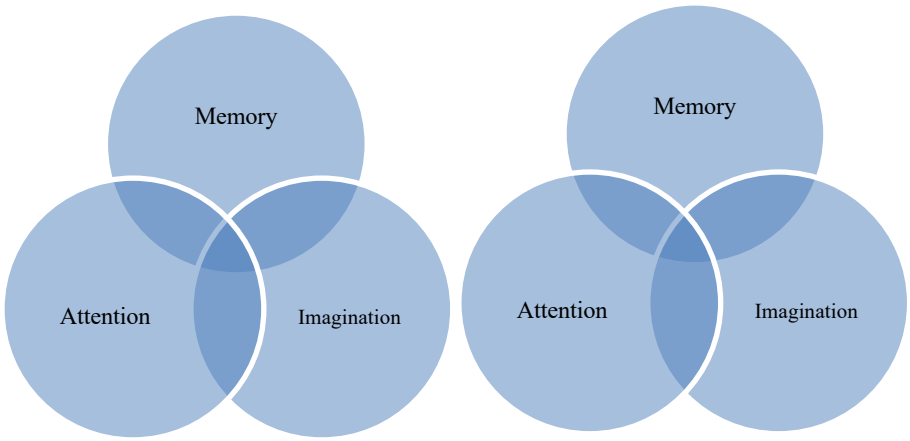
1.4 Next steps, from clinical observation to research

The demand from the autistic community and the health service to provide solutions for better care and support for autistic people provides further rationale for exploring my clinical observations through this thesis. The causal model describes how autism function can be multi-faceted and promotes a broad view when considering the influences on autism ideation. The definition for, and cognitive process of ideation are detailed in Chapter 2; however, the foundations of this study stemmed from the skills analysis conducted through clinical practice and knowledge of autism and ideation.

To explain further, when children cannot perform a task, occupational therapists will complete a skill analysis to understand what skills are absent or deficient. Through skill analysis it has been noted by myself and other therapists that autistic children and young people have deficits in play and movement that could be linked to symptoms of ideational dyspraxia i.e., (May-Benson, et al., 2017). These symptoms involve a lack of ideas (at a cognitive level) of how to use the body and interact with objects. This skill requires imagination (to adapt preformed knowledge about the movement and use of objects), memory (of previous use of objects and movement) and attention (to support the focus on

the task and reconfiguration of thoughts). Undoubtedly, other skills, for example, motivation, also contribute; however, according to the literature, memory, attention, and imagination are among the most important skills in ideation (Briggs & Reinig, 2007; Graham & Bachman, 2004; Masson-Oursel, 1940; Reid, 1983; Ward, 1918). Referring to 1.3.1.2, the executive function theory and the subsequent supporting evidence, it is notable that memory and attention in autism differ from the general population. In addition, evidence supports the notion that imagination is also different in autism. A schema in Figure 2 illustrates initial thinking about the interplay of these skills. It demonstrates how many critical skills required for ideation are known to be different in autism. Imagination, executive function, and autism are expanded upon in Chapter 2.

Figure 2 How Autism Function may link to abilities in ideation



Areas of deficit in autism *Skills required for ideation*

1.5 Summary

Autism is a complex and multi-faceted condition which is not fully understood. Ongoing autism research is essential in ensuring that health and social care services are supporting autistic people in the right way. The increase in autism prevalence means that the efficiency and effectiveness of this support is paramount. Guidance on future autism research emphasises improving understanding of autism symptomology and increasing the evidence

base for interventions for problematic symptoms or traits. Clinical observations and knowledge of autism and ideational dyspraxia formed my initial hypothetical link between ideation function and autism. Chapter 2 will further explore the definition and concept of ideation. Chapter 3 continues to orient towards the causal model by adopting a scoping review to cast a broad net to understand what is already known about autism ideation.

CHAPTER 2: DEFINING AND OPERATIONALISING RELEVANT TERMS AND CONCEPTS

2.1 Introduction

This chapter documents the literature review used to establish a detailed understanding of the core concept of ideation as a background to the study. The review outlines a historical overview of how our knowledge about ideation has developed over time, which was used to provide a definition and working knowledge of the concept of ideation. The then addresses how ideation relates to interconnecting concepts, including in the context of therapy. Finally, the review details the ideational process and discusses how ideation function could link to autism.

2.2 The Research Question and Objectives

The review aims to understand, contextualise, and define ideation. The review also aims to understand better what the literature says about the function of ideation in autistic people and the implications of this.

Objective

- Conceptualise and define ideation
- Identify potential links between ideation and autism

Review questions

- What is ideation?
- How is the term used in different fields of research?
- How do we form ideas?
    - What is the ideational process?
    - What are the necessary skills in ideation?

- Do the skills in ideation relate to deficits in autism?
- Do the skills in ideation relate to autistic traits?

2.3 Method

The method of review was online only. The search terms 'ideation', 'ideational' and 'idea formation' were entered, using truncation symbols to find extensions of words. Boolean connectors limited searches that would not be relevant. For example, ideation AND NOT suicide excluded articles related to suicidal ideation (Machi & McEvoy, 2016). The electronic databases used were SCOPUS, Allied and Complementary Medicine Database (AMED), Cumulative Index to Nursing and Allied Health Literature (CINAHL), PsycINFO, MEDLINE, and Cochrane. Additional search sources included OTseeker and the National Autistic Society online library. Incremental searching of reference lists from relevant articles was also completed. No time limit was set. Initially, literature was sought on ideation and autism independently, enabling the theories and processes to be understood before looking at the relationship between autism and ideation.

2.4 Understanding Ideation

The search on ideation identified a surprising lack of literature. In 1983, Reid, stated, '[m]any professionals and educators, including those on the 'creative side,' tend to assume that ideas come by magic (or osmosis) and prefer to relegate ideation to the realm of the mysterious' (Reid, 1983). This indicates that a lack of literature was evident before the 1980s. Understanding how the concept of ideation was established and has evolved was necessary to clarify the use of the term.

2.4.1 Defining Ideation and similar terms

The review looked at literature from a broad range of disciplines in various research fields. The term ‘ideation’ was mapped out across time. This mapping was created by conducting literature searches, checking the titles and abstracts, and counting the results. This information was then placed into a table (Table 1). The categories used in the literature search databases identified the research fields.

Table 1 Number of published literature containing 'ideation' as a key phrase from 1960-2023

Field of research / **Year**	**1960-1969**	**1970-1979**	**1980-1989**	**1990-1999**	**2000-2009**	**2010-2020**
Medicine and pharmacology	50	50	53	42	60	65
Medical sciences inc. Neuroscience	-	-	13	5	11	2
Psychology	50	50	23	28	9	11
Therapy/Nursing		-	-	-	4	5
Social sciences		-		7	3	4
Non-medical sciences	-	-	-	2	1	1
Business, economics &engineering	-	-	5	33	10	10
Arts and humanities	-	-	6	12	2.5	2

The mapping exercise demonstrated reduced use of the term ideation in psychology literature. Assuming it would be doubtful that idea formation ceased to be researched, a search was initiated to look for replacement terms. In the late 1990s, the volume of psychology research about human thought processes increased. The focus on ideation was replaced by creativity and generativity within thought (Kounios et al., 2001; Runco & Pritzker, 1999). Simultaneously, management and business applied psychology theory (Frederiks et al., 2018; Grimes, 2017; Kier & McMullen, 2020; Lotin, 2001; Morris et al.,

2001). Within business, ideation continues to be used (Kier & McMullen, 2020). However, even in this field Graham & Bachman, (2004) described terminology around ideation as inconsistent and confusing, with some authors replacing ideation with other terms such as innovation. They note that ideation and innovation are not the same because innovation only describes improving something that already exists (Graham & Bachman, 2004).

Creativity and generativity have also been used to describe processes similar to ideation. For example, the search term 'ideation' produced results that included research on 'generativity of ideas', i.e., Low et al., (2009) and Turner, (1999). This suggested a need to explore generativity and creativity to understand how they differed from ideation and the relationship between the terms. The original theories, the psychological tests (used to determine cognitive demands) and the literature related to cognitive processes were explored for both concepts.

2.4.1.1. Understanding generativity and distinguishing between ideation and generativity

The literature associated with ideation refers to generativity as a term used to describe a neurocognitive process. Psychology literature included generativity in the context of generating creative thoughts and ideas. Epstein's (1988) Generativity Theory is an example of this use of generativity.

Epstein's theory (1988) is a predictive theory of creative behaviour in people. Therefore, it will likely be a driver in using the term generativity within the literature about novel behaviour (Epstein, Robert, 1991). This theory assumes that memory, insight, and attention are used to solve problems, including producing novel ideas (Bushe & Paranjpey, 2015; Epstein, et al., 1984; Slater, 2003). Epstein's generativity does not appear to have an

exclusive test, however, the testing methods used within studies involved generating spontaneously appropriate responses. Testing examples include-producing words beginning with a specific letter (Dichter et al., 2009b; Lezak, 1995; Russell, 1997) or generating 12 different actions and following 12 instructions with a car and a doll (Lewis & Boucher, 1995). In this context, it will be noted, generativity tests did not test imagination or attention, skills required within ideation (Ward, 1918).

2..4.1.2 Understanding creativity and distinguishing between ideation and creativity

There is broad consensus that creativity involves the process of creating something unique and worthwhile (Finke et al., 1992; Glaveanu,. & Kaufman, 2019; Glaveanu, et al., 2020; Sternberg, & Cambridge, 1999; Sternberg, & O'Hara, 1999). Popular creativity tests examine the cognitive processes involved in "flexibility, "elaboration," "redefinition," and various types of "fluency" (Carson et al., 2005; Kaufman et al., 2016). Use of these terms suggests that creativity requires developing or expanding preexisting ideas or concepts.

Examination of the literature that details the cognitive processing of creativity can be used to expand understanding of this term. Albert Oliverio, (2008) concluded that creativity involves two consecutive steps: 1. Generation of novelty, mainly in the ventral striatum, and 2. Analysis of novelty by the prefrontal cortex that transforms it into creative behaviour. Others' work supports this notion (Kim, 2005; Sternberg, & O'Hara, 1999; Zhang, & Sternberg, 2011).

Both the cognitive demands involved in testing and the cognitive process described here support early findings by (Guilford, 1967). Guilford (1967) compared creativity to ideation and identified that the crucial difference between them is that creativity involves generating novel ideas. He concluded that creativity is more than ideation; it can be understood as an expansion of ideation requiring a nonconforming attitude, behaviour, and flexibility.

Ideation alone includes ideas that are not necessarily original or novel. For example, in Ward's (Ward, 1918) original articulation, ideation begins in infants as a way of them building very primitive ideas, i.e., on how to reach a bottle for a drink, which would not necessarily span into creative thinking. More recent researchers support this position (Dulgheru, 2015; Runco, & Cayirdag, 2006; Sternberg, & O'Hara, 1999).

Following this exercise of exploring similar terms, ideation was selected as the most appropriate term to use to describe the formation, execution, and expression of ideas.

2.4.2 A working definition of ideation

Ideation is "the process of generating or conceiving ideas and concepts that may be useful for attaining some desired state or outcome" (Briggs & Reinig, 2007).

This definition has the benefit of referring to processes of generating and conceiving ideas, as referenced in psychology literature. It also acknowledges the aspect of 'attainment of outcome', which captures the functional role of ideation, as referenced in therapy literature on ideation. It reflects that ideation is a cognitive process that is used to support function and, as such, can be studied and measured. This definition is a reference point for this thesis.

2.4.3 The function of ideation

The earliest literature identified in the search was from 1876 when James Mills developed his ideation theory. This theory explains how all humans use sensation on a cognitive level. In this theory, he described ideation as the process in which a series of thoughts form an action. An example would be watching water boiling, recognising and recalling what this

looks and sounds like, and knowing what steps build on from this. For example, boiling water is part of a sequence of tasks used to cook food (Stephen, 2005).

Developing the original work by Mills (1876), (McCosh, 1876) explored more detailed concepts regarding how ideation occurs. He reported that ideas are formed from the principles of association, whereby memory is recalled and then associated with another or several other memories. To expand on these theories, Ward (1918) further analysed ideation as a cognitive process, starting at the beginning of the process by looking into what motivates the initiation of ideation. Ward concluded that basic instincts, such as how to get water, initially drive ideation. Although these basic tasks initially drive ideation, it is conceptualised as a developmental process. As intellect develops, more complex ideas can be formed (Ward, 1918).

2.4.3.1 The seven stages of the ideational process

Ward (1918) explored the ideational process and described this as an extension of memory processes. He broke down the ideational process into seven stages. These seven stages are similar to how others conceptualise ideation (Husserl et al., 2012; J McCosh, McCosh1876; Osborn, 1953; Read, 1911).

1) Orientation
2) Preparation
3) Analysis
4) Holding the information
5) Changing into a different metaphor
6) Finalising
7) Evaluation

Table 2 outlines the skills and cognitive processes involved in these stages, with cognitive functions taken from literature about cognitive skills in ideation and creativity (Briggs & Reinig, 2007; Finke et al., 1992; Harvey, 2019; Ritter & Mostert, 2017; Robertson et al., 1996).

Table 2 Stages of ideation and cognitive skills required

Stage	**Description of function**	**Cognitive skills required**
Orientation	Identification of the question or problem	Motivation Attention Memory Auditory/visual processing
Preparation	Information gathering from existing memory	Working memory and attention
Analysis	Analysis of information, including limiting information and association relevant memories	Memory and attention. Association of memories
Holding the information	Concentrating on the forming elements (combining memories, etc.)	Attention
Changing into a different metaphor	Often, this involves imagination, with ideation being the foundation of these ideas	Imagination Attention Memory
Finalising	Acting out, sharing, or concluding idea	Praxis Verbal skills
Evaluating	Using feedback to assess/evaluate idea success	Processing of sensory feedback and/or higher cognitive external or internal feedback

2.4.3.2 The role of ideational fluency in ideation

The term 'fluency' is commonly found in the literature about ideation, creativity, and generativity. In psychology literature, fluency refers to a cognitive process that affects the ability to generate words, ideas, and mental associations (Cameron et al., 2020). Therefore, within the ideational process, fluency relates to generating ideas (Bizzozero et al., 2013; Hirshorn & Thompson-Schill, 2006; Vannorsdall et al., 2012). However, fluency tests (ideational fluency and verbal fluency) appear only to examine the retrieval of information (Henry& Crawford, 2004; Prescott et al., 2006; Rende et al., 2002). This means that these tests may have limitations when assessing ideation. However, fluency remains relevant as another way of describing part of the ideational process.

2.4.4 Ideation from a therapy perspective

Whilst the field of psychology hosts most of the literature on ideation, some literature outlines the concept from a clinical therapy background. Ayres is an occupational therapist who can be credited with applying the concept of ideation to the therapy setting, specifically concerning her theorisation of praxis (Ayres, 1972). 'Praxis' is a theoretical concept that refers to engaging, applying, exercising, realising, or practising ideas (Miller et al., 2014). In 1972, Ayres theorised praxis as a process that involves ideation, planning, and execution of a motor act. She referred to ideation as a cognitive function partly dependent on the integration of sensory inputs and consequential knowledge of potential body actions. Ayres , (1972) also stated that ideation requires knowledge about objects and their possible uses and is developed using the body in purposeful activity. Involvement of 'physical' functionality indicates a movement away from conceptualising ideation as simply a cognitive process. This broader conceptualisation is also evident in May-Benson and Cermak's (May-Benson, & Cermak, 2007) process model of ideation. This model was

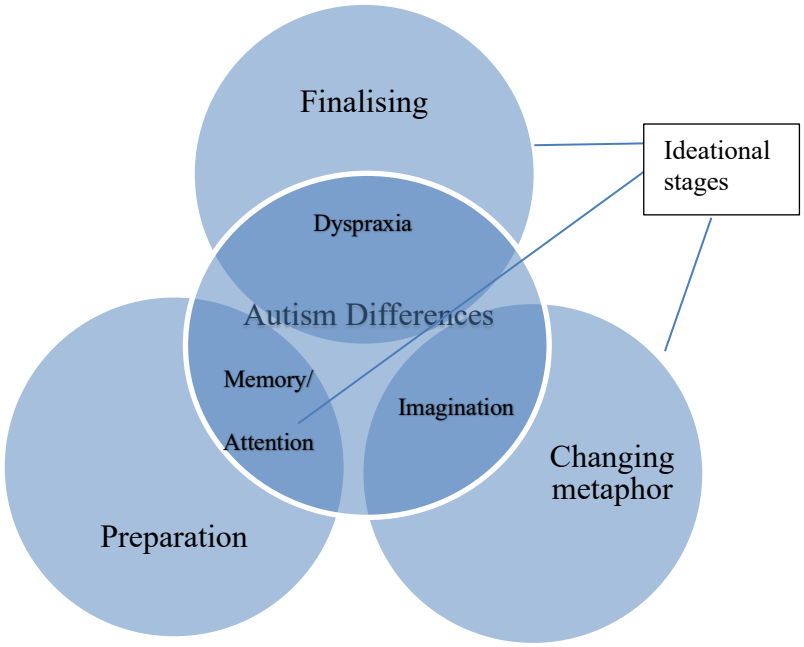
based on both Gibson's (1977) Theory of Object Affordances and work by Roy et al., (1991) around apraxia**.** Apraxia is a neurological condition characterised by a loss of the ability to perform activities that a person is physically able and willing to do (Roy et al., 1991).

May-Benson and Cermak state that 'ideation ability (or ideational praxis) requires knowledge of objects and appropriate actions for things to recognise and act on object affordances' (May-Benson, & Cermak, 2007). Many original descriptors of ideation do not reference the use of objects (Osborn, 1953; Runco, M. A., 2004; Ward, 1918). The theoretical and process literature indicates that ideas can be formed without objects (Husserl et al., 2012; McCosh, 1876; Osborn, 1953; Read, 1911). Objects are likely included within descriptions of ideational praxis because ideation in praxis is not easily observable without objects, suggesting that object use is uniquely based on the theory of praxis.

2.4.5 Autism function and links to ideation function

The literature on the ideational process offers hints as to why ideation could present differently in autistic people since many of the skills included in the ideational process are also deficient in autism. Specifically, three main areas of autism dysfunction may be linked to ideation: executive function, imagination, and motor function (Figure 3, The stages in ideational process and autism differences).

Figure 3 The stages in the ideational process and autism differences



2.4.5.1 Links between ideational dyspraxia and autism

To outline how autism ideation may link to dyspraxia, two bodies of evidence are explored:

1. Research that links ideation to dyspraxia (Ayres, 1972; Gibbs et al., 2007; Miller et al., 2014; Serrada-Tejeda et al., 2021)

2. Literature that indicates a commonality between dyspraxia and autism (Chukoskie et al., 2013; Dowd et al., 2012; Downey & Rapport, 2012; Maski et al., 2011; Schmahmann, 2010; Stoodley et al., 2012).

Concerning autism ideational dyspraxia, the research is limited; only two studies were identified in the search (Miller et al., 2014; Serrada-Tejeda et al., 2021). Other research can be linked to expand what is known about autism and ideational praxis; for example, MacNeil & Mostofsky, (2012); Smith et al., (2005) found that autistic people had more ideomotor

deficits[3] than controls. Although this study measured ideomotor skills, some evidence suggests a lack of ideomotor skills can be caused by poor ideation (Miller et al., 2014). The evidence available regarding autism ideational dyspraxia is discussed further in Chapter 3-Scoping Review.

2.4.5.2 Links between autism executive function and ideation

Executive function difficulties are common in autistic people (Ambery, et al., 2006; Geurts, et al., 2009; Geurts, et al., 2004; Geurts, et al., 2020b; Hill, 2004; Sergeant et al., 2002; Yeung, & Chan, 2020). It is also noted that research has linked executive dysfunction to poor generativity (Daniels, 2008; Hughes, et al., 1994; Hughes, Claire & Russell, 1993). The core executive functions include self-awareness, attention, inhibition, working memory, emotional self-regulation, self-motivation, planning, and problem-solving (Chan et al., 2008). Memory, attention, and generativity are all noted within Ward's (1918) 7-stage ideation process and, therefore, are deemed essential functions in forming ideas. Consequently, it was deemed important to investigate how executive function in autism is impaired.

A study by (Amberyet al., 2006) into neuropsychological functioning in autistic adults found that the participants only had deficits in some, not all, areas of executive function. Because of this (Ambery, et al., 2006) highlighted the need to investigate individual executive functions. One of the areas that show consistent deficits is memory. However, debate remains about the specific area of memory that is dysfunctional.

[3] Ideomotor dyspraxia is where the problem lies not with creating the idea but knowing how to use the body to achieve it (Ayres, 1972)

Studies have shown that people with higher-functioning autism have better than average long-term memory but poor working memory (Boucher, Jill et al., 2012a; Bucaille, Aurélie et al., 2015; Desaunay et al., 2020a). More specifically, studies indicate that the episodic element of working memory is impaired (Grainger et al., 2016a; Shalom, 2003). Episodic memory is significant in generating a new idea (Boucher,2007). Free recall is an aspect of memory deemed essential in generativity (Boucher, 2007). Because of the link between ideation and generativity, free recall may also be necessary in ideation. Many authors have found that this too is an area of memory in which people with autism experience difficulty (Boucher., 2007; Bruck et al., 2007; Jarrold,. et al., 1996; Joseph & Tager-Flusberg, 2004; Kleinhans et al., 2005; Lewis & Boucher, 1995; Maras & Bowler, 2012; Mattison et al., 2015; McCrory et al., 2007; Turner, 1999). As opposed to deficits in memory, (Boucher, 2007) concluded that autistic people do not have difficulties with cued memory and recognition and have superior semantic, perceptual, and verbal working memory.

Another cognitive aspect of the ideational process is attention (Ward, 1918) (see Table 2). Autism research supports that autistic people have difficulty with attention; however, the specific type of attention deficit is unknown (Ames & Fletcher-Watson, 2010; Korhonen et al., 2014). As with memory function, the impact of attentional deficits on ideation is unknown.

2.4.5.3 Links between autism imagination and ideation

The seven stages of ideation and the wider ideation literature, i.e., (Masson-Oursel, 1940; Read, 1911; Stokes, 2016; Ward, 1918) strongly indicate that imagination is a skill required in ideation, and it is a core difficulty in autism (Jarrold, Christopher & Conn, 2011; Scott & Baron-Cohen, 1996; Vyshedskiy, 2021). While some researchers have suggested that

executive functions are to blame for lack of imagination (Hughes, et al., 1994; Hughes, Claire & Russell, 1993; Ozonoff, Sally et al., 1991), others argue that executive dysfunction in autism does not fully explain why imagination, particularly creative imagination, is dysfunctional (Baron-Cohen, 1987; Jarroldet al., 1996; Vyshedskiy, 2021). The debate about the role of executive function in autism imagination lacks a conclusion. Therefore, in autism ideation research, imagination and executive function should be considered separate entities.

2.5 Summary

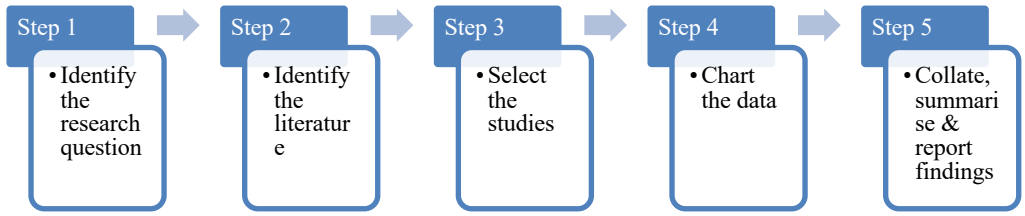
Ideation is the function that enables the formation of ideas. A seven-stage ideational process can be used to demonstrate the cognitive skills required. The ideational process involves cognitive functions such as memory, attention and imagination, all cognitive functions which are known to be different in autism. As well as cognitive differences, dyspraxia in autism may also have links to ideational abilities. This potential crossover of skills needed for ideation and skill deficits in autism supports the idea that ideation may be deficient in autistic people. What needed to be explored next was what is already known about autism ideation.

CHAPTER 3: SCOPING REVIEW

3.1 Introduction

This chapter documents the scoping review conducted to establish the evidence base related to autism ideation. The review follows the five-step process developed by (Arksey & O'Malley, 2005) (Figure 4) as covered in Joanna Briggs Institute (JBI) guidance (Munn et al., 2014).

Figure 4 Five-step scoping review process (Arksey & O'Malley, 2005)



The functions of a scoping review suited the position of this research topic, given that the topic had emerged from clinical observations and clinical inquisition (Armstrong et al., 2011; Iannizzi et al., 2021). An initial search confirmed that a review on this topic did not exist. The PRISMA-P review checklist was completed to improve the quality of the review (Moher et al., 2015). The review was not registered as it is not classified under the same guidelines as a systematic review. Additionally, this review was not intended for interventions (the primary aim of PRISMA monitoring) (PRISMA, 2023). The author has not been involved in any of the studies in this review. The scoping review was initially completed in 2018 before completing the research study discussed in Chapter 4. Searches were re-run on 17th October 2023 to ensure all up-to-date information was considered.

3.2 The Research Question and Objectives

The review aimed to understand better what the literature says about the function of ideation in autistic people and the implications of this.

Objective

- Explore what the literature says about ideation in autism

Review questions

- What research has been conducted in developed countries on autism ideation?
- How is ideation researched in autism studies?
- What are the differences in ideation in autistic people compared to non-autistic people?
- What further research is required to expand what is known about autism ideation?

3.3 Method

3.3.1 Identifying the relevant literature

The search terms were identified through a Population, Concept, and Context protocol (PCC) (Munn et al., 2014). Literature in search databases tend to have assigned subject headings. In health research these are often referred to as Medical Subject Heading (MeSH). To ensure all relevant literature was sought the MeSH database was accessed via PubMed home page, to check for alternative search terms. The search concepts entered were ‘autism’ and ‘ideation’. These are used to index citations allowing you to retrieve all records on a particular subject regardless of the terminology used by the author The Medical MeSH searching strategy linked the search term ideation to ‘suicidal ideation'; however, suicidal ideation was not relevant as this only relates to ideas about attempting suicide. The MeSH

search of the term 'autism" prompted Asperger's and Autistic Spectrum Disorder, which were then used in the search. Truncation symbols were used to find extensions of words and Boolean connectors to limit the search to relevant literature (Machi & McEvoy, 2008). The complete list of search terms and the string of search terms used are shown in Table 3.

Table 3 Search string terms.

PubMed search string (final version)	Autism AND ideation ANDNOT suicide*+Autism AND generativity + autism AND ideational ANDNOT suicide+Aspergers AND ideation ANDNOT suicide*+Aspergers AND generativity + Aspergers AND ideational ANDNOT suicide+ Autism Spectrum Condition AND ideation ANDNOT suicide*+Autism Spectrum Condition AND generativity + Autism Spectrum Condition AND ideational ANDNOT suicide+Autism ANDideationaldysprxia+AutismANDaprxia

The electronic bases used were SCOPUS, Allied and Alternative Medicine and Database (AMED), Cumulative Index to Nursing and Allied Health Literature (CINAHL), PsycINFO, MEDLINE, and Cochrane. Additional search sources included OTseeker and the National Autistic Society online library. Incremental searching of reference lists from relevant articles was also completed.

3.3.2 Selecting the studies

Inclusion and exclusion criteria were set to ensure the literature selected answered the research question, preventing the review findings from becoming too broad (Machi & McEvoy, 2008). The inclusion criteria were based on the review objectives, utilising the core elements of the PCC. The preliminary search informed the PCC. The titles and abstracts of the articles were used to check that the criteria were met. The criteria were also checked during the full review of the articles.

Inclusion criterion

Population

- Studies involving autistic participants. The studies must reference that the participants' diagnosis had been evidenced. Evidence would include a certified diagnostic report or diagnostic testing within the studies.
- Studies that used the diagnostic terms Autism Spectrum Disorder, Higher Functioning Autism and Asperger Syndrome are included because they were commonly used prior to clinical guidance in 2011 that the diagnostic term Autism Spectrum Disorder should be used 'stand-alone' (Szatmari, 2011).
- Studies with participants who were autistic and had intellectual (learning) disabilities. It is accepted that cognitive deficits will impact ideation (Jauk et al., 2013). Therefore, while it was necessary to include people with an intellectual (learning) disability due to them representing 50% of the autistic community (Emerson & Baines, 2011) these studies had to include controls with matched intelligence.
- Except for a secondary diagnosis of intellectual (learning) disability, included studies must have confirmed autism as the only diagnosis. Other studies that had participants with additional diagnoses were excluding from the scoping review. Other diagnoses would imply confounding variables, such as medication, that could invalidate an overall conclusion (Brookhart et al., 2010). In addition, even with controls for the additional diagnoses it is unlikely this would enable analysis of the results to exclude the impact of the other diagnosis, for example, depression in autism may present differently to depression in a non-autistic person. Making it difficult to determine the effect of coexisting diagnosis on autism ideation versus the effect of the co-existing diagnosis on ideation alone.

- The age of the study participants was not limited. However, due to the developmental nature of ideation (Runco, Mark A., 2004), studies involving children were only included if age-matched controls were used.

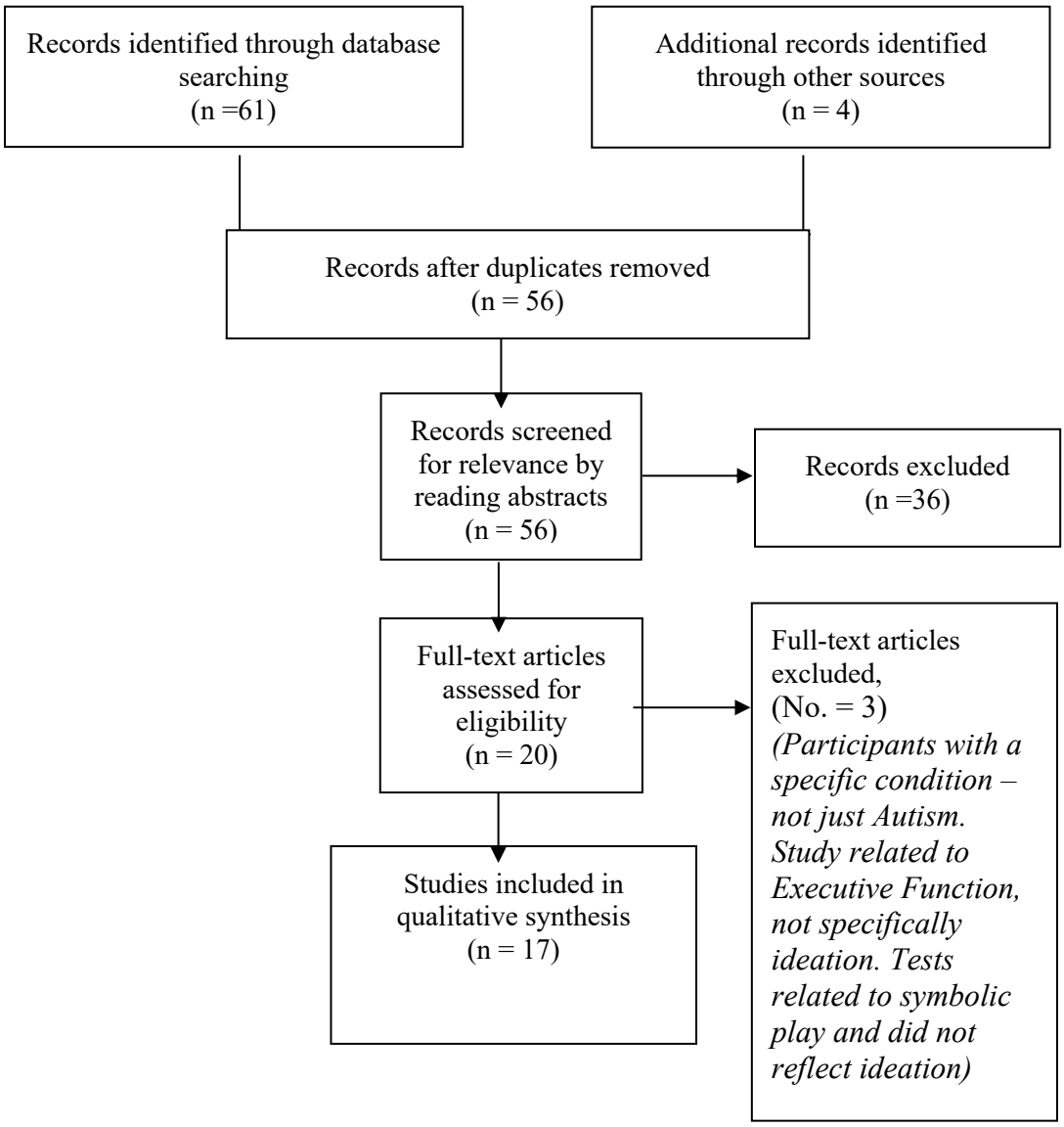
Concept

Primary studies that tested ideation and/or generativity in autistic participants. The terms apraxia and ideational dyspraxia were identified during the preliminary exploration of ideation and are therefore included in the search. The term generativity was included because it can used as a replacement term for ideation in psychology literature.

Literature Sources

- Only studies were conducted within developed countries because of unknown variables caused by different cultures and healthcare provisions and the effect on the traits of autism. In addition, other countries have varying diagnostic criteria for autism, increasing the risk that subjects may not have autism as defined in the United Kingdom.
- Only literature written in English language due to limited translation resources.
- Only literature written after 1980 was included because the autism diagnostic criteria differed from the current criteria before this (Adams et al., 2016). Before the 1980s, many variations of what constitutes autism existed. For example, theorists believed it to be a subtype of schizophrenia. It was not until 1993 that the International Classification of Diseases (ICD) listed autism independently from psychosis (American Psychiatric Association, 2013; Mezzich, 2002; World Health Organization, 2019).

A total of 17 studies met the selection criteria. The PRISMA diagram below provides an overview of the process.



3.3.3 Extracting and charting the data

The studies were critiqued using the Critical Appraisal Skills Programme (CASP) tools; this enabled a critique of the studies' variables and provided tools to determine the validity and reliability of the studies. CASP tools address concepts such as researcher/sampling bias and the 'trustworthiness' of the evidence produced (CASP, 2002). However, CASP tools have

been criticised as lacking depth of appraisal (Bury & Mead, 2002). Therefore, a further appraisal of the research was conducted using the Scottish Intercollegiate Guidelines Network (SIGN). The SIGN guidelines have been developed for the use of healthcare professionals when research is being considered as evidence (Taylor, 2006). Checklists enable specificity of the review based on the methods used. Checklist 4, Quasi-experimental studies, was used (SIGN, 2009). The findings of these reviews are not stated individually, as this would breach the scope of the review. The findings were used to identify the overall limitations of the studies. An example is provided in Appendix A.

The next stage of the review involved 'charting" the data from the research literature. The JBI Scoping Review Extraction Tool was used (Appendix B). A summary of the charted data is shown in the charting table, Appendix C. The charting table includes the author/date of the study, study design, population (including age range, sex, and diagnosis of participants), and relevant findings. These table headings were selected to provide a snapshot of the key information and support the detailed documentation of the results. Regardless of the method, all findings relevant to the study have been reported. This structure is advocated by (Machi & McEvoy, 2008).

3.3.4 Collating, summarising, and reporting findings

Whilst the key data is included within the charting table, Appendix C, a summary of the scoping review studies, excluding results, is listed below.

- All studies have been completed in England, America, or Italy.
- Sixteen studies were quasi-experimental designs that included controls and used clinical measures and psychometric tests; one was a case study. Details on the clinical measures and psychometric tests used are listed in Appendix D.

- The sample size of the autistic participants ranged from 1 to 39, with an average of 15 autistic participants.
- The male participants far outweighed the number of females. On average, 78% of the participants from all the studies collectively were male. Two studies included only male participants (Begeer et al., 2009; Kleinhans et al., 2005). In this regard, it is noted that more males are diagnosed with autism than females (Loomes et al., 2017).
- Twelve studies involved children only, two involved adults and children and three used adults only.
- Ten studies included participants with comorbid intellectual (learning) disabilities (with well-matched controls).

How the studies tested ideation

- Ten of the studies tested ideational fluency (Ambery et al., 2006; Begeer et al., 2009; Boucher, J., 1988; Dichter et al., 2009a; Kleinhans et al., 2005; Lind, Sophie E. & Bowler, 2010; Minshew et al., 1992; Turner, 1999). Tests of ideational fluency include verbal fluency and design fluency. Verbal fluency tests require words generated based on a given letter or category (letter or category cue/prompt). Design fluency tests involve creating designs, e.g., using four lines to connect a series of dots, following specific rules such as 'create as many designs as possible using only the filled dots'. Seven of the studies used letter fluency tests (Ambery, et al., 2006; Begeer et al., 2009; Boucher, J., 1988; Dichter et al., 2009a; Kleinhans et al., 2005; Lind, Sophie E. & Bowler, 2010; Minshew, N. J. et al., 1992; Turner, 1999). Seven of the studies used category fluency tests (Ambery, et al., 2006; Begeer et al., 2009; Boucher, J., 1988; Dichter et al., 2009a; Kleinhans et al., 2005; Lind, Sophie E. &

Bowler, 2010; Minshew, et al., 1992; Turner, 1999)). Two studies used design fluency tests (Kleinhans et al., 2005; Turner, 1999).

- Eight studies within the review are categorised as 'use of objects' tests, whereby participants are tasked with forming new ideas based on the use of miscellaneous objects and themed objects, for example, a toy doll with a random item (Bishop, & Norbury, 2005; Dichter et al., 2009a; Jarrold, et al., 1996; Lewis & Boucher, 1995; Lind, S. E. & Bowler, 2010; Low et al., 2009; Turner, 1999). Use object tests were used to examine generativity. Appendix D summarises the tests used that are relevant to the scoping review.
- Two of the studies specifically tested ideational dyspraxia. One study used tasks that required the participant to perform a sequence of actions in a prescribed order. Five individual tasks assessed ideational dyspraxia, including finger thumb apposition-sequential (FTAS); the Luria fist test (repeated sequence of 3 movements, fist, open hand, side hand); 3-block bridge building, 6-block pyramid building; and tandem gait (Miller et al., 2014). One study used the Test of Ideational Praxis (Serrada-Tejeda et al., 2021).

The data charting process, detailed in 3.3.3, assisted in a meta-summary of findings. Only findings that relate to the scoping review objectives were used.

3.4 Results

The results of the studies and the further evaluation of the test demands (considered with corresponding results) enabled the identification of themes. This process is advised by Paterson et al., (2022) and Nowell et al., (2017). Findings, for example, 'poor generativity of play" or 'generativity correlated' with free recall, were grouped, and the most frequently occurring findings were considered to represent a strength of a finding. Less common or

opposing findings were also included, but further analysis of the study methods was completed to interpret the results comprehensively. Some key themes were identified following an analysis of the psychometric test demands, for example, whether they gave prompts or not. The results of the studies based on the tests they used are demonstrated in Appendix E. Key themes are outlined in Table 4.

Table 4 Themes and key findings

Themes	Key Findings
Ideation when 'freely" generating ideas (no prompts)	• All studies that tested the entire process of ideation (production of ideas without a prompt) showed that autistic participants produced fewer ideas than controls
Ideation when given cues or prompts	• Studies using tests that provided categories showed that autistic participants could produce a similar number of responses to the controls. • Studies using tests that provided letters had different results; some studies showed inferior performance from autistic participants, and some studies showed similar performance across autistic and control groups. • The provision of a cue or prompt elicited the chaining or grouping of ideas in autistic participants more than controls. • Increased visual/imagery guidance provided by the prompt may have improved ideation. • The number of toys offered did not increase the number of ideas produced in autistic children compared to controls.
Relationships between idea generativity and attention and memory function	• Within the ideational process, it was noted that there is a difference between generating an idea and generating a strategy to retrieve an idea. • Episodic memory is required within the ideational process. Participants with autism have better perceptual memory and worse episodic memory than controls. • A positive correlation between verbal fluency tests (letter and category) and memory exists in both groups • The autistic case study described needing a prompt or cue to begin a memory. • Memory abilities positively correlate with generativity in autistic groups more than controls.

	• Note: Imagination is part of the ideational process. Lack of imagination is a trait of autism. Studies found a positive correlation between memory and imagination in autistic group more than in controls. • Attention issues linked to poor generativity, specifically due to the inability in attention switching were found more in the autistic group than controls.
Ideation and autistic traits	• Studies found that it is the generativity of imagination that is the problem in the autistic group only. • Instruction and prompts improve imagination in the autistic group only. • Studies showed a positive correlation between repetitive scores and generativity in both groups but more so in the autistic group. • A lack of flexibility of thought could cause a correlation between generativity and communication in the autistic group. • Studies indicated that lack of flexibility of thought and poor ideation could link to difficulties with adapting to new places, people, and routines (traits of autism), in the autistic group more than controls. • Studies indicated that ideation could be linked to poor play skills. • Studies indicated that a lack of inhibition could affect ideation.
Ideational Praxis in Autism	• Studies indicate no correlation in either group regarding age and praxis abilities • Studies indicate that the autistic group had more severe ideational dyspraxia than the control group; the autism group had more severe buccofacial dyspraxia than the control; the autism group had poorer basic motor function than the control; autism group had poorer eye movement performance than the control. • Studies report no correlation between ideational dyspraxia and simple motor tasks in either group. • Studies indicate ideational dyspraxia correlated with motor integration in the autism group but not control. • Greater ideational dyspraxia was associated with increased autistic mannerisms, repetitive behaviours, and restricted interests. • Autistic group performed worse than control group on tests of ideational praxis and play scale. • Ideational praxis and play skills correlate.

3.4.1 Ideation without Prompts

Some studies used tests that did not provide prompts or cues (Appendix F). These test methods required the 'free' development of ideas. All studies that tested ideation without prompts or cues consistently found that autistic people produce fewer ideas than controls (Begeer et al., 2009; Bishop& Norbury, 2005; Boucher, 1988; Dichter et al., 2009a; Lewis & Boucher, 1995; Lind, & Bowler, 2010; Low et al., 2009; Turner, 1999).

3.4.2 Ideation when provided with cues or prompts

Some of the studies examined ideation using ideational fluency tests. Each test provided different levels of prompts or cues. Eight studies that used category fluency tests (prompts of category) found no impairment in the autistic participants compared to controls (Boucher, 1988; Dichter et al., 2009a; Kleinhans et al., 2005; Lind, & Bowler, 2010; Minshew, et al., 1992). Six studies used letter fluency tests (prompt of a letter) and produced mixed results. Turner, (1999) and Ambery, et al., (2006) found that autistic participants had poorer performance with letter fluency. In contrast, Lind & Bowler (2010) and Minshew et al. (1999) reported no difference between the autistic and control participants. In comparing the letter and category tests, Boucher (1988) and Kleinhans et al. (2005) found that participants performed better than average on category fluency but worse on letter fluency or miscellaneous word generation.

In summary, most studies found that autistic participants performed worse than controls in letter fluency but showed no significant difference against controls in category fluency. This supports the notion that the more imagery, context, or guidance involved in the prompt, the better autistic participants could generate ideas. For example, categories, such as 'names of animals', provided more guidance than letters, such as 'words beginning with T'.

Some authors investigated this notion further. Boucher (2007) suggests that performance improvement could be because category fluency tests better support the chaining of ideas. The chaining of ideas involves the association of an idea from the idea that proceeds it. Similarly, Turner (1999) found that the autistic participants' 'clustered' their ideas. For example, one idea led to another, with all ideas relating to the same topic. In support of this, Boucher (1988) reported that autistic participants produced more grouped words within the miscellaneous words test than the controls. Indicating a reliance on cues that could link to abilities in association, another skill necessary for ideation (Runco, 2004).

Jarrold, (1996) used various prompts to test how different prompting methods affected generativity in autistic participants. One of the prompts involved providing toys. The provision of additional toys did not influence the number of pretend play ideas; however, verbal prompts and instruction did, concluding that the number of ideas produced was increased, primarily when prompts provided some form of guidance. Irrespective of the method or type of prompt or cue, the results of the studies reflect that people with autism have difficulty with the free generation of ideas. However, autistic participants improved their ideational abilities with prompts or cues. Autistic participants performed worse than controls without a prompt but almost equal to controls with verbal prompts and instructions.

3.4.3 Relationships between idea generativity and difficulties with autism memory and attention function

Turner stated that poor association, as opposed to poor memory recall, could account for problems with generativity (Turner, 1999). In conflict with Turner's (1999) findings, Ambery et al. (2006) reported that memory recall impacted negatively on ideational fluency

(correlation between visual memory and verbal fluency). Ambery et al. (2006) note that visual memory enables mental imagery by recalling objects and environments. Cues and or prompts stimulate visual memory. Visual images from memory are then used to support better ideation. From this it is concluded that research around memory function and ideation is as yet inconclusive.

Boucher (1988) also hypothesised that autistic people have difficulties generating information from long-term memory without prompts or cues, limiting creativity and originality (skills involved in ideation). In support of this, Boucher's (2007) case study participant reported that to recall a memory, he requires a prompt, leading to the chaining of thoughts. For example, he recalls the vending machine in a room, then the chair next to the machine, then the door, and so on, leading to remembering the whole waiting room.

Adding evidence to the notion that memory may impact ideation, Jarrold et al. (1996) found that generativity deficits in imaginative play were consistent with other cognitive differences in autistic people, including free recall memory. Expanding on these links, (Low et al., 2009) associated memory problems directly with the ideational process. They found that memory is recalled into working memory, a visuospatial plan is formed using imagination, and a new idea is generated. In support of this, Boucher (2007) concluded that event memory positively correlated with generativity. Panerai et al. (2014) found working memory to be worse in autistic groups than in controls. The inability to use event memory affects the ability to generate event-based scenarios. Boucher (2007) describes how episodic and perceptual memories are at either end of a spectrum, where episodic memory recalls different modalities from other memories and combines them, meaning that the memories are relational. In contrast, perceptual memory is a ‘single item’ memory and is the type of

memory in which autistic people excel (Boucher, 2007). This could explain why prompts produced better ideation in autistic people based on improved memory function.

Jarrold et al., (1996) noted a gap in understanding the functional difference in generating an idea and 'generating a strategy to retrieve an idea' (Jarrold et al., 1996, p.296). Jarrold et al. (1996) hypothesised that processing deficits could contribute to the problems with generativity and, thus, ideation. Whether generating a strategy to retrieve an idea is related to memory function is unclear and warrants further research. These findings further support the preceding theories on the role of memory in the ideational process and indicate that, for autistic people, memory deficits could be the basis of a problem in ideation.

Regarding attention abilities in ideation, previous paediatric research has suggested that a lack of generativity is linked to an inability to pay attention to internally stored play schemas caused by a failure to disengage from external salient stimuli (Harris, 2000). Jarrold's study supports this, and they noted that autistic children in a minimally furnished play space with no toys, hence limited external stimuli, could pretend to play as well as they could when given multiple toys (Jarrold, et al., 1996). One suggestion is that problems drawing attention away from stimuli impact the generativity of play. Additionally, Jarrold and colleagues noted children had difficulties with inhibiting and activating attention to other tasks, although this was not directly linked to the generativity of ideas, it is worth noting because this redirection of attention would also be required when generating new ideas (Jarrold, et al., 1996)

3.4.4 Potential links between ideation and autistic traits

Imagination

It is generally concluded that imagination is essential to the ideational process (Runco, 2004). One of the diagnostic traits of autism is a lack of imagination (Mezzich, 2002). It is also known that generativity is an essential skill in imagination (as outlined in 2.4.1); therefore, studies on imagination and generativity are relevant when looking at the potential links between imagination (as an autistic trait) and ideation. In studies that investigated generativity, researchers also found that autistic participants produced fewer imaginative responses (Jarrold et al.,1996, Low et al.,2009; Scott & Baron Cohen, 1996; Turner,1999). It is noteworthy that in both the typically developing groups and autistic groups, children's generativity positivity correlated with imagination.

However, only the autistic children showed improvement in generativity of imaginative play with verbal instruction, concluding that autistic children could produce imaginative responses but needed prompts and instruction to do this (Jarrold et al., 1996). Scott and Baron Cohen (1996) mirrored this finding and concluded that the deficit in performance was not due to a generativity deficit since autistic children were no different to controls in the ability to generate words or ideas of natural objects. This could indicate that it is precisely the generativity of imaginative responses which causes deficits. Furthermore, Jarrold et al. (1996) noted that imaginative play was created more slowly by autistic people than controls despite well-matched intelligence and communication, again suggesting that problems with imagination are related to deficits in skills required to generate imaginative responses but concluding that autistic people could imagine.

Flexibility, inhibition, and repetition

Poor flexibility of thought has been directly linked to autism (compared to controls) Panerai et al. (2014). Furthermore, flexibility of thought deficits could also link to other traits of autism, such as repetitive behaviours (Low et al., 2009; Turner, 1997). Bishop and Norbury (2005), Dichter et al., (2009), and Jarrold et al., (1996) claim that because poor generativity could be associated with difficulties in the flexibility of thought, a primary cause of communication dysfunction in higher-functioning autism could be linked to generativity (Bishop, & Norbury, 2005). However, Bishop and Norbury (2005) and Boucher (1988) discussed that poor language skills alone could not cause difficulties with ideation. Additionally, Paneral et al (2014) found that adaptive thinking links to performance in the flexibility of thought, both skills deficient in autism, however, adaptive thinking did not correlate with communication deficits in their autistic participants.

Turner (1999) found that autistic participants appeared to have difficulty moving from one idea to the next, reflecting problems with inhibition. Turner (1999) hypothesised a link between ideation and inhibition and lack of flexibility in thought. Early ideation theories, including by Ward (1918), suggested that people need to inhibit existing ideas to make new ideas, thus supporting the idea that poor inhibition could link to poor ideation.

As a secondary finding, studies noted that autistic participants produced more repetitive answers ;, Bishop, & Norbury, 2005; Miller et al. 2014; Turner, 1999). Possibly, this is because poor generativity of novel ideas caused increased repetitive responses. Turner (1999) explains that intact generativity is a natural precursor to effective rule-governed behaviours. Therefore, poor generativity will result in repetitive behaviours. This means that autistic individuals could repeat behavioural patterns because of an inability to generate

novel designs. Findings by (Dichter et al., 2009a) contradicted these findings; however, participants in this study showed no correlation between generativity and repetitive behaviours. To note, Dichter et al. (2009a) cited concern about the reliability of the Repetitive Behaviours Scale used in the study (Bodfish et al., 1999), potentially reducing the significance of these findings.

In summary, studies have shown there may be links between difficulties with the flexibility of thought, association, inhibition, and generativity (Low et al., 2009; Turner, 1997; Bishop & Norbury, 2005; Dichter et al., 2009 & Jarrold et al., 1996). Studies also made links between autistic traits, including repetitive behaviours and lack of imagination and generativity (Ambery, et al., 2006: Bishop, & Norbury, 2005 Dichter et al., 2009; Jarrold et al., 1996; Low et al., 2009; Turner, 1999). Turner (1999) suggested that generativity difficulties might be further researched to understand repetitive and restrictive autistic traits better.

3.4.5 Potential links between ideational dyspraxia and autism

Two studies explored ideational dyspraxia in autistic participants and non-autistic controls (Serrada- Tejeda et al., 2021 & Miller et al., 2014). In both studies, the autistic group showed more severe ideational dyspraxia than the control (Serrada-Tejeda et al., 2021 & Miller et al., 2014). Miller's study found that the autistic group had more dyspraxia symptoms, including problems with buccofacial praxis and eye movement. Interestingly, no correlation was noted between ideational dyspraxia and simple motor tasks in either group, enabling a distinction between ideational skills and motor movements (Miller et al., 2014). Furthermore, ideational dyspraxia correlated with motor integration in the autism group but

not the control; this indicates that the problem occurs in integrating the senses as opposed to the physical action of the movement (Miller et al., 2014).

Miller and colleagues noted that in autistic children, ideational dyspraxia positively correlated with increased autistic mannerisms (r_S (17) = −0.40, p < 0.05) and with increased repetitive behaviours and restricted interests (r_S (17) = −0.47, p < 0.02) (Miller et al., 2014). Serrada-Tejeda et al., (2021) noted that the autistic population performed worse than controls on both the test of ideational praxis and play scales. Furthermore, results of multiple linear regression models found a linear relationship between ideational praxis and play development (t =2.94; p = 0.005) and adaptive leisure skills (t = -3.04; p = 0.004), but not with social interaction skills (t= 0.05; p = *0.72*).

In summary, these studies suggest that ideational dyspraxia is more prevalent and severe in autistic children than controls and that ideational dyspraxia relates to specific autistic traits. This research also indicates that ideational abilities relate to the child's play development and leisure skills.

3.5 Discussion

The results of the scoping review have included an exploration of the findings. The following discussion focuses on factors that could have influenced the results of the studies and the conclusion of the scoping review.

3.5.1 The influence of autism on the validity and reliability of the studies

The potential impact of diagnostic differences between Asperger's syndrome and Autism Spectrum Condition was considered within the evaluation of Kleinhans et al. (2005) study. However, within this study, the only difference noted between the higher function autism

and Asperger's group was in visual scanning (which is unlikely to affect ideation) Kleinhans et al., (2005), positing that the different diagnostic labels used in these studies did not affect the results that related to ideation.

It could be argued that autistic traits could affect the validity and reliability of results if reasonable adjustments are not made within the research. For example, autistic participants may have difficulty coping with new people and environments (Attwood, 2008). The only researchers who commented on this were Lewis and Boucher (1995). From the study information, it is difficult to comment on the extent to which the participants 'traits affected the validity of the results, not only because of the lack of discussion around this but because each participant would be affected differently due to the diverse presentation of autistic traits.

Deficits in communication is also an autistic trait. However, all of the studies considered verbal language abilities and the possible effect on results.

3.5.2 Tests used in the studies and their ability to examine ideation

The studies used various tests to measure ideational fluency and generativity. To confirm the studies examined ideation as described in this thesis (Chapter 1), the work of (Runco, Mark A., 2004) was considered. Runco (2004) expanded knowledge on the original theories of ideation to facilitate an understanding of what constitutes a comprehensive assessment of ideation. (Runco, Mark A., 2004) concludes that an examination of ideation requires testing the fluency (number) of ideas, originality of ideas, and flexibility. This is supported by (Dinar et al., Aug 2, 2015), who also adds novelty as an element. These elements are included in tests that measure the number of alternative uses for an object, such as the Use

of Objects Test (Turner, 1999) and the Test of Ideational Praxis (May-Benson, & Cermak, 2007). Appendix G outlines how these tests met the requirements for examining ideation.

A large-scale study by Vannorsdall et al., (2012) concluded that ideational fluency represents 'a cohesive and discernible domain of cognition that specifically involves the ability to retrieve or generate idea' (Vannorsdall et al., p. 401), thus giving merit to using ideational fluency tests in ideation studies. However, some ideational fluency tests, including verbal fluency tests (word fluency and category fluency), do not examine the entire ideation process, only the memory component (Delis et al., 2001). Bizzozero et al., (2013) conclude that both letter and category fluency tests provide cues. They specify that category fluency tests provide a semantic cue, whereas the letter fluency test provides a phonological cue. The difference in the cues affects how participants access answers, meaning that adequate performance in verbal fluency does not indicate intact ideation.

Using prompts within some tests also affected other findings beyond the total score. For example, some of the studies reported no deficit within imaginative ideas. However, these studies provided prompts within testing and did not examine 'free' imagination (Jarrold, Smith, Boucher & Harris, 1994; Lewis & Boucher, 1995). This area requires further research.

Some aspects of the test scoring could have altered the reliability of the results. For example, Bishop and Norbury (2005) used the total number of answers provided on the Patterns Meaning Test Doherty & Mair, (2012) not the total number of correct results. Interpretation of the results means that the control group and higher functioning autism group produced the fewest responses. However, the control group performed the best when counting the

correct answers. This supports the notion that ideation is not about the speed of verbalising thoughts but the ability to generate new ideas.

3.5.3 Limitations of the scoping review

As discussed, several restrictions were imposed by the scoping review literature inclusion and exclusion criteria. These restrictions include the date range and exclusion of studies with participants who have secondary diagnoses. Whilst these exclusions have been well justified, with additional resources the inclusion criteria could have been broadened.

The outcome of the search reflected some limitations on the findings. Some of the studies involved low numbers of participants. The studies did not state the ethnicity or give much context to the socioeconomic background of the participants. In three of the studies, the mean age of the participants was not provided. Whilst these factors did not prevent meeting each study's aims, they did limit the ability to comment on the generalisability of their results.

3.6 Research Recommendations

This review provided a solid foundation for further research. Two primary research considerations have emerged from the review. Firstly, because attention and memory are part of the ideational process and it is known that autistic people have differences in both functions, it is unclear if these functions are to blame for poor ideation. Secondly, the review began to uncover potential links between ideational deficits and autistic traits, including imagination. However, this has mainly been a secondary finding, and no definite conclusion has been formed (Jarrold et al., 1996; Low et al., 2009; Turner, 1999).

Investigating relationships between memory, attention and ideation, and between autistic traits and ideation should enable a better understanding of deficits in ideation and potentially indicate why some traits exist. This, in turn, has the potential to inform and improve therapy and early interventions. The scoping review, therefore, informed the hypotheses specified in the following Chapter.

3.7 Summary

This scoping review suggested that autistic people have difficulties with ideational fluency, imagination, and generativity, all of which are part of the ideational process. Autistic participants consistently performed worse than the controls in tests that required 'free' ideation (Begeer et al., 2009: Bishop & Norbury 2005; Boucher, 1988; Dichter et al., 2009; Lewis & Boucher, 1995; Low et al., 2009; Turner, 1999, Serrada- Tejeda et al., 2021; Scott & Baron Cohen, 1996).

Autistic participants increased the number of responses when given a prompt or cue; this improvement was significantly greater than within the control group (when given a prompt or cue).

This scoping review noted links between ideation and autistic traits. Researchers also connected ideational abilities, repetitive behaviours, inhibition, and association, although these findings were secondary (Turner, 1999). Studies showed initial links between memory, attention, and generativity (Boucher, 1995; Ambery et al., 2006; Boucher, 2007; Jarrold et al., 1996; Low et al., 2009). Some researchers began to look at the cause of this link but have yet to form a conclusion (Boucher, 2007; Jarrold et al., 1996; Low et al., 2009).

This scoping review identified gaps in our understanding of autism ideation, and from this, the working hypotheses were formed. Chapter 4 will discuss the methodology and methods used to test these hypotheses.

CHAPTER 4: METHODOLOGY AND METHOD

4.1 Introduction

This chapter describes the research aim and begins with the research hypotheses and questions. The chosen methodology, research approach and study design are detailed. The study method, including the participant recruitment process, test administration and the chosen statistical analysis technique, are described. Finally, this chapter outlines the ethical considerations of the study.

4.1.1 Study aims, hypotheses, and research question

This study aims to further understand ideation in autism by addressing the following questions:

1. In autistic people, is there a relationship between ideation and attention compared to non-autistic people?
2. In autistic people, is there a relationship between ideation and memory compared to non-autistic people?
3. In autistic people, is there a relationship between ideation and autistic traits compared to non-autistic people?

The null and alternative hypotheses are as follows:

Null Hypothesis 1. Ideation abilities and attention function do not correlate differently in autistic people compared to non-autistic people.

Alternative Hypothesis 1. Ideation abilities and attention function correlate differently in autistic people compared to non-autistic people.

Null Hypothesis 2. Ideation abilities and memory function do not correlate differently in autistic people compared to non-autistic people.

Alternative Hypothesis 2. Ideation abilities and memory function correlate differently in autistic people compared to non-autistic people.

Null Hypothesis 3. Ideation does not correlate with autistic traits, especially repetitive and restrictive behavioural traits and imagination. Ideation abilities will not correlate differently with autistic traits in autistic people compared to non-autistic people.

Alternative Hypothesis 3. Ideational abilities will correlate with autistic traits especially repetitive and restrictive behavioural traits and imagination abilities. Ideation abilities will correlate differently with autistic traits in autistic people compared to non-autistic people.

4.2 Methodological Foundation and Research Approach

4.2.1 Methodological considerations based on epistemology and research philosophy

A quantitative methodology using a quasi-experimental design addressed the research questions, establishing the existence or otherwise of relationships between the variables in two sample groups (autistic and non-autistic). In line with the epistemological basis of quantitative research, this study was deemed social scientific in its approach (Bhattacherjee, 2012). The variables of ideation, attention, memory, and autistic traits are arguably all 'real' measurable biological scientific functions, as supported by Bhattacharjee (2012). Looking at the validity and utility of the autism diagnosis, as advised by (Jablensky, 2016), also clarified the application of a realist view when used in this study. Although Jablensky (2016) generally debates the validity of mental health diagnoses, autism spectrum disorder is different in that it is defined by a unique group of traits and underpinned by

neurophysiological differences (Frazier et al., 2012). In terms of how useful the diagnosis is to autistic individuals and how useful it is in research; the utility will somewhat depend on the individual. However, a diagnosis can support access to services and interventions and enable people to understand their behaviours under a diagnostic framework (Elder et al., 2017). This study aims to contribute to the utility of this diagnosis by seeking to understand autism further.

Inductive enquiry was used in Chapters 1, 2 and 3 to ensure clarity of the terms used and to support the understanding of ideation before a deductive approach was applied through testing the hypothesis within the study.

4.2.2 Study design

Contributions to understanding autism ideation are providing foundation knowledge. The literature search and scoping review formed a platform of knowledge to support the notion that autism ideation is different. The next step was to build on knowledge about the relationships between a select number of known autism differences and ideation, then examine whether these relationships are different in autism by comparing the results with a non-autistic control group. The research questions and hypotheses do not aim to seek out a cause therefore, an experimental approach was not necessary. However, a quasi-experimental design enabled the use of standardised and norm-referenced tests of ideation, autistic traits and executive functions produced comparative data suitable for quantitative examination. A substantial body of research has also used this approach to examine generativity and ideational fluency in autism. These studies used clinical measures and psychometric testing of participants' abilities. Often, they used well-matched controls and then correlated the results to generate conclusions (Baker et al., 2021; Begeer et al., 2009;

Bishop, & Norbury, 2005; Kleinhans et al., 2005; Lee & Schertz, 2020; Lewis & Boucher, 1995; Lind, & Bowler, 2010; McDuffie et al., 2005; Sayorwan et al., 2018; Turner, 1999). No studies have been found that address the hypotheses stated within this thesis.

The use of non-experimental quantitative designs including observations, interviews, and using archival data was considered. However, adequate archival data does not exist, as concluded in Chapter 3. Other studies looking into generativity have used observations; for example, (Minshew, et al., 1992) used observations of generativity in play. However, this approach may produce less reliable results when measuring executive functions. Reliability is essential because the results must be generalisable to the study population (Burchett et al., 2020).

4.2.3 Selecting the tests

The research question outlined the variables that required testing, including attention, memory, autistic traits, and ideational abilities. Attention and memory are broad functions; the tests needed to examine only the necessary areas of these functions. The final selection of each test was based on the assurance that necessary functions would be tested, and that the validity of the tests should not be affected by autistic traits; details of the test selection are as follows.

4.2.3.1 Measures for Attention

Attention is a crucial component in ideation because attention focuses on memories and enables the formation of ideas (Ward, 1918). This theory of the attention and memory relationship is commonly accepted (Acheson et al., 2011; Atkinson et al., 2018; Baddeley, Alan, 2012; Baddeley, et al., 2019; Chun et al., 2011; Coolidge & Wynn, 2005; Lavie et al.,

2004). Neural imaging studies have established four different aspects of attention, namely sustained, executive (focus on steps of a task), selective, or a focus on one thing at a time and divided, or a focus on two events at a time (Aoki et al., 2017; Knudsen, 2007; Konrad et al., 2005; Mirsky et al., 1991; Posner & Rothbart, 2000). Research has yet to specify the specific types of attention that affect ideation; therefore, all types of attention need to be measured.

Various methods can be applied to measure attention; attention is often assessed through cognitive, behavioural and emotional questionnaires, such as Conners Third Edition (Conners, 2008); as mentioned questionnaires can have limitations when obtaining objective measurements of cognitive function as they are based on the person's perspective and opinion therefore, the selected test needed objective scorable measurement techniques that examine the types of attention outlined above.

The Test of Everyday Attention (TEA) is based on a neuroanatomical model of attention and tests all the necessary elements of attention (Robertson, Ward, Ridgeway & Nimmo-Smith, 1996). Within the TEA, the terms selective attention, sustained attention, and attentional control are used to describe the assessment areas (Robertson et al., 1996). The TEA was, therefore, selected as the test for attention.

The Test of Everyday Attention

The TEA uses eight subtests comprising visual and auditory tasks to determine the participant's patterns of strengths and weaknesses (Crawford et al., 1997). The subtests mimic everyday tasks, enabling a better understanding of what is required, improving motivation, and reducing anxiety (Manly et al., 2001). In the general population, this

increases validity, however this is especially important with this participation group because of autistic traits. The TEA is designed for adults aged between 17-80. Standardisation research showed good validity of the TEA (Robertson et al., 1996). Since then, further research has supported the validity and reliability of the TEA (Bate et al., 2001; Manly et al., 2001). Other researchers have used the TEA autistic participants. A critical review of these studies determined that TEA had strong reliability and validity (Wodka et al., 2016).

As with the memory testing (see below), the validity and reliability of individual subtest scores were considered. TEA research supports the use of individual subtests (Crawford et al., 1997; Manly et al., 2001; Robertson et al., 1996: Crawford et al., 1997). Since the entire test takes approximately one hour to administer, some subtests were excluded to limit the test time. Excluded sub-tests significantly weighted on skills deemed not essential for ideation, including auditory-verbal memory and other non-attention-specific skills such as complex mental arithmetic (Robertson et al., 1994). The chosen subtests examine all necessary areas of attention.

Robertson and colleagues acknowledge that the subtests may not be entirely exclusive in the type of attention they assess and, therefore, describe the categories of tests as 'weighted on' a particular area of attention (Robertson et al., 1996). Therefore, in this thesis, cautious clinical interpretation of the attention categories was necessary.

4.2.3.2 Selecting a measure for testing memory

When deciding which areas of memory required testing, there were two main considerations:

1) Memory profiles of autistic people
2)) Types of memory that affect ideation.

Chapter 2 discussed memory and attention in autism. Summarising these considerations, autism is a unique condition in that areas of difficulty in memory exist alongside areas of exceptional memory performance Czermainski et al., (2014) however, a substantial body of evidence has established that working memory is impaired in autism, particularly phonological memory (part of working memory) (Boucher, et al., 2012b; Bucaille,. et al., 2016; Desaunay et al., 2020b; Desaunay et al., 2020c; Habib, et al., 2019; Kercood et al., 2014a; Wang, et al., 2017). Research has also identified problems with episodic memory, which is part of long-term memory (Boucher, J., 2007; Boucher, Jill et al., 2012b; Grainger et al., 2016b; Grisdale et al., 2014; Lombardo et al., 2007; Toichi et al., 2002).

In addition to consideration of the autistic memory profiles, it was necessary to look at which areas of memory are known to affect ideation and examine these. As previously mentioned, Ward (1918) reported that episodic memory is essential when generating ideas because this part of the memory function enables conscious recollection of events and experiences. These memories are then used to build ideas. In support of this, the scoping review findings also indicated that deficiencies in episodic memory could be linked to a lack of generativity (Boucher, 2007).

Finally, the scoping review found that autistic individuals often had difficulties when asked to recall information freely; this applied to both long and short-term free recall (Bennetto et al., 1996; Bruck et al., 2007; Henry, et al., 2017; Maras & Bowler, 2012; Mattison et al., 2015; McCrory et al., 2007). These findings indicated that the areas of memory that required testing were long-term episodic memory, immediate and delayed recall and working memory (Cheke & Clayton, 2013)

The Child and Adult Rivermead Behavioural Memory Tests, Version 3 (RBMT-3) (Wilson et al., 2003) was selected for the study because it examines all the required aspects of memory function (Guaiana et al., 2004; Wester et al., 2013). Cheke and Clayton (2013) researched tests examining episodic memory, concluding that Unexpected Questioning most accurately examines episodic memory. This test was considered an alternative to the RBMT-3 but was disregarded because of its inability to examine immediate and delayed recall.

The Rivermead Behavioural Memory Tests- Version 3

The RBMT-3 is designed to test adults from ages 16-89. It involves the completion of 10 subtests. All subtests (with the exception of the 'orientation and date' subtest) measure delayed recall, immediate recall, or delayed recognition. This span examines both episodic and working memory and visual and verbal memory aspects. The subtests are based on everyday tasks, an approach unique to memory testing that increases ecological validity (Jones et al., 2011). Using everyday tasks within testing is beneficial for autistic people as it is assumed to be more logical, uses tasks that may be familiar to participants and limits the influence of restrictive and repetitive traits.

Validity was tested and confirmed as part of the RBMT development (Wilson,. et al., 1989). Subsequently, other studies have confirmed that the test has good clinical validity (Wilson, et al., 1989; : Fong et al., 2019). A study by (Makatura et al., 1999) suggests that the RBMT-3 was the most accurate test in classifying memory impairments as rated by clinicians. The RMBT-3 has been noted to be sensitive in identifying different levels of memory impairments and differentiated those with and without risk of cognitive impairments (Fong et al., 2019).

The use of individual subtests within the analysis of the results would enable more specificity on how particular types of memory relate to ideation. The validity testing of the RBMT subtests supports their individual use (Wilson, Cockburn, & Baddeley, 1991). Additionally, other research, including previous autism studies, has confirmed validity in data taken from individual subtests, i.e., Jones et al. (2011).

4.2.3.3 Measures for Autistic Traits

'Autistic traits' is a term used to identify specific actions or behaviours displayed by autistic people. To confirm a diagnosis of autism, an assessment of the person's autistic traits is required, as outlined in the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2013) and the International Classification of Disability (World Health Organization, 2019). Ensuring that the test selected looked at the same traits used for diagnostic purposes meant that the study examined autistic traits as defined in the UK. Therefore, the test selected for autistic traits conformed to the current diagnostic list. According to the DSM-5, autism is indicated by persistent deficits in each of three areas of social communication and interaction (see A.1. through A.3. diagnostic criteria, Appendix H) plus at least two of four types of restricted, repetitive behaviours, including deficits in imagination (see B.1. through B.4. Appendix H).

Chapter 2 established imagination as part of the ideational process. Additionally, the scoping review in Chapter 3 found that poor imagination (Jarrold, C. et al., 1996; Low et al., 2009; Turner, 1999), as well as repetitive behaviours (Ambery, et al., 2006; Bishop, & Norbury, 2005; Turner, 1999), linked to generativity. Therefore, the test's measures must include poor imagination and traits reflecting repetitive behaviours.

A primary way of assessing autistic traits is using diagnostic tools or assessments, such as the Autism Diagnostic Interview-Revised (Rutter et al., 2003b). Diagnostic assessments were considered for use in this study; however, this would not have been practical because of their time to complete. Previous studies have used participants' existing diagnostic assessments; however, because most participants' diagnostic assessments originate from childhood, as adults, their current autistic traits could differ. A short screening tool is often used as part of the initial diagnostic process. Various screening tools can produce a profile of the person's autistic traits. One of the most used in England is the Autism-Spectrum Quotient (AQ) (Baron-Cohen et al., 2001). Another screening tool considered was the Australian Scale for Asperger Syndrome (ASAS) (Garnett & Attwood, 1995); this is a clinician-rated questionnaire that can be used for adult assessments. Its major drawback is the lack of clear scoring criteria, making it potentially problematic for use in the study. The AQ was, therefore, chosen for testing traits.

The Autism-spectrum Quotient Questionnaire

The Autism-spectrum Quotient (AQ) is a self-completed questionnaire for adults with intelligence within the normal range that measures the degree of autistic traits (Appendix I-AQ 50). Items listed on the AQ derive from cognitive differences in autism and the domains in the 'triad' of autistic symptoms (Rutter et al., 2003b; Wing & Gould, 1979). The AQ consists of 50 questions, with 10 assessing five domains relevant to autistic traits (social skill, attention switching, attention to detail, communication, and imagination). The AQ has a forced-choice format. Additionally, the questions ask about the person's preferences instead of asking people to judge their behaviours, making the questions more accessible for this participant group to answer (Auyeung et al., 2008). The AQ shows good validity when tested against age-matched controls and excellent test-retest reliability (Baron-Cohen

et al., 2001). This research also showed that IQ and socioeconomic status did not influence scores (Baron-Cohen et al., 2001). In 2005, the AQ was evaluated for its usefulness as a screening questionnaire and was shown to have good receiver operating characteristics (Woodbury-Smith et al., 2005: Ruzich et al., 2015).

The total and subtest scores can be used in research studies; Lundqvist & Lindner, (2017) verified the use of AQ sub-scores. They used Rasch analysis (1960) to determine the degree to which items in the AQ accurately characterise autistic traits while also evaluating the validity of the test. Lundqvist and Lindner (2017) concluded that using the sub-scores might be more accurate than the total scores. The authors of the AQ looked at the internal consistency of the items in each of the five domains. They found the Cronbach's alpha coefficients (Cronbach & Meehl, 1955)to be moderate to high (Communication .65; Social .77; Imagination .65; Local Details .63; Attention Switching .67) (Woodbury-Smith et al., 2005).

4.2.3.4 Measures for Ideation

Runco (2004) states that testing ideation involves calculating the number of ideas (fluency), the number of unique ideas (originality), and the number of different categories implied by the ideas (flexibility). Frequently used metrics for testing ideation are fluency, elaboration, novelty, and quality (Dinar et al., 2015; Vannorsdall et al., 2012). The scoping review concluded that ideational fluency tests do not measure the entire ideational process and are inappropriate for assessing ideation when used in isolation. Fluency, flexibility, and originality are all measurements included in tests that evaluate the number of alternative uses for an object (Appendix G), such as the 'alternative uses test' developed by Guilford in 1967 (Guilford, 1967) as adapted and used by Turner (1999) and Jarrold, Boucher and Smith (1996). The limitation of the 'alternative uses test' centers around the lack of data to validate

the use of the test to measure normal function. Researchers have adapted this test as identified by Vartanian et al., (2019) and often used it with well-matched controls or to stimulate the creative areas of the brain, for example in MRI imaging studies, (Fink et al., 2009). Its efficiency of use in other types of research is difficult to conclude.

Another similar test is the Test of Everyday Praxis (TIP) (May-Benson & Cermak, 2007). This test covered all required measurements of ideation (Appendix G). The TIP could be viewed as an adapted version of the alternative uses test, with the added advantage of providing a score sheet, and most importantly is supported by some validity testing research and norms data.

The Test of Ideational Praxis

The Test of Ideational Praxis (TIP) (Appendix J) assesses a child's ability to perceive object affordances and to demonstrate their ideas for interaction with specific objects (May-Benson & Cermak, 2007). The test consists of one item, a piece of string, and is scored based on the participant's demonstration of various actions or ideas identified for that object. As a measure of the test validity for use in the study, the definition and testing of ideation as described in the TIP compared favourably to the findings of the preliminary search in Chapter 2, 2.4.3.1, Understanding Ideation (May-Benson, 2005; May-Benson & Cermak, 2007).

Theories of praxis form the basis of the TIP. This brought about concern because this study looks at ideation and not movement. However, the literature concluded that neither quality of motor planning nor execution influenced TIP scoring, even with dyspraxic participants (May-Benson & Cermak, 2007). The TIP enables the participants to demonstrate ideas

without requiring verbal explanation; this has the benefits of relying only on observational methodology and reducing the effect of social and communication traits on the test outcomes.

Various preliminary norms are available for the TIP May-Benson and Cermak (2007). Within the validity studies the oldest participants were 8 years old; when considering the use of the standardised scores for this study, the scores for 8-year-olds were used. Although, this was not necessary to test the hypotheses; the average mean score is 20, with a standard deviation of 5.8. The norms for identifying ideational dysfunction are a mean of 15 with a standard deviation of 1.7. Scores below one standard deviation indicate ideational problems (see score forms Appendix J) (May-Benson, 2005). The TIP was tested for validity by May-Benson and Cermak (2007) and then more recently by (Lane et al., 2014); both studies showed strong interrater reliability and were found to demonstrate test-retest stability over two weeks.

4.2.3.5 Piloting the Test of Ideational Praxis

As the TIP was developed for use with children, it was necessary to pilot the test to determine the appropriateness of its use with adults. The piloting process involved ten adult friends and colleagues who varied in age and employment status. None of the participants had poor mental health or physical or intellectual (learning) disabilities. The testing was completed at an NHS work base. Participants completed a questionnaire to evaluate their TIP experience (Appendix K). This piloting also helped indicate the time the test took and enabled practice administering the test.

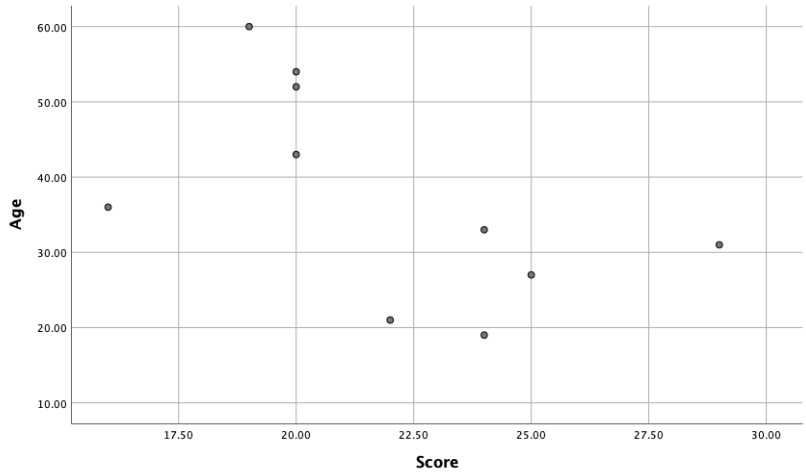
The results from the piloting questionnaire confirmed that participants understood the test's purpose and instructions. However, the environment had an impact. Participants reported that noise was distracting and hearing the timer added pressure and 'made thinking harder'. One participant also said that hosting the test within an activity room enabled ideas to be sought from the items and activities within the space. The participants reported that using the standardised language could be viewed as childlike, for example, test instructions that state, 'here I have a toy I want you to play with'. Despite half of the participants commenting on this, they did not feel it affected their motivation, and one participant reported that the word 'toy' prompted more responses. The participants reported they found the test more challenging than expected but not so difficult that it affected motivation. As an action from the pilot within the study, the term 'item' replaced 'toy' and 'use it' replaced 'play with'; both changes should not have influenced the test validity. The tests took, on average, 10 minutes to undertake. The score sheet became easier to use with practice, an unexpected benefit of the pilot test.

As a by-product of piloting the test, the participants' scores were compared to the normative TIP children's scores. The mean score achieved by the adult participants (21.6) was above that of the cut-off score (14.2) used to indicate ideational dysfunction in children (May-Benson, 2005). The age of the participants did not create a statistically significant variation in scores (p = .10) (Table 5 and Figure 5).

Table 5 Demographic data and results of TIP pilot test

Participant Number	Participant Age	Participant Sex	TIP score
1	31	m	29
2	19	f	24
3	27	f	25
4	54	f	20
5	52	m	20
6	36	m	16
7	60	f	19
8	33	f	24
9	21	f	22
10	43	m	20

Figure 5 Age correlated with TIP scores



4.3 Method

This section explains how the sample size was determined and then details the participant inclusion/exclusion criteria with justifications. It then describes the recruitment and screening processes for the study and control populations, followed by test administration details and ethical considerations.

4.3.1 Determining the Participant Sample

The hypothesis testing requirements were used to determine the type and number of participants. The inclusion/exclusion criteria are set to manage the risks of confounding variables that could invalidate the study.

Participant inclusion/ exclusion criteria

Below are details of both groups' inclusion and exclusion criteria and justifications. To ensure potential participants met the criteria, they were required to fill out the participant screen (Appendix L). This participant screen used a self-report method and a criterion-referenced rather than norm-referenced approach, as advised by Rogers & Holm (2016). When the screen was given to the potential participants, it was made clear that this was a screen for participation eligibility, not a diagnostic screen.

In addition to targeted questions, a box for free text was provided to enable further details prompted by the questions and allow for free text on other conditions that might affect participation. I reviewed the responses on the screen. If the screen had indicated that mental or physical functioning might affect participation in the tests, further details would have been sought, and clinical skill and more formal testing would have been used to support the criteria testing; however, this was not necessary. An informed decision was made about whether the criteria were met, and the participant applicants were informed.

Inclusion criteria:

- Diagnosis of autism or Asperger's Syndrome required for the autistic group only

The participants were acquired from an autism charity. All members have received a formal

diagnosis of autism. The charity confirms people's diagnosis before they become a member. When recruiting participants, I double-checked that the participants had a report or letter confirming the diagnosis. All participants had an autism diagnosis provided via the NHS or Local Authority (previously, in the local area, autism assessments were completed through a joint health and local authority panel). If participants had a 'non-NHS' diagnostic assessment, a plan was in place. The assessment would have been considered against NICE guidance to enable a judgement on the validity of the diagnosis (National Institute for Health and Care Excellence, 2017).

Exclusion criteria:

- People unlikely to cope with the cognitive demands of the task (as indicated by a diagnosis of learning disability or other cognitive disability)

The reason for this exclusion is that cognitive difficulties would invalidate the tests. Invalidation is mainly due to the level of understanding required to follow and complete the tests; for example, the counting elevator test, a subtest within the Test of Everyday Attention, requires adding and subtracting the number of elevator levels, a task that might be difficult for people with an intellectual disability. Using this example, even with well-matched non-autistic controls, determining the impact of the intellectual disability on the low scores would have been difficult.

The second reason for this exclusion is that it would be difficult to determine the effect that this type of cognitive impairment has on ideation. Ideation is claimed to be developmental in nature (Ward,1918); however, the impact of IQ on the development of ideation has not yet been studied; therefore, it would be unclear if an intellectual disability or autism caused

deficits in ideation. At this point in the study of ideation, it was important to confine the study population to those without additional diagnoses, which would have confounded the findings. Also, this approach meant that identifying modifications needed in future research processes could be better identified.

Several measures were in place to screen for intellectual disabilities. The charity from which the autistic participants were recruited was specifically for adults with autism and no intellectual disability. The participant screen asked if the participant had an intellectual disability. In addition, the psychometric tests required the examiner to check participants' understanding of the tasks before the initiation of the testing. Finally, the test results were screened for any abnormally low scores. Although a few participants scored below average on some of the subtests, no participant scored significantly below average on all subtests of each test. If identified at testing, this would have been addressed as a potential indication of cognitive/learning differences and likely resulted in the removal of this participant's test results.

Finally, the screen included the person's ability to participate in daily tasks independently and, specifically, the person's ability to engage in the completion of the tests, providing another opportunity to identify learning or support needs.

- People who have poor mental health

Significant mental ill-health would invalidate the standardisation of the tests and may also affect the participant's ability to provide informed consent. A formal assessment was not deemed necessary and was not possible with the author's resources. However, given the comorbidity of mental health needs in autistic people (70%, as reported by (Cranage, 2018)),

the fact that an individual's mental health can fluctuate and onset of poor mental health can be sudden, the participant screen had a particular focus on mental well-being and helped inform of a person's current presentation. A question about concentration, which is used as a measure to assess mental wellness, was included in the screening questionnaire, to indicate the effects of comorbid mental health diagnosis, i.e., insomnia (Alhola & Polo-Kantola, 2007), anxiety and depression (Hallion et al., 2018; Keller et al., 2019).

Finally, the participant screen also asked about the person's ability to complete the test. It also gives insight into mental health and physical difficulties and reflects the person's perception of their ability to participate, which, if negative, could affect motivation (Timler et al., 2019).

- People with a diagnosis of Attention Deficit Hyperactivity Disorder (ADHD)

ADHD has a high comorbidity rate with autism (Hours et al., 2022). Those with diagnosed ADHD would have been excluded from the study because, when looking at the relationship between attention and ideation, an attention deficit would create a confounding variable that would make the hypothesis challenging to determine. The participant screen included a concentration question which gave a further opportunity to 'flag up' potential participants with ADHD (Wilens & Spencer, 2010). No participants reported having ADHD nor was poor concentration noted to affect test participation in any participant.

- Children and young people under age 16

The decision to only include adults in this study was primarily to limit the effect development may have on executive function and ideation.

- People who do not speak or understand the English language.

This criterion was implemented due to resource limitations for translating test materials.

Age, gender, and spoken English language use and understanding were identified and confirmed via the participant screen.

Determining the Sample Size

Considering the fledgling state of the hypothesis, it was felt that involving large groups of participants would be unethical. This is considered to be poor practice before research has provided a positive signal supporting a hypothesis (Kara, 2018). Therefore, the target number of participants was based on the predicted number required to achieve the significance level (.05). The significance level was based on the differences expected within the sample group, limiting type 1 and type 2 errors, as (Burns & Grove, 2007) advised. Whilst statistical error sample size might be expected, the extent of this is limited by sampling methods and through analysis of the confidence intervals.

A power calculation was competed using an online calculator called G*Power version 3.1.9.7 (Faul, Erdfelder, Buchner, & Lang, 2009). The statistical test, a two-tailed correlational analysis with z test (discussed below), was inputted, and the sample number was determined and given a power and effect size. The effect size was set at .8, this was selected based on an average of effect sizes calculated from a sample of studies in the scoping review that examined the Test of Ideational Praxis or the Use of Object Test, using the calculation advised by Cohen (1988), that is, the mean of the treatment group minus the mean of the control group, divided by the standard deviation of one of the groups. For example, the Test of Everyday Praxis mean results from Serrada-Tejeda et al., (2021) effect

size=0.77. The err probability was set at .05 and the power was set at .8 as advised by Bhandari (2023).The power calculation suggested a sample population of 56 (Appendix M).

In addition to the power calculation, when considering the sample size, it was also considered that the studies within the scoping review noted a difference in ideational abilities between 0.001 and 0.005, indicating that it was acceptable for this study's confidence interval to be set at 95%. Most of those studies reported statistical significance at 5% using sample sizes of 14-54. Therefore, it was expected that a sample number of 40 would provide a confidence interval of 95% (confidence widths -1.96, +1.96) for .05 correlational values (level of significance) (Moinester & Gottfried, 2014).

4.3.2 Recruitment of the participants

A convenience sampling approach was used to recruit both study populations. The study was first completed with the autistic sample because I anticipated it would be more challenging to recruit this population and because it enabled age and gender matching of the control sample.

Recruiting the autistic study group

The autistic participants were recruited from a charity known to me through my professional role. The charity provides advocacy support and social groups for autistic adults and young people over age 13 who do not have an intellectual disability. Based in East Yorkshire, the organisation has a membership of over 3,000. The membership profile consists of people who live locally as well as those who are based elsewhere around the country. Approximately 90 members visit the charity base; of this cohort, most are males aged between 17-and 30. Members join the organisation via self-referral or signposted by other health, social care and voluntary organisations. The charity operates from premises in a city

centre, easily accessible by public transport. It provides facilities for social groups and several individual rooms for 1-1 appointments and has a regular attendance of around 90.

To explore whether it was suitable for the study and gauge their interest in involvement, the charity manager was approached to learn more about the charity, including how it operated and its membership. The manager was supportive and suggested using the charity base as the location for conducting the tests with the autistic participants only (a control group on site would have been disruptive for charity club members). This was advantageous because it offered a private testing environment familiar to the autistic participants. The manager also agreed to my attendance at social meetings, where she would introduce me to the attendees to explain the project.

The recruitment process I developed was designed to take account of autistic traits. The participant information sheet was coproduced with two autistic colleagues (Appendix N), who advised on aspects of the content and layout; for example, they felt it was important to be clear on who would be present when completing the tests. Copies of the participation information sheets were left in the charity's common rooms to ensure they were freely available. An easy-to-read version was also developed and available. I gave an informal presentation about the project at one of the regular meetings. I attended sessions regularly over eight weeks, allowing potential participants to get to know me and feel comfortable if they would like to ask questions. I checked that anyone interested had read the participant information sheet and was aware of what the research involved and that they would not receive the test results individually.

Recruiting the control study group

The control group was recruited from associates of staff working at my NHS workplace and family and friends. People were approached individually to explain the study and what was required of those in the control group. All those interested in participating were supplied with a participant information sheet, which included my contact details. In this sheet, it was made clear that participation would not provide them with their own test results or information indicating whether they did or did not have autism. Those willing to participate were asked to complete the participant screening questionnaire to check eligibility and then recruited to the study if eligible (Appendix L). An attempt was made to mirror the controls and autistic group in age; as mentioned, this meant that specific groups were targeted for participant recruitment, but also, if people who volunteered were of an age already recruited to or not within an approximate age range of the autistic group, they were replaced on a reserve list. All but two of the participants could be age-matched; of these, participants had a two-year and four-year age gap. Given that the exclusion criteria was consistent for both the control and experimental (autistic) groups (except for autism diagnosis required for the experimental group) and only males participated, the participant groups were well-matched.

Summary of Recruited Participants

In total, 40 participants aged between 17-38 were recruited to the study (M-22.76, SD 4.82). Table 6 shows the age-related statistics. The participants had a wide range of educational achievements and occupations. Only males were recruited despite extending the recruitment timescale. All participants were white British with English as their first language. Participants could still withdraw at any point up until the data was analysed. A withdrawal letter was available (Appendix O). None of the participants requested to withdraw.

Table 6 Age- related descriptive statistics of participants

Sample Group	Number	Min. age	Max age	Mean	Std. Deviation
Autistic	20	17	34	22.55	4.85
Control	20	17	38	23.85	5.61

4.3.3 Administering and scoring the tests

A schedule for completing the tests was set based on opening times at the facilities I used and worked around participants' availability. I ensured the participants had read and understood the details in the participant information sheet, they signed the consent form immediately before testing (Appendix P).

As discussed, the charity building hosted the testing for the autistic group. This location enabled the participants to complete the tests in a familiar environment, which is essential considering the difficulties autistic people can experience when adapting to new people and environments. The testing was completed over 13 weeks; weekly sessions were held between 3 p.m. and 9 p.m.

For the control group, the testing occurred in the outpatient clinic rooms at various buildings at my workplace and a sports centre within a private bookable room. The testing occurred over eight weeks, once weekly, between 8 a.m. and 7 p.m. (note testing was not completed in NHS work time). These locations enabled safe lone working.

To adhere to the test administration manuals, all testing environments were well-lit; the table and chairs enabled me to sit at 90 degrees with the participants. It is essential to consider that approximately 96% of autistic people have sensory processing difficulties (Howe & Stagg, 2016). Sensory processing difficulties include hypersensitivity to sounds, smells, and

touch. Both testing environments were carefully considered with this in mind, were free from distractions and interruptions, and the chosen room was quiet and situated away from common/waiting rooms.

My professional background and experience enabled the provision of reasonable adjustments to promote the quality of the study. Reasonable adjustments were essential to support standardised engagement in the tests. Examples include supporting verbal communication difficulties by providing participants extra time to think about and ask questions before the tests began, adapting the time required for 'settling in' by allowing breaks in between tests and allowing the company of the familiar staff. No adjustments were made that would invalidate the standardisation for the test.

I made an entry in my reflective journal after initial meetings with potential participants and then after each of the testing sessions to help inform the process e.g. The journal helped me understand how choice of research location could influence the participants. Reflection abstracts are indicated in Appendix Q. I suggested that participants complete the tests in the following order: the test of attention, the test of memory, the test of ideation, and the questionnaire of autistic traits, and they were all happy to do so. This order of test completion was felt to be optimal as the executive function tests would likely require the most concentration, especially the attention test.

Administering and Scoring the Test of Everyday Attention

This study used Version 1 of the TEA, administered in adherence to the test manual, and used the English language Script (Manly et al., 2001). No participants had taken the test before.

The scores from the TEA are norm-referenced. When interpreting the scores, the manual was followed: age categories guided scoring. Each subtest has scaled scores. The scaled scores have a mean of 10 and a standard deviation of 3, ranging from 1-19. Each subtest uses a 19-point scale with a + or – 5 standard deviations of a matched normal distribution, making 10 the mean performance (Evans & Preston, 2011). The analysis used the TEA scaled scores (sustained attention, flexibility of thought and attention switching, divided attention, and sustained attention) correlated with TIP scores,

Administering and scoring the Rivermead Behavioural Memory Test-3

Version 1 of the RBMT-3 was used. The test took approximately 30 minutes to administer. The RBMT-3 scoring was as advised (Wilson, Clare, Baddeley, Cockburn, Watson, & Tate, 1999). The raw scores on all subtests were calculated and totalled. These raw scores were then turned into scaled scores using age bands. Scaled scores had a mean of 10 and a standard deviation of 3. A general memory index (GMI) score representing overall memory performance was calculated by summing up the subtest scaled scores and then converting this to a GMI score using the appropriate conversion table (Wilson et al., 1999). This standardised index has a mean of 100 and a standard deviation of 15.

In addition, to create a score for each of the different areas of memory function, the scores from certain groups of subtests were calculated. The verbal memory score was derived from the scaled scores of the subtests *First and Second Names - Delayed Recall*, *Story – Immediate Recall* and *Story - Delayed Recall*. The areas of memory function taken from the test are standardised and validated within the RBMT-3, including spatial memory, prospective memory, new learning, visual memory, verbal memory, immediate recall,

delayed recall, and delayed recognition. This study analysed these subtest scores, and the GMI scores correlated with the TIP scores.

Administering and Scoring the Test of Ideational Praxis

The TIP was administered and scored whilst the participants completed the test. The entire test took between 5 - 15 minutes to administer and score.

The scoping review provided notional findings that indicate autistic people used chaining as a technique when forming ideas and that their ideation was more repetitive than non-autistic controls (Ambery et al., 2006; Bishop & Norbury, 2005; Turner, 1999). 'Chaining' and repetitive behaviours could link with autistic traits (Baron-Cohen, 2008) and provide insight into the link between ideation and autistic traits. I created an opportunity within the scoring of the TIP to provide further insight on this. The number of chained answers and number of repetitive responses are provided within the results and described within the discussion, however due to the limited scale of enquiry this was not framed as an independent hypothesis.

A repetitive answer is any response that is the same as a previous answer. The first original answer scored one point for the total TIP score, while repetitive answers were not included in the total TIP score. A chained answer refers to responses in which some element or action is repeated, but the other elements differ. The answers usually follow one another—for example, wrap-around finger, wrap-around wrist, wrap-around hand. The first response counted as an original answer. Any following answers are scored as chained answers. The total TIP score came from the number of original and chained responses, as per the scoring manual (May-Benson & Cermak, 2007). Within the correlational analysis, the total TIP

score, the total number of repetitive answers and the total number of chained answers for each participant were used.

Administering and Scoring the Autism Quotient (AQ)

The participants were given verbal guidance on completing the AQ test and then the option to complete the test in private. Most participants stayed in my company, enabling them to ask for clarity if necessary. AQ scoring guidance was followed (Baron-Cohen et al., 2001). The analysis involved the total scores, and the sub-scores of attention switching and imagination correlated with TIP scores.

4.4 Chosen statistical technique

The test scores were inputted into IBM SPSS Statistic (Version 26) predictive analysis software (IBM Corp, 2019). Before entering the results into SPSS, the data were screened for marker errors or indications of abnormalities in performance. When determining the type of statistical evaluation method, the data distribution was evaluated using histograms, Q-Q plots and tests of Skewness, Kurtosis and the Shapiro-Wilk test (Van Buren & Herring, 2020). Some of the Skewness and kurtosis test values were outside +/- 1.96, therefore assuming some skewness and kurtosis that differed significantly from normality. Additionally, the *p* values for the tests using the Shapiro-Wilk Test were not all <.05; therefore, it could not be assumed that the data are approximately normally distributed. Thus, the assumptions required to apply parametric tests could not be met; therefore, although tests such as Pearson's r correlation coefficient arguably produce more 'powerful' statistics Goertzen, (2017), the sample did not meet the assumptions required. Spearman's r, a non-parametric test, was used to conduct the initial part of the analysis, to determine the relationships between the variables separately within each group (Dancey & Reidy, 2007).

To provide an understanding of the nature of the data and allow comment on previous assumptions, specifically 1) The control group are less autistic than the autistic group, 2) Ideation is worse in autistic people, 3) Memory and attention function are different in autism compared to controls, the Mann-Whitney U test was used. The Mann-Whitney U test compared the mean scores of the variables for both groups (Fay & Proschan, 2010; Mann & Whitney, 1947). Additionally, the autistic group scores were compared to other autistic studies, enabling comments on how reflective the participants were of the autistic population.

Finally, to test the hypothesis by determining if differences exist between the autistic and non-autistic groups, depending on the type and strength of the relationships noted by Spearman's correlation coefficient- *z* scores were calculated. *Z* scores compute the extent to which two correlation coefficients are significantly different, given the values of the two correlation coefficients and their associated sample sizes (Andrade, 2021; Hinkle et al., 2003). The z score calculator computes the *z*-score for the significance test and the *p*-value (Andrade, 2021; Hinkle et al., 2003).

4.5 Ethical considerations

The study involving the autistic sample and the study involving the control sample both received Sheffield Hallam University ethical approval (Appendix R -Ethics approval confirmations).

On completion of the test, all participants received a thank you letter and a small confectionary gift (under £10). The value and nature of the gift acknowledged their time and

contribution whilst avoiding unintentional bribery, recognising that autistic participants may be more vulnerable to coercion and bribery (Fisher et al., 2013; Maloret & Sumner, 2014).

4.5.1 Risks to the Participants

The risks associated with participating in the tests were low. However, the three main risks related to 1. cognitive or physical difficulties noted within the tests; 2. information that indicates risks to participants or others disclosed during testing; and 3. the stress caused by completing the tests.

1. It was possible that participants would perform poorly in the tests and identify unknown cognitive difficulties. In this situation, a plan was put in place to signpost participants to local primary care health services for investigation and support.

2. During the testing, no safeguarding concerns were identified; however, before completing the research, a plan was in place to escalate any safeguarding concerns via the local Social Service and NHS safeguarding guidance. Participants would have been supported to access other mental health or health services if necessary.

3. Test completion could be stressful and cause worry for any participants. Ensuring the participants were fully informed of what to expect reduced this likelihood because they could consider the demands of the tests (and risks of potential stress) against their own needs and abilities (Flory & Emanuel, 2004). Additionally, my clinical experience enabled monitoring for emotional dysregulation throughout the testing. The autistic participants had access to familiar staff members should they need support.

4.5.2 Risks to the Researcher

My safety was maintained by ensuring that other people were in the building at the time of the testing and by following the Royal College of Occupational Therapy Professional Standard (Enforcement procedures for the Occupational Therapy Code of Ethics and Ethics Standards 2014) and other relevant policies, including the lone working policy.

4.5.3 Safe management of data

The confidentiality of the participants was maintained by ensuring that no identifiable data was recorded from the point of completing the tests through to the analysis and reporting of the results. Data safety was managed using several methods, and a data management plan is in place (Appendix S). Data is stored within a secure computer and saved within a secure Q drive provided by the university. Written information is stored in a locked cabinet.

4.6 Summary

A quantitative methodology and quasi-experimental design addressed the research hypothesis and questions. Standardised and norm-referenced tests of ideation, autistic traits and executive functions were used to produce comparative data suitable for quantitative examination. Clinical measures and psychometric tests were selected based on careful analysis of the areas needing testing: memory, attention, ideation and autistic traits. Prior to completion of the study, the ethical issues were reviewed and approved by the University Ethics. Reasonable adjustments were made to accommodate autism throughout the research process. In total, 40 men participated in the study, 20 autistic and 20 well-matched controls. The tests were administered and scored following the test guidance, and the data from the test results was placed into SPSS. A comparison of the means using Mann-Whitney U enabled comment on the nature of the data. To test the hypothesis, Spearman's Rank

correlation coefficient analysis was conducted. Then, Z scores of the coefficient results were calculated to understand the significance of any differences between the groups. Chapter 5 will discuss the results.

CHAPTER 5: RESULTS

5.1 Introduction

In total, 40 male adults participated in the study and completed the four selected tests for memory, attention, ideation, and autistic traits. This chapter details the results in three sections corresponding to each of the three hypotheses. Each section presents the means of each test for the autistic and control group. Each section then lists the results used for hypothesis testing (Spearman correlation coefficient and Z scores). The Mann-Whitney U scores show the statistical significance of the difference in means between the groups. This comparison of means was used to test the assumptions that memory and attention differ in autistic people and that ideation is more deficient in autistic people. This chapter then summarises the relevance of the findings for the hypotheses. Full results are available in Appendix T. To ascertain whether this group represented a generalisable sample of autistic adult males, the results from the four tests were compared to the tests' normative data. In some cases, the results were also compared to results from other autism studies. The details of this work are presented in Appendix U.

5.2 Results Relating to Hypothesis 1

5.2.1 Test of Everyday Attention and Test of Ideational Praxis results

Hypothesis Testing

Null Hypothesis 1. Ideation abilities and attention function do not correlate differently in autistic people compared to non-autistic people.

The TEA examines areas of attention by subtests (Table 7). Correlation coefficient scores were derived from subtest scores from the attention test (TEA) and the overall ideation test score (TIP) (Table 8).

Table 7 TEA subtests and areas of attention examined

TEA Subtest	Area of attention tested.
TEA Subtests 4a and 4b	Flexibility of thought and attention switching
TEA Subtest 7	Divided attention
TEA Subtest 8	Sustained attention

Only the autistic group indicated a weak positive relationship between part A *flexibility of thought and attention switching* (r = .299, p = .2), *divided attention* (r =.352, p = .127) and TIP. The correlation coefficient scores for both groups indicated a weak, non-significant, positive relationship between *sustained attention* and TIP (autism r = .332, p =.153; control r =.412, p =.071). The correlation coefficient scores in the control group only indicated a positive statistically significant relationship between part B *flexibility of thought/ attention switching via sub-test* 4b (r =.756, p = .0) and the TIP; however, this subtest made up half of the overall scores (subtest 4a and 4b) for flexibility of thought/ attention switching; therefore because 4a did not reach statistical significance, this is likely to have affected the overall result.

The z scores indicated a statistically significant group difference in the correlation coefficient scores between flexibility of thought and ideation (z = -2.2616, p = .023). This indicates that the relationship between flexibility of thought/attention switching, and TIP is stronger in the control group.

Table 8 Data of the TEA and TIP correlational coefficient using Spearmans (r) and Z scores

Test (v TIP)	Autism (*p*)	Control (*p*)	*Z* Score (*p*)
TEA 2	-.167 (.481)	.305 (.191)	-1.4099 (.158)
TEA 4A	.299 (.2)	.094 (.694)	0.6243 (.532)
TEA 4B	.208 (.378)	**.756 (0)**	-2.2616 **(.023)**
TEA 7	.352 (.127)	.127 (.592)	.6998 (.484)
TEA 8	.332 (.153)	.412 (.071)	-0.2709 (.786)

Note: The sample size for all measures is 40. Bold values indicate significant ($p < .05$) correlations. The correlation coefficient results were also considered, with +/- 0.40 as the threshold for moderate, and +/-0.10 for weak correlations as advised by (Schober et al., 2018).

Assumption Testing

Mann Whitney U test scores were used to explore the differences in the groups' TEA means. The *u* scores, the standard deviation and the mean of the results are listed in Table 9. Overall, the autistic group had lower mean scores than the control group; however, only subgroup 4a, flexibility of thought, had a statistically significant mean difference between the groups ($u = 124$, $p = .031$).

Table 9 TEA mean test scores and Mann Whitney U results assessing group differences.

	Autism (SD. *n* = 20)	Control (SD *n* = 20)	*u (p)*
TEA 2	6.7 (.57)	6.85 (.37)	178.5 (.403)
TEA 4A	9.5 (3.95)	12.1 (2.29)	**124 (.031)**
TEA 4B	12.55 (3.89)	13.2 (3.55)	182 (.621)
TEA 7	10.4 (5.62)	10.1 (4.45)	193 (.848)
TEA 8	7.6 (4.35)	9 (3.36)	162.5 (.3)

Note: Significance values are two-tailed and not corrected for multiple comparisons. Bold values indicate significant ($p < .05$) correlations. Higher mean scores indicate better performance.

5.3 Results Relating to Hypothesis 2

5.3.1 Rivermead Behavioral Memory Test and Test of Ideational Praxis results

Hypothesis Testing

Null Hypothesis 2. Ideation abilities and memory function do not correlate differently in autistic people compared to non-autistic people.

A correlational analysis was undertaken with the general memory score, specific types of memory as rated within the RBMT-3 subgroups and the TIP Total score (Table 10). The correlation coefficient score in both groups indicated a positive statistically significant relationship between the TIP and RBMT-3 General Memory Index (autistic group $r = .555$, $p = .011$; control, $r = .636$, $p = .003$).

The correlation coefficient in both groups indicated a positive statistically significant relationship between the TIP and RBMT-3 verbal memory (autistic group $r = .468$, $p = .011$; control, $r = .576$, $p = .008$) and prospective memory (autistic group $r = .513$, $p = .021$; control, $r = .599$, $p = .025$). Only the correlation coefficient scores from the autistic group showed a statistically significant positive relationship between the TIP and visual memory ($r = .462$, $p = .04$). The Z scores indicated a statistically significant group difference in the relationship between the TIP and visual memory ($z = .9387$, $p = .0347$). The results of both groups showed a weak positive correlational coefficient between the TIP and new

learning and spatial memory, but this score did not reach statistical significance in either group (autistic group r =.427, p = .061; control r = *.236, p* = .314).

The correlation coefficients of both groups indicated a strong positive, statistically significant relationship between the TIP and RBMT-3 immediate recall (autistic group r = 753, p = <.001); control (r = 576, p = .008). However, only the correlation coefficient scores from the autistic group indicated a moderate positive statistical significance relationship between the TIP and delayed recall (r = 546, p = .013) and delayed recognition (r = 581, p = .007).

Table 10 Data of the RBMT and TIP correlation coefficient using Spearman R and Z scores

Test (v TIP)	Autism (*p*)	Control (*p*)	*z* Score (*p*)
RBMT GMI	.555 **(.011)**	.636 **(.003)**	-.3669 (.7136)
RBMT Verbal	.468 **(.011)**	.576 **(.008)**	-.4342 (.6641)
RBMT Visual	.462 **(.04)**	.176 (.457)	.9387 **(.0347)**
RBMT Spatial	.427 (.061)	.236 (.318)	.6288 (.5294)
RMBT Prospective	.513 **(.021)**	.499 **(.025)**	.0548 (.9562)
RBMT New learning	.227 (.335)	.346 (.135)	.3786 (.7049)
RBMT Delayed Recall	.546 **(.013)**	.176 (.458)	1.2676 (.2049)
RBMT Delayed Recognition	.581 **(.007)**	.176 (.457)	1.1417 (.1564)
RBMT Immediate Recall	.753 **(<.001)**	.576 **(.008)**	.9428 (.3457)

Note: The sample size for all measures is 40. Correlation coefficient moderate relationship = +/- 0.40; weak relationship= +/-0.10. Bold values indicate significant (p < .05) correlations.

Assumption testing

Mann Whitney U test scores were used to explore the differences in the groups' RBMT means. The *u* scores, the standard deviation and the mean of the results are listed in Table 11.

In all the areas of memory tested, the autistic group had lower mean scores than the control group. A statistically significant difference was noted between the group's mean GMI scores ($u = 124.5$, $p = .041$). A statistically significant difference was also noted between the group's mean spatial ($u = 134.5$ $p = .029$), and prospective memory scores ($u = 70$, $p = <.001$).

Table 11- RBMT mean tests scores and Mann Whitney U results assessing group differences.

	Autism (SD *n* = 20)	Control (SD *n* = 20)	*u (p)*
RBMT GMI	91.4 (16.856)	101.35 (11.324)	124.5 **(.041)**
RBMT Verbal	25.05 (8.24)	25.15 (6.20)	196 (.914)
RBMT Visual	17.3 (4.21)	19.15 (3.10)	145.5 (.135)
RBMT Spatial	19.15 (3.72)	21.2 (2.35)	134.5 **(.029)**
RMBT Prospective	33.35 (9.27)	42.05 (3.17)	70 **(<.001)**
RBMT New learning	17.4 (6.95)	22.25 (2.79)	141 (.088)
RBMT Delayed Recall	63.4 (15.06)	71.35 (4.76)	132 (.065)
RBMT Delayed Recognition	18.2 (4.88)	19.15 (3.10)	164.5 (.33)
RBMT Immediate Recall	37.75 (11.61)	39.2 (6.65)	167 (.371)

Note: Significance values are two-tailed and not corrected for multiple comparisons. Bold values indicate significant ($p < .05$) correlations. Higher mean scores indicate better performance.

5.4 Results Relating to Hypothesis 3

5.4.1 Autism Quotient and Test of Ideational Praxis results

Hypothesis Testing - Null Hypothesis 3. Ideation does not correlate with autistic traits, especially repetitive and restrictive behavioural traits and imagination. Ideation abilities will not correlate differently with autistic traits in autistic people compared to non-autistic people.

To test Hypothesis 3, a correlational analysis was completed between the assessment of autistic traits (AQ) and the ideational test (TIP). The correlational analysis involved the overall AQ scores (out of 50) and TIP scores (Table 12). The correlation coefficient scores from both groups showed a moderate, statistically significant, negative correlation between the TIP and the AQ (autistic r = -.556, p = .011; control r =-.784, p = <.001). Note the relationship was negative because the higher the AQ, the more autistic traits; however, higher TIP scores mean better ideation. High AQ scores tended to link to low TIP scores.

5.4.2 Autism Quotient Sub Scores and Test of ideational Praxis results

A correlational analysis was undertaken with specific subsets of autistic traits (Table 13). The correlation coefficient score in the control group only indicated a moderate, statistically significant relationship (r = -.770, p = <.001) between the AQ *imagination* sub-scores and the TIP Total score.

Correlation coefficient scores of both groups indicated a weak negative relationship between the AQ *attention switching* sub-score (this reflects repetitive and restrictive traits) and the TIP (autistic group r = -.278, p = 235); only the control group correlations reached statistical significance *(*r = -.610, p = .004).

Table 12 Comparison of the AQ and TIP correlation coefficient using Spearman's and Z scores

Test (v TIP)	Autism (p)	Control (p)	z Score (p)
AQ Total	-.556 **(.011)**	-.784 **(<.001)**	1.24969 (.21140)
AQ Attention Switching scores	-.278 (.235)	-.610 **(.004)**	1.2344 (.2170)
AQ Imagination scores	-.085 (.722)	-.770 **(<.001)**	-2.72632 **(.0064)**

Note: The sample size for all measures is 40. Correlation coefficient moderate relationship = +/- 0.40; weak relationship= +/-0.10. Bold values indicate significant (p < .05) correlations.

5.4.3 Test of Ideational Praxis sub scores and Autism Quotient results

To add depth of understanding about the relationship between autistic traits and ideation, a correlational analysis was completed on the behaviours noted within the TIP answers and the AQ (Table 13). The two behaviours were repetitive TIP answers and chaining TIP answers.

Correlation coefficient scores from the autistic group indicated a weak positive relationship between the TIP number of repetitive answers and the AQ scores. However, these results did not reach statistical significance (r =.295, p = .207). The correlation coefficient scores from the control group indicated a moderate, statistically significant relationship (r =.820,

p = <.001). The Z scores indicated a statistically significant group difference in the relationships between the TIP number of repetitive answers and AQ scores (z = 2.4862 p = .0129).

The correlation coefficient scores from the control group indicated a moderate, non-significant relationship between TIP-Chained answers and AQ scores (r = 315, p = .129). No such relationship was noted in the autistic group.

Table 13 AQ and TIP Methods correlation coefficient using Spearman's and Z scores

Test (v AQ total)	Autism (p)	Control (p)	Z Score (p)
TIP no. repeated answers	.295 (.207)	.820 **(<.001)**	2.4862 **(.0129)**
TIP no. chained answers	.01 (.968)	.315 (.129)	1.0979 (.2722)

Note: The sample size for all measures is 40. Correlation coefficient moderate relationship = +/- 0.40; weak relationship= +/-0.10. Bold values indicate significant (p < .05) correlations.

Assumption Testing

The u scores, the standard deviation and the mean of the results are listed in Table 14 and Table 15. The mean score from the AQ was significantly higher in the autistic group (u = 42.5, p = <.001). The mean score for AQ attention switching was also significantly higher in the autistic group (u = 81.5, p = .001). The mean score for AQ imagination was also higher in the autistic group, although the difference in the group means was not statistically significant. The results strongly suggest that the autistic group has more autistic traits than the controls.

Table 14 AQ mean clinical scores and Mann Whitney U results assessing group differences.

	Autism (SD *n* = 20)	Control (SD *n* = 20)	*u (p)*
AQ Total	25.92 (5.670)	12.45 (8.450)	42.5 **(<.001)**
AQ Attention Switching scores	6.1 (2.049)	3.35 (2.519)	81.5 **(.001)**
AQ Imagination scores	4 (1.298)	2.85 (2.54)	143 (.118)

Note: Significance values are two-tailed and not corrected for multiple comparisons. Bold values indicate significant ($p < .05$) correlations. Higher mean scores indicate higher degree of autistic traits.

The mean score for the TIP was significantly lower in the autistic group ($u = 67.5$, $p = <.001$). The number of repeated TIP answers was significantly higher in the autistic group ($u = 119$, $p = .001$). The number of chained TIP answers was higher in the autistic group, although the difference in the group means was not statistically significant.

The findings suggest that ideation in autistic adults is worse than in controls.

Table 15 TIP mean clinical scores and Mann Whitney U results assessing group differences.

	Autism (SD *n* = 20)	Control (SD *n* = 20)	*u (p)*
TIP no. repeated answers	1.9 (2.198)	0.45 (0.686)	119 **(.018)**
TIP no. chained answers	2.15 (2.680)	1.85 (1.496)	191.5 (.81)
TIP Total	9.25 (3.972)	16.1 (5.6)	67.5 **(<.001)**

Note: Significance values are two-tailed and not corrected for multiple comparisons. Bold values indicate significant ($p < .05$) correlations. Higher mean scores indicate better TIP performance, more repetitive answers, or more chained answers.

5.5 Additional Noteworthy Results

5.5.1 Additional Correlational Analyses

While investigating the three hypotheses, several other findings were identified. Given the paucity of knowledge in this area, these results are worth reporting for future research. Several correlational coefficient scores in the autistic group indicated a statistically significant positive relationship between elements of the RBMT (memory test) and the TEA (attention test) (Table 16). The correlational coefficient scores in the autistic group indicated a statistically significant positive relationship between TIP chaining answers and the TEA subtest 4 ($r = .448$ $p = .029$).

Table 16 Noteworthy results from memory and attention test scores

	TEA 4 Flex. of thought and attention switching	TEA 7 Divided attention	TEA 8 Sustained attention
RBMT GMI		.591 (p = .006)	.547 (p = .013)
RBMT Verbal		.518 (p = .018)	
RBMT Spatial	559 (p =.01)		.645 (p = .002)
RBMT Prospective	.570 (p = .009)	.540 (p =.014)	.552 (p = .012)
RBMT New learning			.677 (p = .001)
RBMT Delayed recall	.451 (p = .046)	.552 (p = .012)	.669 (p = 001)

5.6 Summary

Hypothesis 1. The results are in accord with the null hypothesis. Whilst the results provide a positive signal that there is a relationship between attention and ideation in people with and without autism, they do not support the notion that the relationship between attention and ideation is unique to autism or that there is a difference overall between the strength or direction of that relationship in autism compared to non-autistic people.

Hypothesis 2. The results reject the null hypothesis. Statistically significant results indicate there is a relationship between memory function and ideational abilities in people with and without autism. This indicates that memory function relates to ideation abilities. Results suggest that memory and ideation are related differently in autistic people. More specifically, the statistically significant results indicate a relationship between verbal memory, prospective memory, and ideation. However, uniquely to the autistic group, a statistically significant relationship was found between visual memory and ideation. A statistically significant result indicated there is a relationship between immediate recall and ideation in both groups. However, uniquely to the autistic group, the results showed a statistically significant relationship between delayed recall and delayed recognition and ideation. The correlation between new learning and spatial memory and ideation did not reach statistical significance. However, it did give a positive signal that these types of memory also have a relationship with ideation.

Hypothesis 3. The results reject the null hypothesis. The statistically significant result indicates a relationship between the degree of autistic traits and ideational abilities. This indicates that a higher degree of autism relates to worse ideation abilities.

When investigating what type of traits correlated with ideation, the results support that there is a difference in relationships noted within the two groups (autistic and non-autistic people). Results indicated a relationship between imagination traits and ideation scores only in the non-autistic participants. The result provides a positive signal that there is a relationship between attention-switching traits and ideation; the strength of this relationship is more significant in the non-autistic group.

Furthermore, results indicate a difference in the relationships between the groups in that results provide a positive signal that there is a relationship between the chaining of answers and the degree of autistic traits in non-autistic adults only. The results provide a positive signal that there is a relationship between repetitive ideation and autistic traits. Results indicate a difference in the strength of the relationship in that non-autistic adults showed a stronger relationship between repetitive ideation and autistic traits.

It is important to note that the relationships' strength and direction are measured regardless of overall ideational ability. For example, a strong relationship between memory and ideation in the control group could occur with excellent memory and ideation function. The statistically significant findings outside of the hypothesis testing are important because although these results do not directly address the hypothesis, they could be significant in understanding the nature of the relationships between executive function, autistic traits, and ideation in autism. This will be discussed in Chapter 6.

CHAPTER 6: DISCUSSION

6.1 Introduction

This chapter will interpret the results and evaluate their significance in relation to the null hypotheses. The findings are then discussed within the context of existing evidence to establish how they contribute new knowledge to our understanding of ideation in those with autism and the relevance and applicability of that knowledge's contribution to health and social care professional practice. The chapter will then move onto considering the study limitations and finish with recommendations for clinical practice and for further research.

For each of the three hypotheses, firstly the mean test results will be interpreted to understand the sample population in relation to the generalisability of the results and also to apply comment on the general function of ideation. Then, significant points from the evaluation of the results are outlined to provide further insight into rejecting or accepting the null hypothesis.

6.2 Interpreting the findings

6.2.1 Attention and ideation in autism

The results support the notion that autistic attention is deficient compared to non-autistic controls; the TEA mean scores from the autistic group were consistently lower than the controls. The autistic participants' scores showed a more obviously bimodal distribution than the controls; most participants scored either well above average or well below on the same tests. It is acknowledged that this variation could have affected the means noted in this group.

The correlational analysis indicated a weak positive relationship between attention and ideation function. The first null hypothesis stated that ideation abilities and attention function do not correlate differently in autistic people compared to non-autistic people. The results mean the null hypothesis cannot be rejected because one part of the attention-switching subgroup score (4b) showed a statistically significant group difference. The other scores, including the other part of the attention-switching score (4a) did not show a statistically significant group difference, suggesting that overall, the relationship between attention and ideation did not differ in both groups, suggesting that attention affects ideation in both autistic and non-autistic adults.

Subtests 4a and 4b of the TEA measure flexibility of thought and attention switching respectively. The control group showed a statistically significant relationship between subtest 4b and ideation, and the autistic group showed a weak correlation between both subtests (4a, 4b) and ideation. Furthermore, these relationships were present despite 65% of the autistic participants scoring above average in subtest 4 TEA (only 20% scored below average), indicating a marked absence of this type of attentional deficit in the participants. Additionally, many attention scores correlated with memory abilities, but subtest 4 did not. This suggests that it is unlikely that memory problems caused this correlation. It is reasonable to assume that in both groups, the results from subtest 4 suggest that attention switching, and flexibility of thought relate to ideation.

Some research has disputed the relationship between divided attention difficulties and autism Bogte et al., (2009); however, this study supports the notion because while the difference between the groups' means was not statistically significant only the autistic group showed a positive correlation (not statistically significant) between divided attention and

ideation, indicating that the relationship between autistic divided attention and ideation is not caused by poor performance.

6.2.2 Memory and ideation in autism

In relation to memory function, the results indicate that the sample population reflected a representative autistic sample, firstly because mean scores showed that the autistic participants' memory was worse than the controls; secondly, because the autistic participants' memory scores reflect what the literature suggests about autistic memory function (Appendix T).

A statistically significant correlation between the TIP and GMI in both groups indicated a positive relationship, suggesting a relationship between memory and ideation, indicating that participants with better memory had better ideation or vice versa. The second null hypothesis states that ideation abilities and memory function do not correlate differently in autistic people compared to non-autistic people. The study findings allow the null hypothesis to be rejected. More types of memory correlated to ideation in the autistic group. Results suggested that the relationship between visual memory and ideation was unique to the autistic group; this result was found despite no significant difference in the group means, suggesting it is unlikely that the relationship between visual memory and ideation was due to poor visual memory scores.

The results from both groups indicate that the better the participants' verbal, prospective and immediate recall, the better their ideation; however, results suggest the relationship between delayed recall and delayed recognition and ideation was unique to the autistic participants. No previous studies have confirmed a link between autism ideation and specific

types of memory function, making these findings a new contribution to knowledge.

Additionally, in the autistic group, the strength of the relationship was statistically significant between the RBMT-3 immediate recall and the TIP despite most low scores (when compared to the normative sample) occurring within tests of delayed recall (61%) as opposed to immediate recall (33%) and delayed recognition (6%). Again, this suggests that low scores on the RMBT-3 are not likely to be the cause for the relationship between memory and ideation.

6.2.3 Autistic traits and ideation

The results indicate that, as expected, the autistic group had a higher degree of autistic traits than the controls; this was apparent through the AQ total mean, the AQ attention switching mean, and the AQ imagination mean.

The study findings support the conclusions of the scoping review that autism ideation, as measured by the TIP scores, is worse than that of non-autistic controls. Firstly, because the TIP scores of the participants fell below 15.3 (the TIP cut-off score for indicating ideational dysfunction in 8-year-olds). Secondly, the scores from the autistic participants were lower than those of the non-autistic adult participants within the TIP pilot. Thirdly, the TIP autistic group mean was significantly lower than that of the experimental control group. The scoping review indicated that certain behaviours (or methods) were applied by the autistic participants which were not by the non-autistic controls when generating and delivering ideas. These methods included chaining of answers and repeating answers suggesting that autistic ideation is more repetitive than controls and that the autistic group 'chain' more ideas than do controls.

The third null hypothesis states that ideation does not correlate with autistic traits, especially repetitive and restrictive behavioural traits and imagination: ideation abilities will not correlate differently with autistic traits in autistic people compared to non-autistic people. The findings of this study allow rejection of the null hypothesis as the results suggest that participants with a higher degree of autistic traits had worse ideation. This was true in both the autistic and control groups, although this is clinically more relevant in the autistic group because they had a significantly higher degree of autistic traits than the control group. No previous studies have confirmed a link between autism ideation and the degree and type of autistic trait, making this finding a new contribution to knowledge.

When considering what type of autistic traits correlate with ideation, the findings also reject the null hypothesis, however not in the anticipated way. There was a group difference in the relationship between ideation and imagination; however, only in the control group was a relationship between the degree of imagination traits and ideation scores evidenced, indicating that the autistic participants' imagination abilities did not relate to their ideation abilities.

Another group of autistic traits hypothesised to link to ideation function was attention-switching difficulties. The findings of this study partly support the null hypothesis because the participants with more attention-switching difficulties tended to have worse ideation, however, the group difference was not statistically significant.

The results also suggest a relationship between repetitive ideation and autistic traits; however, only in the control group did the results reach statistical significance.

The other area of behaviour identified in the scoping review was the chaining of answers. The results from only the control group indicated a weak relationship between using chaining answers and autistic traits. Although the chaining of answers did not relate to ideational abilities in the autistic group, the mean scores indicate that these methods or behaviours occurred more in the autistic group than in the control group. This suggests that these methods/behaviours could contribute to ideational function.

6.3 Synthesising the study findings with the literature

The findings of this study are now discussed in relation to existing literature to consider their wider relevance and offer explanations for those findings.

The study findings indicate a positive relationship between visual memory and ideational abilities in the autistic group. No other research has previously investigated the relationship between these two concepts. However, from their small study investigating neuropsychological functioning in autistic adults, Ambery et al. (2006) reported a significant correlation between visual memory and verbal fluency, which is a measure of generativity, a component of ideation.

In my study, overall, the autistic participants did not score poorly in the visual memory test as compared to the control group with no significant difference in the mean scores for the two groups. Stevenson et al. (2021) in their research similarly found that autistic people did not have difficulties with visual memory, rather they reported their participants demonstrated strengths in visual recall, especially in object precision recall. Furthermore,

research has indicated that autistic people process more information through the visual modalities than neurotypical people (Minshew, et al., 1997).

Collectively, the positive correlation between verbal memory and ideation the lack of deficit in visual memory and overreliance on visual processing, suggests that autistic people may rely more on visual memory in ideation than non-autistic people.

In considering whether or not visual memory as a by-product of visual memory and as a standalone function was problematic in ideation, research by Goddard, Low and Melser (2009) on visuospatial planning, examined the cognitive underpinnings of spontaneous imagination in autism. They used a validated imaginative drawing task and executive functions tests to explore generativity, imagination, and visuospatial planning. Their research found that, compared to the neuro typical group, the autistic group displayed significantly lower visuospatial planning and generativity scores and showed deficits in imaginative drawings. These findings suggest an association between generativity and imaginative drawing which was mediated through visuospatial planning ability therefore, suggesting a reliance on visuospatial planning in ideation. The direct relationship between poor generativity alongside strong visuospatial planning ability may indicate that it is the processes applied to the use of visual memories, that is, visuospatial planning that is deficient.

Leevers and Harris (1998) also identified the influence of planning abilities on imagination. They investigated autistic children's ability to identify real and impossible pictures, and to complete pictures to make them look either real or impossible. Their study demonstrated that autistic children and neuro typical children were equally successful at identifying real

and impossible pictures and at completing pictures to make them look either real or impossible. Based on this finding, they suggested that problems with imagination are likely to stem from limitations in the executive abilities required to plan.

One of my study hypotheses was that a relationship would be found between imagination and ideation. Unexpectedly, a relationship between imagination and ideation was not found with the autistic group but was found in the control participants. Considering the control group had better ideation than the autistic group, this finding supports the claims, previously discussed in chapter two, that imagination plays an important role in ideation. Considering the work of Low Goddard and Melser (2009) it may be suggested that whilst imagination plays a role in ideation, autistic people have problems using imagination and so may rely more heavily on their relatively strong visual memory for ideation.

In summary, both pieces of research, considered in relation to my study findings, suggest that, in autistic people deficits in neither imagination nor visual memory alone account for ideational deficits. These findings also suggest that problems with generativity and imagination in ideation may be accounted for by deficits in the sub cognitive subprocess including planning. The likelihood is that deficits in ideation may be a consequence of poor method/ability in cognitive subprocesses, like planning and association.

6.3.1 Cognitive sub processes and their role in autistic ideation

Cognitive processes are grouped into attention, learning, memory, thought, perception and language (Lachman, 2015). Cognitive sub processes are the functions that aid the usefulness of core processes, this may include integration of processes, i.e. memory into new thoughts or support the cognitive function to work more efficiently alone (Karadi et al., 2001). For

example, in working memory the sub process of flexibility that allows the working memory store to remove and update information (Trutti et al., 2021).

Considering the role of cognitive sub processes offers the opportunity to advance our understanding of ideation because it moves us away from hypotheses that focus on core functions i.e., imagination, memory or attention, to hypothesising about the deficit being the way in which information from these core functions is used or combined using cognitive sub processes like planning and association.

Ideation creating a visuospatial plan requires the binding and association of memories and can include imagination. Association works as a strategy in the use of memories (Kounios et al., 2001; Wisniewski, 1997). For this reason, it is likely that association is important in ideation, as previously discussed in the scoping review (Boucher, 1988; Jarrold et al.,1996; Turner, 1999). Association can be displayed through the strategies of chaining or clustering results. What is being observed in these strategies is the cognitive ability to make associations and then link but adapt memories. Findings from my study support that association is important in ideation with the results from the control group showing a relationship between chaining and ideation. Turner (1999) similarly examined the number of clustered responses provided in the use of object test and found that the number of clustered answers was higher in the control group than the autistic group. Based on this finding, Turner (1999) suggested that the absence of clustered answers could reflect a failure to generate, or use, a strategy to apply memories, rather than a failure to produce or retrieve items from memory.

The research discussed supports the suggestion that association and planning (in the context of visuospatial planning) play an important role in imagination, generativity and ideation. Considering the evidence that suggests an over reliance on cues and prompts in ideation in autistic people, further supports the notion that deficits in cognitive sub processes affect autism ideation. Findings presented in the scoping review identified the use of cues in generativity in autistic participants. Studies using category fluency test scores mainly showed that fluency was not deficient in autistic participants compared to controls, a direct contrast to the consistent poor performance in letter fluency tests. The difference between the tests is the number of cues. The scoping review concluded that the greater number of cues given in category fluency tests compensated for poor association (Boucher, 1988; Ditcher et al., 2009; Kleinhans, Akshoomoff & Delis, 2005; Lind & Bowler, 2010). In autistic participants the use of imagination is also improved to par with controls by the use of prompts (Jarrold et al. 1996 & Scott and Baron Cohen 1996). Furthermore, findings suggests that the prompts/cues within these tests may have encouraged the use of logical association through categorising.

In summary, the scoping review concluded that autism ideation is most disrupted when it is un-cued; it is possible the disruption occurs because of the autistic participants' inability to generate an effective strategy with which to use memories and imagination in idea formation. The use of cues and prompts to act as a supplementary cognitive strategy in the cognitive sub processes of association and planning may be part of an autistic ideational strategy. Cues can be provided externally but cues and prompts may also be sought via a self-initiated process. Both routes enable ideation to be achieved albeit less efficiently than in non-autistic processing, due to the extra step required in the process.

An example of this can be taken from Grandin, an autistic American academic, who offers personal insights into the importance of visual memory and the difficulties she experiences in making associations between those visual memories to form new ideas (Grandin, 2009). In order to form a new concept, she describes her reliance on 'realistic photos' that she has stored in her memory and which she then sorts into categories. Grandin states that difficulties occur when challenged with thinking about a new category. She goes on to explain how she developed her ability to form new concepts by consciously practising categorising images and exposure to many varied images (Grandin, 2009). The reliance on images that Grandin has described has also been identified as a strategy used by others and evidenced through magnetic imaging studies (Kana et al., 2006). It is therefore considered that categorising could be an aid in associating memories achieved through prompting association.

Finally, my study found that those in the autistic group produced statistically more repetitive answers than the controls, a finding also noted by Turner (1999). High levels of repetitive responses could be associated with the cognitive subprocess of planning, research by Lange-Küttner & Thomas, (1995) supports this notion, describing repetition as a by-product of slow planning.

To contextualise the working hypothesis that 'cognitive subprocesses may mediate ideation in autistic people', Table 17 indicates how the stages of ideation, which were outlined in Chapter 2 can now be adapted to show whereabouts in the ideational cognitive process subprocesses feature and to show with which core cognitive functions they interplay.

Table 17 Stages of ideation and cognitive skills required for ideation, highlighting areas of potential deficit in autistic people

Stage	**Description of function**	**Core Cognitive skills required**	**Cognitive sub process required**
Orientation	Identification of the question or problem	Motivation Attention Memory Auditory/visual processing	
Preparation	Information gathering from existing memory	Working memory and attention	
Analysis	Analysis of information, including limiting information and association relevant memories	Memory and attention. Association of memories	Association
Holding the information	Concentrating on the forming elements (combining memories, etc.)	Attention	
Changing into a different metaphor	Often, this involves imagination and creation onto already associated memories. The idea is form as a result.	Imagination Attention Memory	Visuospatial planning
Finalising	Acting out, sharing, or concluding idea	Praxis Verbal skills	
Evaluating	Using feedback to assess/evaluate idea success	Processing of sensory feedback and/or higher cognitive external or internal feedback	

= Hypothesised deficits subprocesses for ideation

6.3.2 Exploring the effect of poor ideation on autism

The finding of my study supports previous research in confirming that ideation in the autistic group is worse than in controls. Given that a cause may not be easily confirmed and in line with social autism theories (Chapter 1, 1.3.1.3) it is as important to consider the effect of

poor ideation on function. This can be achieved by looking in more detail at the findings on autistic traits and ideation.

Within one of the scoping review studies, Turner (1999) outlined that limited abilities in idea formation would likely impact on ability to act spontaneously, meaning that behaviour will be limited in originality and variability and will present as repetitive. This can be directly linked to autistic attention switching traits also known as repetitive, restrictive behaviours and interests (RRBIs) (Harrop et al., 2014; Leekam, Susan et al., 2011) In addition to RRBIs, it is considered that impaired ideation would be likely to affect ability to engage in spontaneous behaviour, presenting as a reliance on routines and a preference for predictable and planned situations. In my study a relationship was found between attention switching traits and ideation, this occurred in both the autistic and control group, however, is arguably more impactful to the autistic group because they presented a statistically higher degree of attention switching traits than the controls.

The study indicated that autistic traits relate to ideational function, but the direction of this relationship has not been confirmed. The preceding discussion has informed that core executive functions such as attention and memory and the function of imagination as standalone functions are not likely to cause poor ideation. So far evidence suggests that the role of cognitive sub process including association and planning that work to use information from memory and imagination, may be the source of ideational difficulties in autistic people. This working hypothesis was established by integrating evidence from my study and other studies using psychometric executive function tests as well as a finding from the scoping review that suggested that aspects of autistic ideation may rely on cue and prompts.

Finally, the implications of poor ideation on autistic traits have been considered. These suggest poor ideation is likely to impact on repetitive, restrictive behaviours and interests.

Figure 6 uses a pathway to demonstrate the working hypothesis. It is important to note that what has not been established is the direction of effect between poor ideation and RRBIs. Figure 7 maps out the evidence used to support this pathway.

Figure 6 Proposed pathway for difficulties in autism ideation

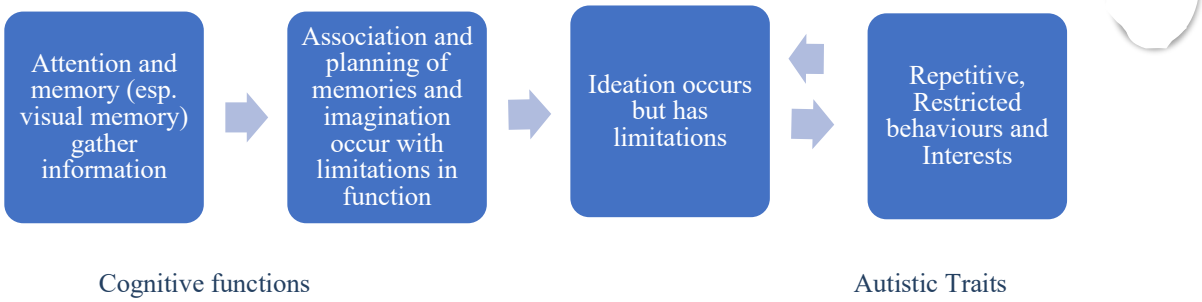


Figure 7 Mapping of evidence for the proposed difficulties in autism ideation

Process	Thesis Findings	Source of evidence
Executive Function Problems	Poor attention correlates with ideation.	*Study*
	Poor memory correlates with ideation.	*Study*
	Reliance on cues/prompts more than control.	*Scoping review*
↓		
Problems with cognitive sub processes including association in memory	Repetitive ideation	*Study*
	Chaining of answers	*Study*
	Cognitive subprocess supports cognitive process including memory and attention	*Literature in Chapter 6*
	Autistic reliance on cues/prompts more than controls	*Scoping review*
	Problems with strategies in retrieving/using memories	*Scoping review*
↓		
Problems in ideation	Ideation worse in autistic participants than controls	*Study*
	Generativity (and fluency skills in ideation) are worse in autism than non-autistic controls	*Scoping review*
↕		
Limits in ideation relate to autistic traits	Degree of autistic traits correlates with ideation abilities.	*Study*
	Repetitive/restrictive behaviors correlate with ideation (noted through AQ-Attention Switching)	*Study*

6.4 Application of the findings to professional practice

This thesis arose from questions identified in clinical practice. Chapters 2 and 3 highlighted that existing knowledge ideation in autism is limited. The output from this thesis can be used to contribute to professional knowledge to improve clinical practice with autistic people. Fundamentally the scope of ideational deficits in autism may have implications for a person's ability to control, regulate, and modify their behaviour in all areas of functioning; however, the findings from this thesis suggest the clinical response does not need to be complex or intense.

6.4.1 Improve awareness of autism ideational difficulties

The first recommendation centres around new knowledge that the degree of autistic traits relates to ideation abilities. In this regard it is noted that the absence of health literature on autism ideation is reflective of a lack of awareness. Understanding the role of ideation on function and considering the potential effects of ideational difficulties will enable appropriate support to be put in place and strategies to be actioned, as detailed below. Furthermore, awareness that autistic people may have difficulties with ideation will enable clinicians to consider this when assessing a patient's function. This also applies when working with children and young people whose challenges may be with play and/or socialisation. Finally, awareness of ideational dyspraxia should be promoted to ensure therapists treating dyspraxia are considering a holistic view of the process of praxis.

6.4.2 Increase understanding of the role of prompts and cues in autistic ideation and apply to practice

The second recommendation is based on the knowledge that visual memory relates to ideational abilities and that visual memory is highly relied on by autistic people. The

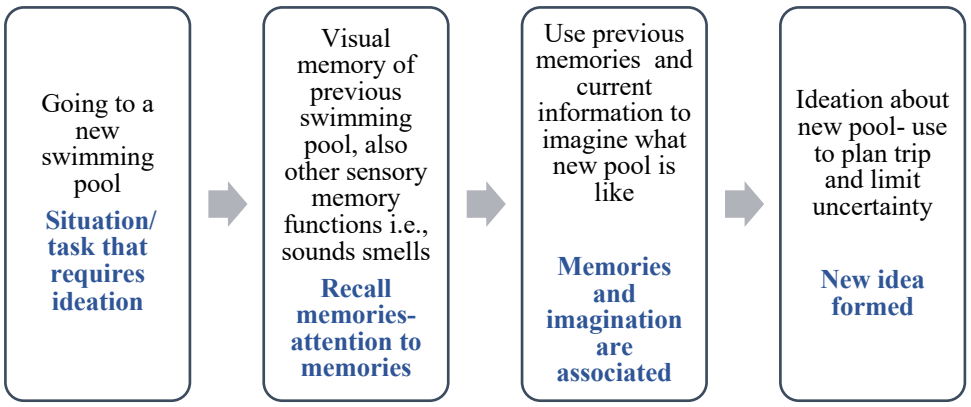
findings of the scoping review and study suggest that the use of visual cues and prompts supports cognitive processes which wrap around memory and therefore improve the use of memory in ideation.

Ideation is fundamental in everyday functioning. It enables planning and adaptation within daily activities and also allows expression in communication and diversity in creative thought.

The findings of this study suggest the importance of providing prompts and cues to assist with ideation, which could in turn, reduce the hypothesised effect on autistic traits. The practical application of cues and prompts is frequently used in occupational therapy to improve performance in daily living tasks (Booth et al., 2001; Hayes, 2013; Kaya & Yucesoy-Ozkan, 2022; McQuiddy & Moore Brennan, 2016). Whilst cues are recognised as an intervention approach in autism, there is a lack of guidance about how and when they should be used (Fuentes et al., 2021). Understanding the role that cues can play to support ideation in real-life situations can bring about new clinical reasoning in autism practice.

The following task example illustrates how the structured use of cues might be used in practice to support ideation and thereby limit uncertainty. Figure 8 identifies four stages of the ideation process with the cognitive functions at each stage and how they might apply to the situation of going to a new swimming pool.

Figure 8 The stages of ideation, a task example



Blue = cognitive function

Applying a teaching strategy to this situation could enable autistic people to facilitate their ideation through associative memory by following a five-step process.

The steps would be:

Step 1. Write down or draw (represent visually) the new situation

Step 2. Identify components of the new situation

Step 3. Think about a situation with similar components

Step 4. Draw up a list using what you know about the new situation and what you know about a similar situation

Step 5. Conclude new ideas about the situation.

In determining what types of cues might be most beneficial, the findings from my study indicate the value of visual cues to stimulate visual imagery, a finding that is supported by the work of (Rhodes, 1981) who similarly reported that creative thinking improved significantly with visual and auditory stimuli.

Applying this to the task example, Figure 9 offers a series of cues and prompts for each of the five stages that emphasise the visual elements of memory and would prompt visual imagery.

Figure 9 Example of strategy for ideation using cues/prompts

Step	**Example**
Step1. New situation	Visiting a new swimming pool
Step 2. Components of situation	Indoor, swimming pool
Step 3. Similar situation	Swimming pool on holiday
Step 4. List	The pool area smelt like chlorine. The pool area was hot. Change rooms had lockers and wood benches. The changing rooms were hot. The water felt cold at first. The pool room echoed. The floors were tiled and cold. The routine (pay, get changed, swim, shower, get dressed, leave) (New situation information) From the pictures, the pool is indoors. From the pictures, the changing rooms have wooden benches, lockers, etc.
Step 5. Ideation about the new pool	The routine will be (pay, get changed, swim, shower, get dressed, leave). The smell will be of chlorine. The sounds will be echoed. I will be hot at first, then cold when I get in the pool. The pool will look as pictured.

6.4.2.1 Using cues and prompts to develop cognitive strategies in childhood

For adults cues and prompts are likely to be used to almost substitute for poor ideation. However, in autistic children, considering the nature of neuroplasticity, cues and prompts may also have a role in the development of cognitive strategies for improving ideation abilities.

In learning and education settings, cues and prompts are frequently applied, i.e., Bateman & Schwartz, (2022). Similarly, in paediatric occupational therapy and many other disciplines, the use of cues and prompts is an established technique used to rehabilitate or

teach new skills (Kern et al., 2007; McQuiddy & Moore Brennan, 2016). While the use of cues and prompts to aid ideation has not been framed within the context of learning, it is worth noting the similarities to Vygotsky's notion of scaffolding through the provision of cues and prompts (Vygotsky et al., 1978). In this educational application, scaffolding is commonly initiated by someone more knowledgeable than the child. However, scaffolding is also a skill to aid more independent learning (Copple & Bredekamp, 2009; Silver, 2011).

As cues appear to facilitate ideation, scaffolding strategies could likely be beneficial in developing strategies for ideation. For example, a learner could be provided with prompts, be it visual images or physical items, as the learning progresses, the prompt's intensity, type and frequency could be reduced until the learner can independently form their internal mental representations of the cues. Doing this would facilitate independent scaffolding, providing cues for independently facilitated ideation. The personal insights from Grandin (2009) can be used to provide an example of this, Grandin talks about her childhood experience of using card games to boost her skills in categorising memories, a skill in which she later applied to prompt memory and form new ideas. This initial exploration touches upon the potential association between ideation and learning. This area is a potential avenue for further research.

So far, the evidence has suggested that ideation in autism is deficient. This alone justifies that clinicians working with autistic people should have a greater awareness of ideation and its functional role. Whilst the cause of deficits is still unknown, memory appears to from a key role in ideation. The use of prompts and cues has been proven to improve memory function. Additionally, the scoping review suggested a link between the use of cues and prompts to improve imagination and fluency (both skills in ideation), therefore, the

suggestions for clinical practice are centred around using cues and prompts to improve ideation.

6.5 The Study Limitations

There are a number of limitations with this study. Some limitations of the study were clear from the outset and therefore incorporated into the study design such as the sparse state of the existing knowledge and the author's own skills and resources. Other limitations arose less predictably and are described below.

6.5.1 The number of participants and participants demographics

Sample number

The a prior power calculation suggested that 56 participants would be required for the study. However, due to the time limitations originally set for recruiting the autistic sample, only 40 participants were ultimately recruited. Simundic and Nikolac (2009) state that acceptable sample sizes vary depending on the intended use of the findings. For example, in preclinical studies, smaller sample sizes are acceptable (Serdar et al., 2021; Hertzog, 2008). However, it is accepted that the power of the findings will be reduced by the limited sample size (Suresh & Chandrashekara, 2012). Post hoc power calculations are not generally recommended (Heckman et al., 2022; Althouse, 2020), and so quantifying the precise impact of this reduced sample size is not possible. However, to mitigate against the risks of type 2 error (caused by low power), whilst potential relationships (correlations between 0.2-0.5) were included in the results, careful and consistent descriptions were applied to the narrative in the findings to ensure a clear identifiable difference between weak positive/negative relationship and statistically significant findings (less than p =.05).

Acknowledgement of the reduction in the power of the results was also taken into account when setting out the clinical recommendations (6.7), in that the recommendations were built on existing evidence and did not involve any new intervention/treatments. Finally, the research recommendation emphasises the need for further research with a larger sample size.

Sample Approach

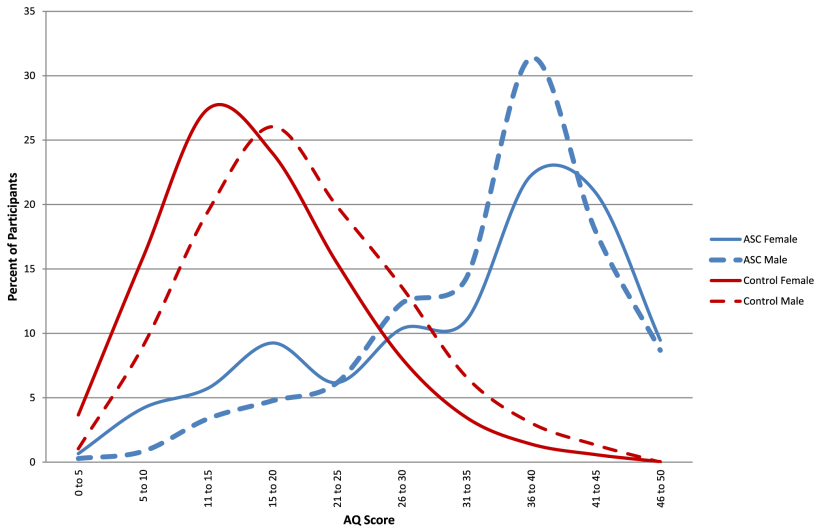
Both study populations were recruited using a convenience sampling approach. For the control group, most participants were associates of staff working at my NHS workplace rather than the staff I work with directly, which helped to ensure the diversity of the sample. However, it is acknowledged that this sampling approach may have imposed some limitations on the diversity of the sample. To improve the diversity of the participants, including gender, age and place of residence, other sampling approaches should be applied in future studies (discussed in the recommendations 6.6).

Gender

Despite efforts to recruit female participants, including by extending the recruitment time frame, all the participants were male and therefore, the extent to which these study findings may be generalisable to autistic females is necessarily limited. The lack of female participants can be largely accounted for by the gender gap in diagnosis at the time of the study, which was estimated to be 4:1in Europe (range 0.8-5.4) (Zeidan et al., 2022), which will inevitably influence membership of the charity from which the study recruited. However, as time moves on, the gender gap in diagnosis continues to reduce (NHS England, 2023), making male-only samples less generalisable to the overall autistic population. This naturally leads to the subsequent recommendation (section 6.6) for research that prioritises the recruitment of female participants.

It is, however, worth noting that validity research on the AQ did not find any significant gender difference in scores (see Figure 10) (Bishop & Seltzer, 2012; Hoekstra et al., 2007; Ruzich et al., 2015; Bartels, Verweij & Boomsma; 2007).

Figure 10 Distributions of AQ scores: males and females with and without autism



Age

The participants ranged in age from 17-38 years. On the basis that the developmental nature of ideation is not relevant from the adult age onwards (see Chapter 2) and that there was no correlation between the participant's age and their score on the RBMT-3, TEA, or TIP, the study findings can be confidently generalisable to working-age adults. However, given the lack of literature on the effect of ageing on ideation, the extent to which they can be applied to older age adults is necessarily limited.

Intelligence

The study excluded people with a diagnosed intellectual disability but did not specifically test the intelligence levels of the autistic participants. Therefore, intelligence's effect on ideation could not be considered and suggests an area for future research. In terms of my

study, the effect of intelligence on performance in the tests used would not be expected to invalidate the results, on the basis of, for example, the findings of Jones et al., (2011), who did not find a relationship between IQ and the RBMT-3 scores in autistic participants, and Runco et al (2004) who reported that intelligence in adults was not found to affect ideation directly.

Severity of autism traits

The AQ scores from the autistic group ranged from 17-34 with a mean score of 25.92. Although this was higher than the control group mean 12.45 and similar to other studies i.e., Bishop and Seltzer, (2012) autistic mean =24.62; Ketelaars et al. (2008) - autistic mean = 22.5, it is much lower than Baron Cohen's AQ validation studies (Baron Cohen, 2001). Baron Cohen reported 80% of the autistic participants (N= 58) scored over 32 with a study mean score of 35.8 (SD = 6.5), indicating that my study population were mildly autistic. This can be accounted for in part by the approach to recruitment and may limit the extent to which the findings can be applied to those with more severe autism. Regarding the impact on the results, only the threshold participants (who scored more than 26 on the AQ) were used within the same correlations. In all the results, the significance of the correlations increased, for example, AQ (threshold) and TIP total r = .65; the AQ (threshold) and TIP repetitive answers r =.46. Although the sample size is too small to provide definitive conclusions, the general pattern of these scores supports that the more severe the autism, the greater impact this has on ideation.

6.5.2 The nature of the tests

Whilst careful consideration was applied when selecting the tests, there were limitations with some of those chosen.

Limitations when measuring imagination

The AQ used in this study tests imagination in the social context instead of creative thinking (most relevant to ideation) (Dulgheru, 2015; Runco, Mark A. & Cayirdag, 2006; Sternberg, Robert J. & O'Hara, 1999). Craig and Baron Cohen (1999) identified that creative imagination in autism is under-researched; their study indicated that imagination in autistic people was deficient in creativity.

Limitations when testing ideation

The TIP was designed for children; the pilot study was conducted to review the use of the test with adults. The methodology of the test was easily applied, and the scores from the pilot confirmed suitability. Also, the TIP is very similar to the use of objects tests, a test frequently used with adults in other similar studies (Bishop, & Norbury, 2005; Dichter et al., 2009a; Jarroldet al., 1996; Lewis & Boucher, 1995; Lind, & Bowler, 2010; Low et al., 2009; Turner, 1999). As discussed, the TIP had increased validity compared to the use of objects tests. The pilot study informed the modifications made to reduce the limitations; additionally, feedback was gathered throughout testing to check for comments that could reflect poor motivation, lack of understanding or lack of effort. No comments reflected this. Two subjects commented, 'This is harder than I expected' and 'I'm finding this really difficult' but this did not appear to reflect a lack of understanding or motivation.

The use of the string as a prompt was apparent as many of the participants' responses stemmed from the traditional use of string, for example, tie it, wrap it. Whilst acknowledging this, the suitability of the TIP in examining ideation has been explored and confirmed (Appendix F), and although the string provided a prompt, the natural affordances linked to

the string are limited, and so the generation of new ideas are required to obtain a reasonable score, imaginative or not. The use of other items was considered however the string was selected from a number of items because of its higher interrater reliability within the test development (May-Benson & Cermak, 2007). Turner (1999) used a brick for ideational testing; this item choice was ruled out because of the lack of standardisation of its use. However, it is possible that the use of different objects could have affected the results. The TIP mean score was 9.25, which was very similar to the mean score found by Bishop & Norbury (2005) in their study of autistic participants with the Use of Objects Test (mean score was 9.86), whereby a brick, as opposed to string, was used. This supports generally the reliability of the 'use of object' method and potentially reducing the significance of what miscellaneous object is used.

Limitations when testing attention

Robertson and colleagues (1996) described several possible constraints on the validity of the TEA; whilst all of the key constraints, i.e., vision, have been accounted for within the method (inc. testing procedures), verbal intelligence required further consideration. To understand how much verbal intelligence would likely affect the TEA scores, original validity data by Roberson and colleagues (1996) was reviewed. They found that only the Visual Elevator Test and IQ had a partial correlation coefficient exceeding .3. As a result, Robertson and colleagues (1996) suggested that participants with intelligence below average whose *Visual Elevator* score was just below the average should not be seen as an impaired performance. Within this study, the participant's IQ was not known; however, when evaluating the scores against normative results, the *Visual Elevator* scores were especially scrutinised to look for low scores that could, according to Roberson and colleagues (1996),

reflect low intelligence. No isolated (as in the participants only scored poorly in this subtest) low scores were noted in this subtest.

Use of singular executive function tests

Executive functions support each other and are integrated (e.g., Pellicano, 2007; Groot, Wilson, Evans, & Watson, 2002; Kopp & Thone- Otto., 2003). Correlational analysis of the RMBT-3 and TEA enabled an evaluation of the impact of individually measuring executive functions. In the autistic group, findings showed a positive correlation between one of the TEA subtests (N= 7, Divided Attention) and most of the RBMT-3 scores (GMI, Immediate recall (r =52), delayed recall (r = .45), delayed recognition (r = .48*)*, prospective memory (r = .56), visual memory (r =. 45) and verbal memory (r = *.53*)). This correlation indicated the better the participants divided attention, the better their memory function or vice versa. In relevance to this study, in the autistic group, divided attention was the most significantly correlated attentional function to ideation. Therefore, this correlation warrants further investigation because, in practice, the treatment of memory function is different from that of attention; it is possible that the treatment of attention would not effectively improve ideation if the treatment of memory function is absent. However, it is equally important to consider that only one of the attention subtests correlated with RBMT-3, supporting the independent testing of attention and memory in ideation. In conclusion, it is important to consider the integration between executive functions; however, this study demonstrates valid mapping of executive functions independently.

6.6 Recommendations for further research

The following research recommendations are based on examining specific variables in more detail and expanding the original lines of enquiry.

- To improve generalisability, this study should be repeated with a larger sample and alternative sampling approaches to enable recruitment of a more diverse sample in terms of gender, a wider spectrum of autism, and a range of ages, including both children and older adults. To achieve this, recruitment could be expanded using various media tools to advertise for participants nationally or internationally. Additionally, female autism social groups for example, SEE Autistic Women, run through the Autistic Society, could be targeted as part of a wider recruitment approach.
- In relation to imagination and autistic ideation, the findings of this study were at variance with those of the literature review, which may be related to the fact that the tests used did not include tests of creative imagination. Repeating the research with the addition of tests that specifically examine creative imagination would be valuable in clarifying and advancing our understanding of the relationship between imagination and autism ideation.
- The study suggested the importance of executive function in ideation and the potential impact of cognitive sub-processes on these functions. Future studies addressing the two following questions would advance our theoretical understanding in this area.
    - How does association in memory affect the retrieval of ideas?
    - How does visuo-spatial planning affect ideation?
- The importance of visual memory and the use of visual cues in ideation as a strategy within professional practice, was explored in some detail earlier. Applied research,

using a range of methodologies, should seek to evaluate the effectiveness of those strategies, including where and how they might be used to support ideation in autistic people.

- Our understanding of the functional challenges of ideation and the strategies that autistic people adopt in relation to ideation is very poorly understood. Qualitative research that captures the personal accounts of autistic people would help to address this gap in knowledge and refine the use of strategies to maximise their effectiveness.

6.7 Recommendations for Clinical Practice

A number of clinical recommendations are proposed:

- There should be greater awareness of ideation, specifically, clinicians should be aware of ideational difficulties in autism and consider this within functional assessments. And particularly within occupational therapy during skill analysis and assessments of occupations. In occupational therapy, the TIP can be used to measure ideational performance.
- Using prompts is an established method used within occupational therapy, building on existing practice, the extended use of cues and prompts should be applied to assist ideation function in autism. This research suggests it would be helpful to include visual stimuli in cues, either through promoting visual imagery conducted by the person (mental imagery) or using physical prompts that are visually stimulating. The intensity and frequency of prompts should depend on the person's abilities and should be scaffolded to reduce dependency on prompts being provided by other people.

- Practitioners should look out for ideational dyspraxia in autistic patients with dyspraxic symptoms and seek to utilise interventions proven to support dyspraxia.

When disseminating clinical recommendations, it is important to ensure the safe use of knowledge. For example, it is important to be clear about what research has a significant evidence base and what has not. Some of the clinical recommendations are supported by existing research evidence. For example, when autistic children are thought to have ideational dyspraxia, providing recommendations to utilise cues and prompts to aid ideation in motor planning appears to have a well-founded evidence base. My current role as Transformation Lead for an NHS adult and children's neurodiversity services offers an excellent opportunity to identify the most appropriate services and professional groups to share this learning.

Given the functional nature of ideation, dissemination among occupational therapists is an obvious target group. However, ideation would also affect function in adaptive behaviours and communication. Therefore, specialist nurses, psychologists and speech and language therapists may also find the work interesting. Third-sector autism services, for example, charities, may not employ professionals but may also benefit from dissemination; for example, autism play support within early help services.

Finally, disseminating thesis findings to autism special interest groups would enable sharing the study across a wider geographical area to service users not connected with professional or more informal autism organisations.

6.8 Summary

When integrated with wider literature, this study's findings indicate that within autism, deficits in visual memory mediate with ideational function. Research also indicated that within memory, the function of cognitive sub processes such as visuospatial planning and association could contribute to poor ideation. Therefore, the findings highlighted the role of cues and prompts in supporting association, memory, and ideation. Although the study did not find a direct correlation between ideation and imagination, results from the control group and scoping review suggest that imagination, on some level, influences ideation. The results from both groups suggest a relationship between ideation abilities and autistic traits, including attention-switching traits. The potential role of ideation in supporting attention-switching traits, RRBIs, has been acknowledged. This knowledge informed the proposed pathway that maps difficulties in autism ideation.

The clinical relevance of the findings identifies that using prompts and cues could support ideation and imagination, pointing toward clinical applications of techniques that support cue generation.

Discussion about the limitations of the study population concluded that the generalisability of the results only applies to the working adult age range of the participants and that the AQ overall scores reflected that this group of participants were potentially less autistic than a typical sample of the autistic population. The impact of the nature of the tests was considered against the findings, and whilst it is accepted that any psychological testing has limitations, the effect of these on the results does not pose significant risks of invalidating them.

The chapter concluded with recommendations for future research and clinical recommendations and dissemination plans. The following chapter offers a personal reflective account and demonstrates how the study influenced clinical practice during the research journey.

CHAPTER 7 REFLEXIVITY

7.1 Reflexivity

To maximise the knowledge learnt throughout this doctorate programme, reflexivity was used. Whilst reflections on practice initiated the research journey, applying reflexivity supported questioning of my initial ideas and enabled the use of acquired knowledge throughout the process, including from the scoping review, steering the ongoing direction of the study. A further example was merging study findings with other research to develop a suggested pathway of autism ideation (presented in Chapter 6, Figure 7). The single and double loop model of reflection, as described by (Schön, 1987) was applied. Single-loop learning occurs when a change or problem is noted, and the response is reactive, using existing knowledge; this is often achieved through reflection. Double loop learning occurs when problems are pointed out, and reflection supports broader responses than a typical response, supporting reflexivity. In this case, single-loop learning occurred through identifying clusters of similar behavioural reactions and thinking, leading to ideation being recognised as a potential cause.

The double loop reflection identified the problem as a potential lack of ideation. Still, importantly, the reflexive approach helped open questions to address the 'what, why and how', confirming first that ideation is deficient, addressing the potential cause of ideational deficits and understanding how and if this relates to autistic traits. This process helped to enhance the meaningfulness of the research to the people it affects: '*what* does this mean for the person?', '*why* ideation?' and '*how* does this impact on function?'. Double-loop reflection was also used when applying the findings of this study to clinical practice. Specifically, this process enabled me to establish links between existing knowledge from

clinical practice and what I have learned. The key areas of reflection have been summarised below:

7.1.1 The workplace and clinical practice

Reflexivity has promoted discussion with colleagues about understanding autism, developing shared interest across the workforce, and increasing my motivation to improve clinical practice. Initiating change in the workplace can be challenging. However, two aspects of this thesis can support change. Firstly, the clinical recommendations from this thesis are supported by the research findings and improve clinical reasoning. Secondly, the recommendations are simple and practical and should have immediate effects. On this note, it is also important to use reflection when implementing the clinical recommendations to ensure feedback about effectiveness from the staff's and patient's perspectives.

7.1.2 Procedure and service design

Reflexivity has informed my decisions about new approaches to service delivery. I was involved in establishing a ‘needs-led’ neurodiversity service for children and young people. The needs-led approach was partly influenced by my reflection on this research and the success of initiating research based on understanding functional difficulties by addressing unmet needs. The paradigm of neurodiversity and hence the ‘neurodiversity’ service also supports this in that a diagnosis is not required to address functional difficulties.

On the other hand, knowledge acquired from the research results and learning about cognitive functioning in autism indicated that it is important to understand the mental and physical (praxis) profiles of autism to tailor support for individuals. As Transformation Lead for the NHS Trust (Adult and children's Autism and ADHD services), I have also overseen the restructuring of the workforce model. Reflection on the need to understand physical and

cognitive functional ability meant that the staffing model within the neurodiversity services was developed to address this, for example, by appointing clinical psychologists and occupational therapists to assess these functions.

7.1.3 Innovation

Throughout the thesis, and especially when meeting the participants, I became very aware of the uniqueness of autism in each person. This was also reflected in the results of the tests. This study has brought about new findings through innovative thinking about the challenges faced by autistic patients. The uniqueness of autism indicates that an innovative research approach to understanding autism is essential. My drive to continue autism research and to encourage learning about autism has resulted in research and training being part of a 2-year Autism Quality Improvement Program within the workplace.

7.2 Summary

Reflexivity has served as a key tool in identifying this research topic and steering the research journey. Reflexivity ensured that the clinical importance of this research is held in mind throughout the research process and has allowed for learning to be implemented into practice to ensure that it makes a difference as far as possible. The following chapter details the clinical and research recommendations and dissemination plans required to expand the use of this knowledge and continue research in this area.

CHAPTER 8: CONCLUSIONS

8.1 Conclusion

This research journey stemmed from clinical observations of autistic children and adults and their functional difficulties. This study has achieved its aim and contributed to what is known about autism ideation. The literature review sourced literature about ideation and enhanced understanding of the ideational process, which enabled the project's key themes to emerge. In particular, some of the cognitive functions used in the ideational process are also known to be difficulties in autism, suggestive of a possible correlation. In addition to clinical observations, this proposed correlation supported the notion that autism ideation could differ from neurotypical ideation. The scoping review findings concluded that autistic people perform worse in tests involving ideation than controls. The review suggested potentially fruitful areas for further investigation: executive function and ideation and autistic traits and ideation.

The empirical study examined three hypotheses using a quantitative non-experimental methodology with a participant sample of 20 autistic and 20 non-autistic male adults. The method involved four psychometric tests that addressed memory, attention, autistic traits, and ideation.

The results support that attention plays a role in ideation, although this was not considerably different in autistic participants. This study found that memory and attention relate to ideational abilities. Specifically, the study concluded a statistically significant positive correlation between both groups' verbal memory and prospective memory and ideation. Both groups also showed statistically significant results that indicate a relationship between

immediate recall and ideation. However, unique to the autistic group, a statistically significant positive correlation was also found between visual memory and ideation as well as delayed recognition and recall, and ideation. The strength of this evidence informs that memory function mediates with ideation; however, only in the autistic group did visual working memory relate to ideation.

This study also showed how autistic traits related to ideational abilities, particularly in the case of attention-switching traits. A relationship was also noted between the degree of autistic traits and increased repetitive ideation. In the autistic group, no relationship was found between imagination and ideation nor between chaining of responses and the degree of autistic traits; however, in the control group, a relationship between imagination and ideation was indicated, suggesting that imagination does play a role in ideation.

This thesis combined empirical findings with various research literature, arguably enabling new contributions to knowledge beyond its original scope. Findings suggest the following:

1. That ideational deficits may have routes in memory differences, specifically visual memory.
2. That the role of cognitive sub processes including association in memory may be relevant in the ideational process.

Additionally, a proposal for difficulties in autism ideation was developed. This process outlines the role of executive function in ideation and the relationship between ideation and autistic traits, specifically those relating to repetitive and restrictive behaviours. The exact causal effect and direction of effect remains unknown i.e., it is still unknown if poor ideation causes or is caused by more repetitive autistic traits or, to give another example, if poor

imagination traits cause ideational deficits or vice versa. It is also noted that both could be caused by another unidentified factor.

This thesis has explored the concept of ideation, highlighting the importance of ideation in human function. By investigating the links between cognitive differences in autism and ideation, the thesis has produced new knowledge about autism.

This study has realised the potential of better understanding autism ideation and highlighted how research can further explore this field. Limitations notwithstanding, the findings of the thesis have suggested clinical recommendations of a nature that could be expected to have an immediate impact. In this way, theory and clinical relevance have been brought together, an undertaking not always easy to achieve in fields heavily invested in theoretical underpinning. The findings raise awareness of ideation and, together with the research recommendations, broaden the scope of autism research, continuing and expanding the exploration and understanding of this condition.

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APPENDICES

Appendix A- Example of SIGN critical review

Methodology Checklist 4: Case-control studies

Study identification (*Include author, title, year of publication, journal title, pages*)
Begeer et al 2009 Additive and subtractive counterfactual reasoning of children with Autism with high functioning ASD

Guideline topic: Ideation in Autism

Key Question No: 1

Reviewer: M Field

Before completing this checklist, consider:

1. Is the paper really a case-control study? If in doubt, check the study design algorithm available from SIGN and make sure you have the correct checklist.

2. Is the paper relevant to key question? Analyse using PICO (Patient or Population Intervention Comparison Outcome). IF NO REJECT (give reason below). IF YES complete the checklist.

Reason for rejection: Reason for rejection: 1. Paper not relevant to key question □ 2. Other reason □ (please specify):

In a well-conducted quasi-experimental study:

Does this study do it?

1.1 The study addresses an appropriate and clearly focused question.
Can't say
Only focus of study stated no clear question defined

Selection of participants

1.2 The cases and controls are taken from comparable populations.
Yes
Controls/cases matched on ethical, racial, class and on verbal and full scale IQ

1.3 The same exclusion criteria are used for both cases and controls.
Yes
Excluded additional diagnosis in both groups

1.4 What percentage of each group (cases and controls) participated in the study?
Cases: 72

Controls: 71

1.5 Comparison is made between participants and non-participants to establish their similarities or differences.
Yes

1.6 Cases are clearly defined and differentiated from controls.
Yes
Demonstrated within table considered age, IQ and background. Sex not compared however only 11 girls in study. Also all case confirmed diagnosis of HFA.

1.7 It is clearly established that controls are non-cases.
Yes

ASSESSMENT

1.8 Measures will have been taken to prevent knowledge of primary exposure influencing case ascertainment.
Unable to determine

However questions used is tests are unlikely to have been asked before relating to the assessments used.

1.9 Exposure status is measured in a standard, valid and reliable way.
Yes
Used norms measures tests, tests video taped and scored by 2 independent coders.

CONFOUNDING
1.10 The main potential confounders are identified and taken into account in the design and analysis.

Yes

STATISTICAL ANALYSIS

1.11 Confidence intervals are provided.

Yes

MANOVA and ANOVA conducted to analysis the effect of different groups

2.1 How well was the study done to minimise the risk of bias or confounding?

Hypothesis stated, authors details stated and no obvious link to assessment establishment, no research funded information stated. no participation rewards stated. Although independent coders used no information about these, or the administrators of the test noted.

High quality (++)

Acceptable (+)

Unacceptable – reject 0

2.2 Taking into account clinical considerations, your evaluation of the methodology used, and the statistical power of the study, do you think there is clear evidence of an association between exposure and outcome?
Yes
The results indicated clear patterns of dysfunction in ASD compared to control in ideational abilities. Limited sample size and sample cultural, ethical and gender diversity.
2.3 Are the results of this study directly applicable to the patient group targeted by this guideline?

Yes

2.4 **Notes.** Summarise the authors conclusions. Add any comments on your own assessment of the study, and the extent to which it answers your question and mention any areas of uncertainty raised above.

see results matrix - although only part of the test used directly related to ideation the links between imagination and counterfactual

Appendix B- JBI Data Extraction Tool

Scoping Review Details	
Scoping Review title:	
Review objective/s:	
Review question/s:	
Inclusion/Exclusion Criteria	
Population	
Concept	
Context	
Types of Study	
Study Details and Characteristics	
Study citation details (e.g. author/s, date, title, journal, volume, issue, pages)	
Country	
Context	
Participants (details e.g. age/sex and number)	
Details/Results extracted from study (in relation to the concept of the scoping review)	
E.g. Quality of Life Domains assessed	
E.g. Number of items in tool	
E.g. details of psychometric validation of tool	

Appendix C-Summary of the charted data

Author/ Date	Study Design	Population				Relevant Tests	Findings
		Diagnosis	No	Sex	Age		
BOUCHER 1988	Quasi-experimental	Autism, some level of Learning Disability v control	14	All M	10-15 yrs	Verbal Fluency Tests (Delis, Kaplan &Klamer, 2001): • Category fluency • Miscellaneous word generation.	• Category fluency – no difference noted between control and ASD • Miscellaneous word generation- ASD performed worse, ASD produced more 'group works' than control.
MINSHEW et al., 1992	Quasi-experimental	Autism v control	30	Not specified	Adolescent and young adults (not specified)	Verbal Fluency Tests: • Letter fluency • Category fluency	• ASD group produced fewer words in both tests than control; this did not reach statistical significance.
LEWIS & BOUCHER, 1995	Quasi-experimental	Autism, Learning Disability (2 groups v control)	30	23M 7F	3-15yrs	Ideational Fluency Tests: • Ideas for play with a car then a doll (elicited play) scored on functional and symbolic ideas. • Instructed play with doll and car scored on ability to follow instructions.	• ASD is impaired in generating new ideas for the car but not the doll. Overall produced fewer play ideas. • The control group provided more ideas with the doll than the car. • Authors feel the doll provides more visual cues to generate ideas than the car. • No differences across groups inability to follow instructions.
JARROLD, BOUCHER & SMITH, 1996	Quasi-experimental Three experiments Experiment 1	Moderate learning disability (MLD), Autism (ASD) (2 groups)	28	20 M 8 F	Children (not specified)	Participants were given a doll then a doll with 'junk' (props). Scored in 5 areas, for example, no play, functional play, pretend play.	• MLD had more pretend play with doll and junk than with doll alone. • ASD same amount of pretend play with or without the junk. • ASD more functional play with just doll. • ASD more manipulative play and 'no play' than controls. • ASD less time in functional play than controls. • ASD also more time 'pausing' in play than controls. • Conclusion- not just imagination that causes deficits in play – meta representational problems. ASD can pretend but have poor production of pretence.
	Experiment 2	Moderate learning disability Autism (2 groups) N=30 Age=	30	22 M 8 F	Children (not specified)	Pretend to play verbally instructed using three categories, emotional, social, and physical	• All groups have the lowest scores on the emotional instructed play. • Conclusion – ASD unimpaired inability to act out appropriate responses to instructed pretend play.
	Experiment 3	Moderate learning disability, autism, control (2 groups v control)	30	LD-5(F) 10 (M) ASD 3(F) 2(M)	Children (not specified)	Testing pretend play with and without prompts/props.	• ASD worse than controls with and without props in pretend play

SCOTT & BARON-COHEN 1996	Quasi-experimental	3 groups Autism Learning Disability Control (no diagnosis)	15 (Autism) 14 (LD)	Not specified	Autism – 8-16 LD- 9-16 No diagnosis control 4-5	Experiment 1 investigated if children with autism could introduce changes to their representations of people and houses, using Karmiloff-Smith's(1989) technique of asking children to draw "impossible" people or houses. Experiment 2- as above with instruction. Experiment 3. test of Verbal Fluency and a test of imagining multiple functions of a brick (like use of objects test).	• No significant difference between the groups, in drawings of 'real house'. Difference in autism and control drawing the 'real man' however this was due to high scores in control group not deficit in autism. • Autism produced sig less drawings of imaginary (impossible) house or man than control and LD groups. • When asked to draw something scary- autism produced significantly less 'unreal' drawings than control and LD group. When asked to draw something 'real and scary' no difference in the groups. When subjects were instructed to draw an imaginary or impossible thing Autism group worse than control and LD group. • For the use of object test the autism group produced significantly less answers than control. But not significantly less than LD group. • The verbal fluency test showed Autism and LD group- no difference. Autism and LD group significantly less responses than control. • Experiment **3** found that the deficit in performance was not due to a generativity deficit, since they were no different to controls in the ability to generate words or ideas of real objects.
TURNER, 1999	Quasi-experimental	Higher Functioning Autism, Learning disability with autism (2 groups v control group).	87	72 M 15 F	6-32 yrs	Verbal Fluency Tests including: • Letter fluency • Category fluency Ideational Fluency Tests • Use of objects test • Pattern Meaning Test (Wallace & Kogan, 1965) • Design Fluency Test	• ASD (LD & HFA) performed worse than controls in ideational fluency (use of object and design fluency), design fluency and verbal fluency. • Pattern meaning task & ideational fluency ASD (HFA & LD) more repetition, inappropriate and redundant answers, than controls. • ASD (LD & HFA) produced more incorrect answers in Design fluency than controls. • HFA produced fewer designs than control in the design fluency test. • ASD (LD & HFA) produced less imaginative answers than controls in ideational fluency tests. • HFA did not produce more (as the other groups did) imaginative/novel answers for nonconventional or fixed design items (compared to conventional items and free designs).
BISHOP & NORBURY, 2005	Quasi-experimental	Higher Functioning Autism, pragmatic language impairment, specific language impairment (3 groups all v control group).	74	65 M 9 F	6-10 yrs	Ideational Fluency Tests • Use of objects test • Pattern Meaning Test	• Use of objects test – ASD worse than control • Use of objects test – ASD more repetition than all other groups • Patterns Meanings Test (Wallace & Kogan, 1965) HFA and control produced fewer incorrect answers than the other groups. • Pattern Meaning Test – total number of responses indicated that both HFA and the control group produced fewer results. • Patterns Meaning Test – total number of correct responses – worse in ASD than controls. • Patterns Meaning Test – ASD more repetitive answers than controls.

KLEINHANS AKSHOOMOFF & DELIS, 2005	Quasi-experimental	Higher Functioning Autism or Asperger's Syndrome (Participants v test norms)	12	All M	14-45 yrs	Ideational Fluency Tests • Verbal fluency • Category fluency • Design fluency (Mann-Whitney U test (Delis et al., 2001)	• Letter fluency – ASD worse with letter fluency • Category fluency – no difference • Design fluency – ASD performed worse. • Mann Whitney U test was used to assess the difference between HFA and Asperger's, and the only difference noted HFA worse at visual scanning.
AMBERY ET AL., 2006	Quasi-experimental	Autism v control	47	38 M 9 F	19-67 yrs	• Verbal Fluency Test: • Controlled Oral Word Association Test (Benton, Hamsher & Sivan, 1989) Executive Function Tests: • Stroop Colour Word Reading Test (Trenerry, Crosson, Deboe & Liber, 1989) • Wisconsin Card Sorting Test (Heaton, Chelune, Talley, Kay & Curtiss, 1993)	• ASD produced fewer words (only just statistically significant)
BOUCHER, 2007	Case Study	High Functioning Autism	1	M	Not specified	N/A	• Problems accessing known information resulting in hypothesised positive correction between free recall and free generativity. • Poor event memory could cause poor event generativity resulting in some Autistic traits, including poor imagination and lack of flexibility in routine. • Deficits in episodic memory and episodic memory buffer cause problems in planning and future thinking.
BEGEER, ET AL., 2009	Quasi-experimental	Autism v control	143	132 M 11 F	6-12 yrs	Ideation fluency Test: • RAKIT (Bleichrodt, Drenth, Zaal & Resing, 1984)	• ASD produced fewer ideas • All participants' number of ideas increased with age. • Correlation between ideational fluency and additive counterfactuals (ability to list life events that could have occurred that did not).

DICHTER ET AL., 2009	Quasi-experimental	Autism v control	78	76 M 2 F	Children (not specified)	Ideation fluency Test: • Use of Objects test Verbal Fluency Tests: • Category Fluency • CCC-2 (Bishop, 2003) and SCQ-Test (Rutter Baily & Lord, 2003) tests communication • RBS-R1 (Bodfish, Symans & Lewis 1999) – tests repetitive behaviours.	• Use of Objects – ASD worse • Verbal Fluency Tests – ASD no difference • No relationship between generativity and repetitive behaviours. • Relationship between generativity and communication deficits.
LOW, GODDARD & MELSER, 2009	Quasi-experimental	Autism v control	26	23 M 3 F	Children (not specified)	Ideation fluency Test: • Use of Objects test Executive Function Tests: • Imaginative Drawing Test • Patterns Meaning Tests (Wallace & Kogan, 1965) • Visuospatial tests • Central coherence tests Theory of Mind Tests: • Unexpected and False Belief Tests (Baron-Cohen, 1989)	• ASD worse in Use of Objects Test • ASD worse in Imaginative Drawings Test • ASD worse in Patterns Meanings Test • Imagination worse in ASD • Conclusion – executive function affects generativity and planning in imagination. • Conclusion – a memory is recalled in working memory. Visuospatial planning then occurs; this involves imagination based on memory. Ideas are then produced through generativity.
LIND & BOWLER, 2010	Quasi-experimental	Higher Functioning Autism v control	28	22 M 6 F	Adults (not specified)	• ADOS-2 (Lord, Rutter, Lavore, Risi, Gotham & Bishop, 2012) • Memory characteristic questionnaire Verbal Fluency Tests: • Letter fluency • Category fluency Ideation Fluency Test: • Use of Objects	• ASD worse with episodic and future episodic • ASD Future episodic thinking worse than episodic memory. • Episodic thinking scores positively correlated with ADOS imagination scores. Episodic memory scores did not. • Both Letter and Category Fluency Tests -no difference noted between ASD and control • Use of Objects Test the participants produced fewer answers; however, this did not reach statistical significance.

PANERAI et al., 2014	Quasi-experimental	Autism – higher functioning. Autism mild LD. autism and Controls	27 ASD- (11 ASD, 8 ASD + mild LD); 8 Controls (no LD); 12 controls (mild LD)	25 male, 5 female.	Aged between 7-14yrs	*(1) Planning*. Tower of London (ToL), version included in the BVN 5–11 (Italian neuropsychological assessment battery for children aged from 5 to 11 years) *(2) Mental Flexibility*. Wisconsin Card Sorting Test (WCST), (3) *Response Inhibition*. Stroop test, *(4) Generativity.* Verbal fluency tasks (category and phone- mic) (*5) Ecological EF. BRIEF-Parents Form (*BRI; it represents the capability of changing the cognitive set and modulates emotions and behaviours through inhibitory control; BRI is made of inhibit, shift, and emotional control scales *(6) Adaptive Functioning*. VABS	• inhibition – no difference overall control v ASD. subgroups mild ld autism and control difference. • generativity measures by category fluency - statistically significant difference autism control, autism worse. • flexibility- statistically significant -autism worse than controls • ecological executive function (BRI) autism worse than control. subgroups – shifting, all autism groups worse than control. inhibition- stat sig. difference autism worse than controls. • meta cognitive index- whole group no difference. autism worse than control, including in working memory and planning and organising. • adaptive functioning – autism worse than controls in composite scale, socialisation and daily skills. no difference in communication subscale. • adaptive functioning positively correlated with IQ in all groups. in autism only adaptive functioning also correlated with inhibition and mental flexibility.
MILLER et al., 2014	Quasi experimental	Children with Autism v Controls	20 Autism; 20 controls.	ASD- 17 Male, 3 Female; control, 14	ASD- 8-15; controls 7-15	Dyspraxia was assessed using a 30-item test compiled from items used in previous tests Ideational dyspraxia tasks required the participant to perform a sequence of actions in a prescribed order. Five	• no correlation noted in either group regarding age and praxis abilities • autism more dyspraxic than control • autism worse ideational dyspraxia than control • autism worse buccofacial dyspraxia than control • autism worse in basic motor function than control • autism worse in eye movement performance than control • no correlation between ideational dyspraxia and simple motor task in either group • ideational dyspraxia correlated with motor integration in autism group but not control

						individual tasks assessed ideational dyspraxia including: finger thumb apposition- sequential (FTAS); the Luria fist test (repeated sequence of 3 movements, fist, open hand, side hand); 3-block bridge building, 6-block pyramid building; and tandem gait. (Simple) motor function was assessed with a series of five tasks. The VMI, VMI Supplemental Developmental Test of Visual Perception, and VMI Supplemental Developmental Test of Motor Coordination Gap/null/overlap paradigm - This paradigm is commonly used to assess eye movement and attention.	• children with autism, greater ideational dyspraxia was associated with increased autistic mannerisms (srs subscale) (r_S (17) = −0.40, p < 0.05) and with increased repetitive behaviours and restricted interests (ADOS-g subscale) (r_S (17) = −0.47, p < 0.02).
SERRADA- TEJEDA et al., 2021	Quasi experimental	Autism v controls	20 autism, 20 control	60% males, 40% females	Age between 4-6 years	- Test of Ideational Praxis, the Revised Knox Preschool Play Scale, and the Adaptive Behavior Assessment System II.	• Autism worse than controls on test of ideational praxis and play scale. • Statistically significant relationships were obtained between ideational praxis and play skills development (r = 0.649; p = 0.01), adaptive leisure behavior (r = 0.338; p = 0.04) and social adaptive behavior (r = 0.319; p = 0.04). Results of multiple linear regression models found a linear relationship between ideational praxis and play development (p = 0.005) and adaptive leisure skills (p = 0.004), but not with social interaction skills (p > 0.05).

Appendix D- Summary of the tests used in scoping reveiw

Test	Studies
Ideational Fluency Tests (Delis, Kaplan & Klamer, 2001)	
Letter Fluency	Ambery et. al., 2006 Begger et. al., 2009 (with visual prompts) Kleinhans, Akshoomof & Delis, 2005 Lind & Bowler, 2010 Minshew et al., 1992 Turner, 1999
Category Fluency	Boucher, 1988 (one test of miscellaneous word production one test category) Ditcher et al., 2009 (category fluency type test called Animal Fluency (Lezak, 1995) Kleinhans, Akshoomof & Delis, 2005 Lind & Bowler, 2010 Minshew et al., 1992 Turner, 1999 Panerai et al (2014) Scott & Baron Cohen xxx
Design Fluency Test (Delis, Kaplan & Klamer, 2001).	Kleinhans, Akshoomof & Delis, 2005 Turner, 1999
Generativity Tests	
'Use of objects' (Turner, 1999)	Bishop & Norbury, 2005 Ditcher et al., 2009 Jarrold, Boucher & Smith, 1996 Lewis & Boucher, 1995 Lind & Bowler, 2010 Low, Goddard & Melser, 2009 Turner 1999

Test of ideational praxis (TIP)	Serrada- Tejeda, 2021
Executive Function Tests for Generativity	
Patterns Meanings Test (Wallace & Kogan, 1965)	Bishop & Norbury, 2005 Low, Goddard & Melser, 2009 Turner 1999
Other Relevant Tests	
Theory of Mind Test (Muris, Steerneman, Meesters, Merckelbach, Horselenberg, Van den Hogen, & Van Dongen, 1999)	Low, Goddard & Melser, (2009)
Controlled Oral Word Association Test (Benton & Hamsher, 1989)	Low, Goddard & Melser, (2009)
Repetitive Behaviour Scale (Bodfish, Symans & Lewis 1999)	Ditcher et. al., (2009)
Social Communication Questionnaire (Rutter et al., 2003)	Ditcher et. al., (2009)

Appendix E Numerical data showing the tests used and results for autistic participants

Tests	*No. of studies*	*No. of studies results = Worse than controls*	*No. of studies results = No difference*	*No. of studies results = Better than controls*
Ideational fluency tested through Letter Fluency	*7*	*6*	*1*	*0*
Ideational fluency tested through Category Fluency	*7*	*3*	*4*	*0*
Ideational fluency tested through Design Fluency	*2*	*2*	*0*	*0*
Generativity examined through Use of Objects test	*8*	*8*	*0*	*0*
Generativity examined through Patterns meaning Test	*3*	*3*	*0*	*0*
Ideation tested through tests of ideational praxis	*2*	*2*	*0*	*0*

Appendix F -Cues and prompts provided by each test

Test	*Studies*	*Cues/prompts or no Prompts*
Ideational Fluency Tests *(Delis, Kaplan & Klamer, 2001)*		
Letter Fluency	*Ambery et al., 2006* *Begeer et al., 2009 (with visual prompts)* *Kleinhans, Akshoomof & Delis, 2005* *Lind & Bowler, 2010* *Minshew et al., 1992* *Turner, 1999* *Scott & Baron Cohen 1996*	*Prompt- Letter provided*
Category Fluency	*Boucher, 1988 (one test of miscellaneous word production one test category)* *Dichter et al., 2009 (category fluency type test called Animal Fluency (Lezak, 1995)* *Kleinhans, Akshoomof & Delis, 2005* *Lind & Bowler, 2010* *Minshew et al., 1992* *Turner, 1999* *Panerai et al 2014*	*Prompt – Category provided*
Design Fluency Test (Delis, Kaplan & Klamer, 2001).	*Kleinhans, Akshoomof & Delis, 2005* *Turner, 1999*	*Limited Prompt- designed attaching four dots, following specific rules like- 4 straight lines connecting only filled dots.*

Test	*Studies*	*Free generativity of ideas*
Generativity Tests		
Test of ideational praxis (TIP)	*Serrada- Tejeda 2021*	*No prompts – piece of string provided to generate ideas*
'Use of objects' (Turner, 1999)	*Bishop & Norbury, 2005* *Dichter et al., 2009* *Jarrold, Boucher & Smith, 1996* *Lewis & Boucher, 1995* *Lind & Bowler, 2010* *Low, Goddard & Melser, 2009* *Turner 1999* *Scott & Baron Cohen 1996*	*No Prompts – unusual nonrelated objects provided*

Appendix G- How the elements of ideation are measured in the TIP and Use of Objects Tests

Fluency – the Tests require the participant to state or act out as many ideas as they can- these ideas are counted.

Originality- the Tests score 1 point for each original idea. Ideas that are repeated are not counted. The nature of the use of a piece of string, (used in the TIP) or brick (commonly used in 'use of objects' test) allows the scope for originality to be displayed within ideas.

Flexibility- Like testing originality, the use of the string or brick means that flexibility in ideas is required to expand on the number of ideas. Within the TIP in this study (Chapter 5) measured answers that are chained are counted in the total number of answers however Chained answers also produced a score. Chained answers include ideas that follow on from each other and have one consistent element, i.e., wrap around wrist, wrap around fingers, wrap around hand. This allows for scores to indicate the degree of flexibility in thought.

Novelty- novity is facilitated by using a piece of string or brick- functionally these items have obvious uses i.e., tying up, wrapping around, building however these items also allow for novelty to be displayed i.e., 'use string to dangle in water to make ripples', 'use brick as a weight' etc.

Appendix H- DSM 5 Autism Diagnostic Criteria (plus additional criteria from ICD 10)

A. Persistent deficits in social communication and social interaction across multiple contexts, as manifested by the following, currently or by history (examples are illustrative, not exhaustive; see text):

1. Deficits in social-emotional reciprocity, ranging, for example, from abnormal social approach and failure of normal back-and-forth conversation; to reduced sharing of interests, emotions, or affect; to failure to initiate or respond to social interactions.
2. Deficits in nonverbal communicative behaviours used for social interaction, ranging, for example, from poorly integrated verbal and nonverbal communication; to abnormalities in eye contact and body language or deficits in understanding and use of gestures; to a total lack of facial expressions and nonverbal communication.

   Deficits in developing, maintaining, and understand relationships, ranging, for example, from difficulties adjusting behaviour to suit various social contexts; to problems in sharing imaginative play or in making friends; to the absence of interest in peers.
   Specify current severity: *Severity is based on social communication impairments and restricted, repetitive patterns of behaviour.*

B. Persistent deficits in social communication and social interaction across multiple contexts, as manifested by the following, currently or by history (examples are illustrative, not exhaustive; see text):

1. Deficits in social-emotional reciprocity, ranging, for example, from abnormal social approach and failure of normal back-and-forth conversation; to reduced sharing of interests, emotions, or affect; to failure to initiate or respond to social interactions.
2. Deficits in nonverbal communicative behaviours used for social interaction, ranging, for example, from poorly integrated verbal and nonverbal communication; to abnormalities in eye contact and body language or deficits in understanding and use of gestures; to a total lack of facial expressions and nonverbal communication.
3. Deficits in developing, maintaining, and understand relationships, ranging, for example, from difficulties adjusting behaviour to suit various social contexts; to problems in sharing imaginative play or in making friends; to the absence of interest in peers.
   Specify current severity: *Severity is based on social communication impairments and restricted, repetitive patterns of behaviour.*

B. Restricted, repetitive patterns of behaviour, interests, or activities, as manifested by at least two of the following, currently or by history (examples are illustrative, not exhaustive; see text):

1. Stereotyped or repetitive motor movements, use of objects, or speech (e.g., simple motor stereotypes, lining up toys or flipping objects, echolalia, idiosyncratic phrases).
2. Insistence on sameness, inflexible adherence to routines, or ritualized patterns of verbal or nonverbal behavior (e.g., extreme distress at small changes, difficulties with transitions, rigid thinking patterns, greeting rituals, need to take the same route or eat the same food every day).
3. Highly restricted, fixated interests are abnormal in intensity or focus (e.g., strong attachment to or preoccupation with unusual objects, excessively circumscribed or perseverative interests).

4. Hyper- or hyporeactivity to sensory input or unusual interest in sensory aspects of the environment (e.g., apparent indifference to pain/temperature, adverse response to specific sounds or textures, excessive smelling or touching of objects, visual fascination with lights or movement).

The ICD-11 has also listed.

- Impairment in functional or symbolic play
- Preoccupations with parts of objects in non-functional play materials
- Distress in changes of environment

Appendix I- AQ score sheet and questions

The Adult Autism Spectrum Quotient (AQ)Ages 16+: Scoring Key
For full details, please see:

S. Baron-Cohen, S. Wheelwright, R. Skinner, J. Martin and E. Clubley, (2001)
The Autism Spectrum Quotient (AQ) : Evidence from Asperger Syndrome/High Functioning Autism, Males and Females, Scientists and Mathematicians
Journal of Autism and Developmental Disorders 31:5-17

Responses that score 1 point are marked. Other responses score 0. For total score, sum all items.

		definitely agree	**slightly agree**	**slightly disagree**	**definitely disagree**
1.	I prefer to do things with others rather than on my own.			1	1
2.	I prefer to do things the same way over and over again.	1	1		
3.	If I try to imagine something, I find it very easy to create a picture in my mind.			1	1
4.	I frequently get so strongly absorbed in one thing that I lose sight of other things.	1	1		
5.	I often notice small sounds when others do not.	1	1		
6.	I usually notice car number plates or similar strings of information.	1	1		
7.	Other people frequently tell me that what I've said is impolite, even though I think it is polite.	1	1		
8.	When I'm reading a story, I can easily imagine what the characters might look like.			1	1
9.	I am fascinated by dates.	1	1		
10.	In a social group, I can easily keep track of several different people's conversations.			1	1
11.	I find social situations easy.			1	1
12.	I tend to notice details that others do not.	1	1		
13.	I would rather go to a library than a party.	1	1		
14.	I find making up stories easy.			1	1
15.	I find myself drawn more strongly to people than to things.			1	1
16.	I tend to have very strong interests which I get upset about if I can't pursue.	1	1		

17.	I enjoy social chit-chat.			1	1
18.	When I talk, it isn't always easy for others to get a word in edgeways.	1	1		
19.	I am fascinated by numbers.	1	1		
		definitely agree	**slightly agree**	**slightly disagree**	**definitely disagree**
20.	When I'm reading a story, I find it difficult to work out the characters' intentions.	1	1		
21.	I don't particularly enjoy reading fiction.	1	1		
22.	I find it hard to make new friends.	1	1		
23.	I notice patterns in things all the time.	1	1		
24.	I would rather go to the theatre than a museum.			1	1
25.	It does not upset me if my daily routine is disturbed.			1	1
26.	I frequently find that I don't know how to keep a conversation going.	1	1		
27.	I find it easy to "read between the lines" when someone is talking to me.			1	1
28.	I usually concentrate more on the whole picture, rather than the small details.			1	1
29.	I am not very good at remembering phone numbers.			1	1
30.	I don't usually notice small changes in a situation, or a person's appearance.			1	1
31.	I know how to tell if someone listening to me is getting bored.			1	1
32.	I find it easy to do more than one thing at once.			1	1
33.	When I talk on the phone, I'm not sure when it's my turn to speak.	1	1		
34.	I enjoy doing things spontaneously.			1	1
35.	I am often the last to understand the point of a joke.	1	1		
36.	I find it easy to work out what someone is thinking or feeling just by looking at their face.			1	1
37.	If there is an interruption, I can switch back to what I was doing very quickly.			1	1
38.	I am good at social chit-chat.			1	1
39.	People often tell me that I keep going on and on about the same thing.	1	1		
40.	When I was young, I used to enjoy playing games involving pretending with other children.			1	1
41.	I like to collect information about categories of things (e.g. types of car,	1	1		

	types of bird, types of train, types of plant, etc.).				
42.	I find it difficult to imagine what it would be like to be someone else.	1	1		
43.	I like to plan any activities I participate in carefully.	1	1		
44.	I enjoy social occasions.			1	1
45.	I find it difficult to work out people's intentions.	1	1		
46.	New situations make me anxious.	1	1		
47.	I enjoy meeting new people.			1	1
48.	I am a good diplomat.			1	1
49.	I am not very good at remembering people's date of birth.			1	1
50.	I find it very easy to play games with children that involve pretending.			1	1

Appendix J - Test of Ideational Praxis – Score form

Test of Ideational Praxis Scoring Sheet Teresa A. May-Benson, ScD, OTR/L		
Name: Date:		
Affordance	**Score**	**Scoreable Variations**
Bite-able		
Flip-able		
Go-overable		Raised On Floor
Hang-down-able		
Hang-on-able		Arm Hand Nose Head
Pull against body part		Head Nose Foot Trunk Leg
Scrunch-able		
Shake-able		
Shape-able		
Stretch out between two hands		
Swing-able		One hand R L Two hands
Throw-able		
Tie-able		Head Arm Leg Body Neck Ends of String
Twirl-able		One hand R L Two hands
Whip-able		
Wrap-around-able		Finger Wrist/Arm (R L) Neck Head Body Leg (R L B) Weave fingers
Other:		

Appendix K- Test of Ideational Praxis - Pilot Test Questionnaire

1. How was the environment? Was the room the right temperature, noise level etc.
2. How productive was the working space set out? The position of the researcher, the facilities (desk, drink, etc.)
3. Was the test clearly explained and thus was the test what you expected?
4. Did you understand the purpose of the test?
5. How did you feel when completing the tests? Did you feel the tests were too long, too difficult, too easy, etc.?
6. At the end of the test were you clear about what happens next?
7. Any other comments.

Appendix L- Autistic group- Criteria Screen

Sheffield Hallam University

Understanding Ideation in Autism Study- Michelle Turner

Participant Criteria Screen

This screen will help me check if you meet the criteria to participate in the study. Please read through the following questions and complete the screen. This form should then be returned to me in the envelope provided or completed with me. The outcome about if you do or do not meet the criteria will be discussed with you then. The information on this sheet will be then destroyed or returned to you.

Question	Yes	No	Don't know/NA/do not wish to answer
I am aged between 16-60			
I have a confirmed diagnosis of autism or Asperger's Syndrome i.e., within a professional report			
I have a learning disability * * Learning disabilities do not include dyslexia, dyscalculia these are learning difficulties			
I attended mainstream education			
I have mental health problems			
Currently my mental health effects my ability to concentrate on things			
Currently my mental health is affecting my physical wellness			

Currently my mental health is affecting my participation in daily tasks to the extent that I need help from others			
I feel my mental health will negatively affect my ability to complete the tests in the research			
I am registered disabled based on my physical health			
I take medication that negatively effects my functioning			

Please state anything else about yourself that may affect your ability to complete the tests
Any other comments

Thank you for your time completing this screen.

Michelle Turner

Autistic group- Criteria Screen

TITLE OF RESEARCH STUDY: Understanding Ideation in Autism

This screen will help me check if you have any mental or physical health needs or learning disability that could exclude you from the study. This screen will also make sure you are **not autistic**. Please read through the following questions and complete the screen. This form should then be returned to me in the envelope provided or given in person to me. The outcome about

if you do or do not meet the criteria will be discussed with you within 2 days. The information on this sheet will be stored securely.

Please state your age_____

Question	Agree	Do not agree	Don't know/NA/do not wish to answer
My identified gender at birth was Male			
I **do not** have a diagnosis of autism or Asperger's Syndrome nor am I being assessed for autism			
I **do not** have a learning disability *Learning disabilities do not include dyslexia, dyscalculia these are learning difficulties			
I attended mainstream education			
I have mental health problems			
Currently my mental health effects my ability to concentrate on things			
Currently my mental health is affecting my physical wellness			
Currently my mental health is affecting my participation in daily tasks to the extent that I need help from others			
I feel my mental health will negatively affect my ability to complete the tests in the research (please refer to participant information sheet for details on the tests).			
I am registered disabled based on my physical health			

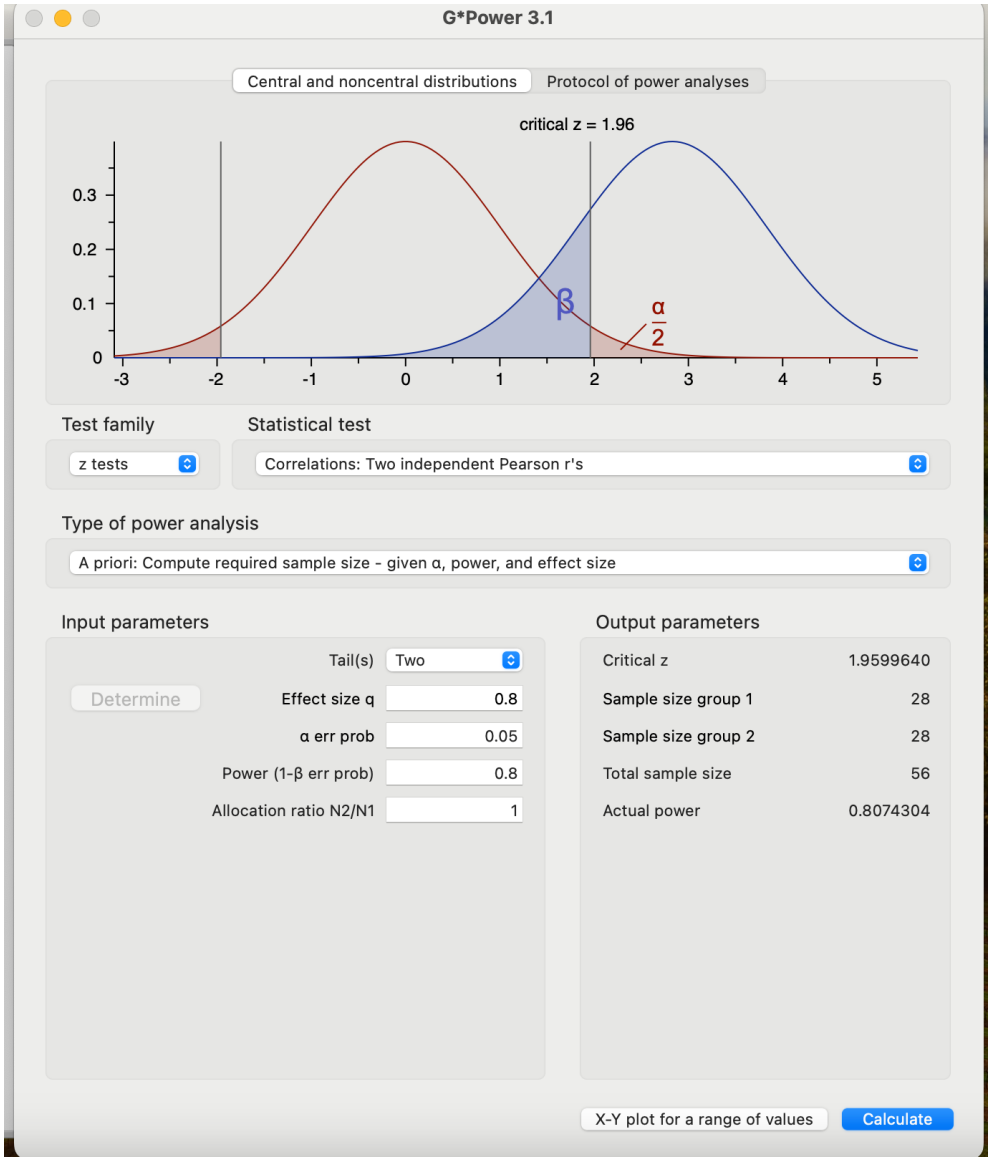
I take medication that negatively effects my functioning			

Please state anything else about yourself that may affect your ability to complete the tests
Any other comments

Thank you for your time completing this screen. Please return to me.

Michelle Field
05 February 2023

Appendix M- Power calculation of sample size



Appendix N- Autisitc Group Participation Information Sheet

Sheffield Hallam University

Would you like to participate in my study?

Ideation is the mental process of generating or conceiving of ideas and concepts that may be useful for attaining some desired state or outcome. This study is titled 'Understanding Ideation and Autism'.

You have been invited to participate because you have a diagnosis of autism and do not have a learning disability, severe mental or physical health condition and are over the age of 16.

This study aims to investigate the link between abilities in attention and memory and ideation and also the link between ideation and autistic traits.

This study would involve participation in:

- 1 assessments of ideation
- 1 assessment of memory
- 1 assessment of attention
- Self-completion of The Adult Autism Spectrum Quotient, a self-questionnaire.

Participation in all of the above assessments is expected to take about 1.5 - 2 hours. Participation will take place in private (with myself) at NAME OF CHARTY at a time chosen by you. Participation can be completed over 1, 2 or 3 sessions.

The results of these tests will only be used to form correlations in the above areas. You will not receive your personal results from the tests. The results will not include personal and/or identifiable data. You do not need to provide your name, however, will need to state your age (within age groups) and ideally the sex you identify with.

This information will be stored securely within Sheffield Hallam University and by myself, Michelle Field. No identifiable data will be stored. Because identifiable data is not required the results of the assessments will not be available.

Participation is voluntary; you are free to withdraw at any time. Once you have completed the assessments the data is entered into a database and any identifiable information is removed, therefore withdrawal of your results will not be possible once this has occurred.

These research results will be published and will also be presented within a viva. This research will enable greater understanding of ideation in autism. This research will also enable therapists and other relevant professionals to develop intervention approaches.

This research is funded partly by Humber Foundation Trust and by the Elizabeth Casson Trust (via College of Occupational Therapy).

As a reward for your time and effort you will be given a confectionery gift courtesy of Hider Foods.

Please contact me for any further information via email on:-
michelleturner800@icloud.com or telephone on 01482 336740.
I will also be available for a chat on Thursday evening's club throughout May 2016.

My supervisor's details are: Dr Alex McClimens and Dr Lisa Reidy, Sheffield Hallam University, Health and Wellbeing Research Institute - Postgraduate Research Centre Sheffield Hallam University, Chestnut Court - Room S006, Collegiate Crescent, Sheffield, S10 2BP, Telephone: +44 (0)114 225 2347.

Sheffield Hallam University

Control Groups - Participant information sheet

Would you like to participate in my study?
Understanding Ideation in Autism

Introduction

Ideation is the mental process of generating or conceiving of ideas and concepts. Ideation is an essential function in everyday life. This study aims to better understand autistic ideation by investigating the link between abilities in attention, memory and ideation and also the link between ideation and autistic traits. Part one of the study has already been completed. This involved a correlational study whereby 20 autistic men participated in tests that measure memory, attention, autistic traits and ideation. The results provided an insight into how ideation maybe different in autistic people. This second part of the study will involve doing the same tests on a control group (who do not have autism) to understand how the results of both groups compare.

Why have you asked me to take part?
You have been invited to participate to act as part of a control group because you **do not** have a diagnosis of autism and do not have a learning disability, a severe mental or physical health condition and are over the age of 16.

Do I have to take part?
Participation is entirely voluntary.

What will I be required to do?

You would be required to participate in four tests which I will administer on a one-to-one basis. They include a test of memory, a test of attention, a test of ideation and completion of an autism screening tool (self-questionnaire). All tests are validated, giving assurance that the tests are able to accurately measure attention, memory, ideation and autistic traits. The tests are mainly desk top tasks that involve answering questions verbally. These tasks are not physically strenuous.

Where and when will this take place?

The tests will take place at a mutually convenient time during February- April 2023 on NHS premises. I have identified suitable rooms in several sites across [name of trust] so we can use one that is convenient for you.

How often will I have to take part, and for how long?

I expect that it will take approximately 1.5 – 2 hours to complete all the tests. We can arrange to do the tests over two shorter sessions if that's easier for you.

What are the possible benefits of taking part?
Through participating in this study, you are supporting research that aims to better understand ideation in autism. This understanding can help people with autism and those who support them have better insight into their strengths and needs. You may also find it interesting to take part and learn about how psychological tests are carried out.

When will I have the opportunity to discuss my participation?

You can contact me using the details below to discuss the study to help you to decide if you would like to participate in the study. Both my phone number and email address are listed below.

Will anyone be able to connect me with what is recorded and reported?
No, the results of these tests will only be used to complete analysis on your scores compared to others. Because the scores used do not include any personal and/or identifiable data the results cannot be traced back to you. To participate in the study, you only need to state your name, age and the sex you identify with once on the consent forms, not the test records. The consent forms will have a unique number to act as an identifier, this number will be used on the test forms.

Who will have access to the test results?

The individual results of the tests will be accessed by myself and shared with my supervisory team. The test results are recorded on score forms that do not contain identifiable data.

What will happen to the information collected for the study?

During the research the consent forms and test booklets will be stored securely within a locked filing cabinet within an NHS premises. I will maintain responsibility for the safe keeping of this data. The data files containing the tests scores and the results from analysis (this does not include any identifiable data) will be stored on a secure SHU site file. Following the research both the consent forms and the test sheets will be stored and archived at SHU. The numerical research data will be saved and stored within SHURDA.

How will you use what you find out?

The test results from the control group will be analysed and statistical tests will be used to compare the scores for the control group and the autistic participants The findings of the study will contribute to a doctoral thesis. All successfully completed theses are electronically uploaded to SHU research archive and freely available. The results of the study will also be included in a journal article submitted for publication.

How long is the whole study likely to last?

This research is expected to continue for 3 months (February-April 2023).

How can I find out about the results of the study?

If you would like a summary of the results this can be provided on request. This thesis will be available via SHURA.

The University undertakes research as part of its function for the community under its legal status. Data protection allows us to use personal data for research with appropriate safeguards in place under the legal basis of **public tasks that are in the public interest.** A full statement of your rights can be found at: www.shu.ac.uk/about-this-website/privacy-policy/privacy-notices/privacy-notice-for-research. All University research is reviewed to ensure that participants are treated appropriately, and their rights respected. This study was approved by UREC with Converis number ER50153302; Further information at: www.shu.ac.uk/research/excellence/ethics-and-integrity

This research is funded partly by Humber Teaching NHS Foundation Trust and by the Elizabeth Casson Trust (via College of Occupational Therapy).

Researcher/ Research Team Details:

Please contact me for any further information via email on:-
Michelle.turner@student.shu.ac.uk or telephone on 01482 336740.

My supervisors' details are: Dr Hilary Piercy and Dr Jon Painter, Sheffield Hallam University, Health and Wellbeing Research Institute - Postgraduate Research Centre Sheffield Hallam University, Chestnut Court - Room S006, Collegiate Crescent, Sheffield, S10 2BP, Telephone: +44 (0)114 225 2347.

You should contact the Data Protection Officer if:	**You should contact the Head of Research Ethics (Dr Mayur Ranchordas) if:**
• you have a query about how your data is used by the University • you would like to report a data security breach (e.g. if you think your personal data has been lost or disclosed inappropriately) • you would like to complain about how the University has used your personal data DPO@shu.ac.uk	• you have concerns with how the research was undertaken or how you were treated ethicssupport@shu.ac.uk

Postal address: Sheffield Hallam University, Howard Street, Sheffield S1 1WBT Telephone: 0114 225 5555

Appendix O- Withdrawal letter

Dear Michelle Turner

In regard to the research ‘understanding Autism and ideation’ completed by you, Michelle Turner I wish to withdraw my participation and for all of my data to be withdrawn. I understand that data can only be withdrawn up until the point of analysis.

Name:

Signature:

Date

Appendix P- Participant consent form

Sheffield Hallam University

PARTICIPANT CONSENT FORM

TITLE OF RESEARCH STUDY: Understanding Ideation in Autism

Please answer the following questions by ticking the response that applies

		YES	NO
1.	I have read the Information Sheet for this study and have had details of the study explained to me.	☐	☐
2.	My questions about the study have been answered to my satisfaction and I understand that I may ask further questions at any point.	☐	☐
3.	I understand that I am free to withdraw from the study within the time limits outlined in the Information Sheet, without giving a reason for my withdrawal.	☐	☐
4.	I agree to provide information to the researchers under the conditions of confidentiality set out in the Information Sheet.	☐	☐
5.	I wish to participate in the study under the conditions set out in the Information Sheet.	☐	☐
6.	I consent to the information collected for the purposes of this research study, once anonymised (so that I cannot be identified), to be used for any other research purposes.	☐	☐

Participant's Signature: _____ Date: _____

Participant's Name (Printed): _____

Participants age_____

Contact details: _____

Researcher's Name (Printed): _____

Researcher's Signature: _____

Researcher's contact details:
Michelle Field
01482 33670

Michelle.turner@student.shu.ac.uk

Please keep your copy of the consent form and the information sheet together

Appendix Q- Reflexivity -Influence on recruitment process

Having worked in autism for over 14 years I thought my understanding and communication skills in this field were adept however on the first visit to the charity I quickly realised how my personality and keenness to recruit participants actually presented as over enthusiasm, which with a group who can struggle with social anxiety and shyness could have heightened anxieties. Through reflection I became mindful that the potential participants were attending a club whereby they have built up trust that this is a socially 'safe' place, the wrong approach might have influenced how they felt about attending the club but also could have pressured socially vulnerable adults into agreeing to participate. Following these reflections, I made time to attend the club, more in the role of a member, joining in computer games, looking through artwork, etc. Getting to know the club members provided me with valuable insight into their interests, strengths, and levels of social skill/anxiety- this information was used to ensure that they felt relaxed and willing to participate in the tests. Time spent getting to know the participants enabled me to ask members what they would like to know about the study, ensuring that the information provided about the study was appropriate to each person, improving the consent and participation process.

In regard to my reflexivity on how I may influence the research, many of the participants knew my position as the lead for diagnostic services and I wondered if this would influence participation- one person did refuse participation as he questioned his own

diagnosis. I naturally have a ‘laid back’ leadership style and I was able to bring in personality attributes appropriate for ‘out of work’ situations whilst maintaining necessary boundaries, examples being, use of humour, talking about personal interests. I also dressed casually. Therefore, should any of the participants need support from the service in which I work they would still view me in a professional capacity.

Appendix R - Ethical Approval Letter

22nd Jan 2021

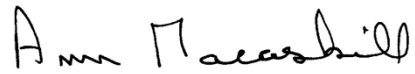
Dear Michelle,

Re: D Prof Ethics: "Understanding ideation and autism" by Michelle Field

Many thanks for getting in touch about the ethics approval for your Professional Doctorate Thesis and the missing approval letter. Due to Covid lockdown of buildings, and the packing up of offices, the paper files from when you applied are unavailable and the old files have not been transferred to the online system yet.

We have examined the approval system for the Professional Doctorate and your ethics proforma had to be submitted with your DPS1 and reviewed by the same team. We have reviewed all of the documentation, which included the reviewers comments on your ethics application and your satisfactory response to them so it is clear that the correct procedure was followed and you passed the DPS1. I can thus confirm that ethics approval was given for your study your titled "Understanding ideation and autism." This will serve as a replacement letter.

Yours sincerely,



Professor Ann Macaskill

Head of Research Ethics

Sheffield Hallam University

07/03/2023

Dear MICHELLE

Title of Ethics Review: Understanding Ideation in Autism
Ethic Review ID: ER50153302

The University has reviewed your ethics application named above and can confirm that the project has been approved.

The following advisory amendments were suggested, which you may wish to address:

I can see that this proposal is a follow on 'control group' data collection study to measure against previous IRAS and FREC approved study with a client population

The forms and completion of the submission all seem to be in order but as this is a study collecting data from a range of participants, some of whom are within the workplace of the researched I would have thought that there would be a letter of approval from the workplace to undertake data collection in this venue?

Otherwise I am happy for the researcher to proceed.

If this is a second resubmission, the Lead reviewers comments will appear below:

You are expected to deliver the project in accordance with the University's research ethics and integrity policies and procedureshttps://www.shu.ac.uk/research/ethics-integrity-and-practice.

As the Principal Investigator you are responsible for monitoring the project on an ongoing basis and ensuring that the approve documentation is used. The project may be audited by the University during or after its lifetime.

Should any changes to the delivery of the project be required, you are required to submit an amendment for review.

If you have a query regarding your application, please contact your Faculty Ethics Administrator in the first instance.

HWB - hwbethics@shu.ac.uk
STA - STAfrec@shu.ac.uk
SBS - sbsethics@shu.ac.uk
SSH - SSH-ResearchEthics@shu.ac.uk

Wishing you success with your study

Kind regards,
Ethics Research Support

Appendix S- Data management plan

Data Management Plan

Understanding Ideation in Autism

1. What data will you collect or create?

The subjects will participate in 4 tests that will test memory, attention, ideation and autistic traits. The scoring is completed on test forms. These tests will produce **numerical data** that will not enable identification of the participants. The scores will then be transferred and saved on spreadsheets that will not use names, specific ages, or dates of birth. These spread sheets will be easy for others to understand. The consent forms will contain **names and ages**, these forms will be stored securely within a secure NHS building then following research archived by SHU.

2. How will your data be documented and described?

The only identifiable data will be the names, sex and ages placed on the **consent forms**. Unique ID numbers will be assigned to participants and used for all data collection. The **test sheets** mainly contain numerical data. Within the documentation of test results the scoring uses age brackets; no single identifiable age is documented. Sex of the participants will be disclosed within the results, but this will not be linked to participant names. The final part of the study requires the participant or to complete a questionnaire about the autistic traits, although this will generate descriptions of the traits the unique ID, not names will be used within the recording and reporting of results. These codes will be used to enable numerical analysis; again, no indefinable data will be documented within results. The numerical data will be placed into **SPSS**.

3. How will your data be structured, stored, and backed up?

During the research the data will be saved on the on the SHU Q drive. Written information including the consent forms and test forms will be placed in a secure locked cabinet within a secure NHS building, following research this will be archived by SHU. Electronic data will be stored by the date of analysis and ref to data set i.e., 22/06/20 Memory/attention.

4. How will you manage any ethical issues?

The study will not commence until it has received SHU ethical approval

5. What are your plans for data sharing after submission of your thesis?

The thesis will be available electronically via SHURA. A journal article reporting the study findings will be submitted for publication.

6. What are your plans for the long-term preservation of data supporting your research?

Following completion of the research the forms will be stored and archived at SHU. The SPSS calculations (anonymous) will be saved and stored within SHURDA.

Michelle Field
12 February 2023

Appendix T - All results data

Correlations control																					
			TIP	TEA2	TEA4A	TEA4B	TEA7	TEA8	AQIM	AQAS	TIPREP	TIPCHA	RBMTGMI	RMBTVERBA	RBMTVISUAL	RBMTSPATIA	RMBTPRO	RMBTNL	RMBTDE.REC	RMBTDE.REC	RMBTIM.REC
Spearman's r	TIP	Correlation C	1	0.305	0.094	.756**	0.127	0.412	-.770**	-.610**	-.761**	-0.396	.636**	.576**	0.176	0.236	.499*	0.346	0.176	0.176	.576**
		Sig. (2-tailed)	.	0.191	0.694	0	0.592	0.071	0	0.004	0	0.084	0.003	0.008	0.457	0.318	0.025	0.135	0.458	0.457	0.008
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	TEA2	Correlation C	0.305	1	0.148	0.112	0.395	.511*	-0.236	-.590**	-0.317	-0.341	.450*	0.365	0.163	0.254	-0.051	.537*	0.268	0.163	0.415
		Sig. (2-tailed)	0.191	.	0.535	0.638	0.085	0.021	0.317	0.006	0.173	0.141	0.046	0.113	0.492	0.28	0.831	0.015	0.252	0.492	0.068
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	TEA4A	Correlation C	0.094	0.148	1	0.375	0.176	.448*	-0.136	-0.165	-0.034	-.525*	0.33	0.198	0.438	0.287	0.225	0.042	0.156	0.438	0.273
		Sig. (2-tailed)	0.694	0.535	.	0.104	0.458	0.048	0.567	0.487	0.887	0.017	0.156	0.403	0.054	0.22	0.34	0.862	0.511	0.054	0.245
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	TEA4B	Correlation C	.756**	0.112	0.375	1	-0.072	0.353	-.629**	-0.248	-.543*	-0.184	.473*	0.424	0.172	0.308	0.173	0.294	0.183	0.172	0.373
		Sig. (2-tailed)	0	0.638	0.104	.	0.764	0.126	0.003	0.292	0.013	0.438	0.035	0.062	0.468	0.187	0.465	0.209	0.44	0.468	0.105
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	TEA7	Correlation C	0.127	0.395	0.176	-0.072	1	0.264	0.046	-0.156	0.088	-0.183	0.22	0.244	0.431	-0.101	0.059	0.384	-0.007	0.431	0.169
		Sig. (2-tailed)	0.592	0.085	0.458	0.764	.	0.26	0.847	0.511	0.713	0.441	0.351	0.301	0.058	0.672	0.806	0.094	0.976	0.058	0.475
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	TEA8	Correlation C	0.412	.511*	.448*	0.353	0.264	1	-0.287	-.526*	-0.204	-0.399	.600**	0.417	.492*	0.298	0.149	0.094	0.031	.492*	0.323
		Sig. (2-tailed)	0.071	0.021	0.048	0.126	0.26	.	0.22	0.017	0.389	0.081	0.005	0.067	0.027	0.202	0.532	0.695	0.898	0.027	0.165
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	AQIM	Correlation C	-.770**	-0.236	-0.136	-.629**	0.046	-0.287	1	.545*	.696**	0.195	-.594**	-.705**	-0.013	-0.188	-.448*	-0.128	-0.323	-0.013	-.490*
		Sig. (2-tailed)	0	0.317	0.567	0.003	0.847	0.22	.	0.013	0.001	0.41	0.006	0.001	0.958	0.427	0.048	0.591	0.164	0.958	0.028
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	AQAS	Correlation C	-.610**	-.590**	-0.165	-0.248	-0.156	-.526*	.545*	1	.625**	0.406	-.533*	-0.408	-0.172	-0.045	-.467*	-0.246	-0.194	-0.172	-0.424
		Sig. (2-tailed)	0.004	0.006	0.487	0.292	0.511	0.017	0.013	.	0.003	0.076	0.015	0.074	0.47	0.851	0.038	0.296	0.411	0.47	0.062
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	TIPREP	Correlation C	-.761**	-0.317	-0.034	-.543*	0.088	-0.204	.696**	.625**	1	.495*	-.470*	-.447*	0.136	-0.093	-0.301	-0.339	-0.302	0.136	-.590**
		Sig. (2-tailed)	0	0.173	0.887	0.013	0.713	0.389	0.001	0.003	.	0.026	0.036	0.048	0.566	0.695	0.196	0.144	0.196	0.566	0.006
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	TIPCHA	Correlation C	-0.396	-0.341	-.525*	-0.184	-0.183	-0.399	0.195	0.406	.495*	1	-0.416	-0.362	-0.171	-0.217	-0.237	-0.101	-0.204	-0.171	-.618**
		Sig. (2-tailed)	0.084	0.141	0.017	0.438	0.441	0.081	0.41	0.076	0.026	.	0.068	0.116	0.47	0.357	0.314	0.671	0.389	0.47	0.004
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	RBMTGMI	Correlation C	.636**	.450*	0.33	.473*	0.22	.600**	-.594**	-.533*	-.470*	-0.416	1	.780**	.543*	.504*	0.384	.485*	0.42	.543*	.786**
		Sig. (2-tailed)	0.003	0.046	0.156	0.035	0.351	0.005	0.006	0.015	0.036	0.068	.	0	0.013	0.024	0.094	0.03	0.065	0.013	0
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	RMBTVERBA	Correlation C	.576**	0.365	0.198	0.424	0.244	0.417	-.705**	-0.408	-.447*	-0.362	.780**	1	0.151	0.207	0.198	0.268	.487*	0.151	.770**
		Sig. (2-tailed)	0.008	0.113	0.403	0.062	0.301	0.067	0.001	0.074	0.048	0.116	0	.	0.525	0.382	0.403	0.253	0.029	0.525	0
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	RBMTVISUAL	Correlation C	0.176	0.163	0.438	0.172	0.431	.492*	-0.013	-0.172	0.136	-0.171	.543*	0.151	1	0.225	0.393	0.367	0.094	1.000**	0.172
		Sig. (2-tailed)	0.457	0.492	0.054	0.468	0.058	0.027	0.958	0.47	0.566	0.47	0.013	0.525	.	0.34	0.086	0.112	0.694	.	0.468
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	RBMTSPATIA	Correlation C	0.236	0.254	0.287	0.308	-0.101	0.298	-0.188	-0.045	-0.093	-0.217	.504*	0.207	0.225	1	0.049	0.242	0.309	0.225	0.39
		Sig. (2-tailed)	0.318	0.28	0.22	0.187	0.672	0.202	0.427	0.851	0.695	0.357	0.024	0.382	0.34	.	0.838	0.304	0.185	0.34	0.089
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	RMBTPRO	Correlation C	.499*	-0.051	0.225	0.173	0.059	0.149	-.448*	-.467*	-0.301	-0.237	0.384	0.198	0.393	0.049	1	0.112	0.193	0.393	0.258
		Sig. (2-tailed)	0.025	0.831	0.34	0.465	0.806	0.532	0.048	0.038	0.196	0.314	0.094	0.403	0.086	0.838	.	0.639	0.416	0.086	0.272
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	RMBTNL	Correlation C	0.346	.537*	0.042	0.294	0.384	0.094	-0.128	-0.246	-0.339	-0.101	.485*	0.268	0.367	0.242	0.112	1	0.38	0.367	.465*
		Sig. (2-tailed)	0.135	0.015	0.862	0.209	0.094	0.695	0.591	0.296	0.144	0.671	0.03	0.253	0.112	0.304	0.639	.	0.099	0.112	0.039
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	RMBTDE.REC	Correlation C	0.176	0.268	0.156	0.183	-0.007	0.031	-0.323	-0.194	-0.302	-0.204	0.42	.487*	0.094	0.309	0.193	0.38	1	0.094	0.354
		Sig. (2-tailed)	0.458	0.252	0.511	0.44	0.976	0.898	0.164	0.411	0.196	0.389	0.065	0.029	0.694	0.185	0.416	0.099	.	0.694	0.125
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	RMBTDE.REC	Correlation C	0.176	0.163	0.438	0.172	0.431	.492*	-0.013	-0.172	0.136	-0.171	.543*	0.151	1.000**	0.225	0.393	0.367	0.094	1	0.172
		Sig. (2-tailed)	0.457	0.492	0.054	0.468	0.058	0.027	0.958	0.47	0.566	0.47	0.013	0.525	.	0.34	0.086	0.112	0.694	.	0.468
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	RMBTIM.REC	Correlation C	.576**	0.415	0.273	0.373	0.169	0.323	-.490*	-0.424	-.590**	-.618**	.786**	.770**	0.172	0.39	0.258	.465*	0.354	0.172	1
		Sig. (2-tailed)	0.008	0.068	0.245	0.105	0.475	0.165	0.028	0.062	0.006	0.004	0	0	0.468	0.089	0.272	0.039	0.125	0.468	.
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
** Correlation is significant at the 0.01 level (2-tailed).																					
* Correlation is significant at the 0.05 level (2-tailed).																					

Correlations AUTISTIC

			Test of Ideati	Rivermead M	Test of eve.d	Test of eve.d	Test of eve.d	Test of eve.d	Test of eve.d	AQ Imaginati	AQ Attention	TIP Repeated	TIP Chaning a	all AQ (50 Q.	RBMT.verbal	RBMT.Visual	RBMT.Spatial	RBMT.Prospe	RBMT.New le	RBMT.delaye	RBME.Delaye	RBMT.Immed
Spearman's r	Test of Ideati	Correlation C	1	.555*	-0.167	0.299	0.208	0.352	0.332	-0.085	-0.278	-0.011	0.382	-.556*	.468*	.462*	0.427	.513*	0.227	.546*	.581**	.753**
		Sig. (2-tailed)	.	0.011	0.481	0.2	0.378	0.127	0.153	0.722	0.235	0.965	0.096	0.011	0.037	0.04	0.061	0.021	0.335	0.013	0.007	0
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	Rivermead M	Correlation C	.555*	1	-0.038	-0.144	0.207	.591**	.547*	0.027	-0.279	0.185	0.23	0.071	.756**	.538*	.510*	.618**	.627**	.797**	0.377	.617**
		Sig. (2-tailed)	0.011	.	0.874	0.544	0.38	0.006	0.013	0.91	0.234	0.435	0.329	0.765	0	0.014	0.022	0.004	0.003	0	0.101	0.004
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	Test of eve.d	Correlation C	-0.167	-0.038	1	0.096	-0.139	-0.145	-0.09	0.273	.486*	-0.075	-0.004	0.252	-0.024	0.169	-0.011	-0.112	0.106	-0.131	0.245	-0.038
		Sig. (2-tailed)	0.481	0.874	.	0.687	0.558	0.543	0.706	0.244	0.03	0.752	0.988	0.283	0.92	0.477	0.963	0.638	0.657	0.583	0.298	0.874
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	Test of eve.d	Correlation C	0.299	-0.144	0.096	1	0.369	-0.016	0.085	0.084	-0.224	-0.212	0.151	-0.394	-0.111	0.07	0.201	0.063	0.092	0.126	0.233	0.187
		Sig. (2-tailed)	0.2	0.544	0.687	.	0.109	0.945	0.721	0.726	0.342	0.37	0.526	0.086	0.642	0.77	0.395	0.791	0.698	0.598	0.322	0.431
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	Test of eve.d	Correlation C	0.208	0.207	-0.139	0.369	1	.461*	0.393	0.076	-0.193	0.159	.488*	0.075	0.126	0.229	.559*	.570**	0.388	.451*	0.119	0.379
		Sig. (2-tailed)	0.378	0.38	0.558	0.109	.	0.041	0.086	0.751	0.415	0.503	0.029	0.753	0.597	0.332	0.01	0.009	0.091	0.046	0.618	0.1
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	Test of eve.d	Correlation C	0.352	.591**	-0.145	-0.016	.461*	1	0.216	-0.219	-0.195	-0.045	0.313	-0.093	.518*	0.405	0.268	.540*	0.347	.552*	0.18	0.353
		Sig. (2-tailed)	0.127	0.006	0.543	0.945	0.041	.	0.36	0.355	0.41	0.852	0.178	0.696	0.019	0.077	0.254	0.014	0.134	0.012	0.447	0.127
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	Test of eve.d	Correlation C	0.332	.547*	-0.09	0.085	0.393	0.216	1	0.096	-0.249	0.046	0.231	0.349	0.327	0.137	.645**	.552*	.677**	.669**	0.174	.579**
		Sig. (2-tailed)	0.153	0.013	0.706	0.721	0.086	0.36	.	0.688	0.29	0.847	0.328	0.132	0.16	0.565	0.002	0.012	0.001	0.001	0.464	0.007
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	AQ Imaginati	Correlation C	-0.085	0.027	0.273	0.084	0.076	-0.219	0.096	1	-.491*	0.219	0.125	0.204	0.141	-0.081	0.192	0.14	-0.021	-0.077	-0.054	0.143
		Sig. (2-tailed)	0.722	0.91	0.244	0.726	0.751	0.355	0.688	.	0.028	0.355	0.6	0.388	0.553	0.736	0.418	0.557	0.932	0.747	0.822	0.548
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	AQ Attention	Correlation C	-0.278	-0.279	.486*	-0.224	-0.193	-0.195	-0.249	-.491*	1	0.072	-0.033	0.293	-0.32	-0.047	-0.298	-0.301	-0.029	-0.262	-0.071	-0.338
		Sig. (2-tailed)	0.235	0.234	0.03	0.342	0.415	0.41	0.29	0.028	.	0.762	0.89	0.211	0.169	0.843	0.201	0.197	0.903	0.264	0.765	0.145
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	TIP Repeated	Correlation C	-0.011	0.185	-0.075	-0.212	0.159	-0.045	0.046	0.219	0.072	1	0.304	0.295	0.057	-0.281	0.032	0.142	0.158	0.024	-0.28	0.085
		Sig. (2-tailed)	0.965	0.435	0.752	0.37	0.503	0.852	0.847	0.355	0.762	.	0.192	0.207	0.812	0.23	0.894	0.551	0.507	0.92	0.232	0.721
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	TIP Chaning a	Correlation C	0.382	0.23	-0.004	0.151	.488*	0.313	0.231	0.125	-0.033	0.304	1	0.01	0.159	0.176	.623**	0.374	0.093	0.383	0.024	0.32
		Sig. (2-tailed)	0.096	0.329	0.988	0.526	0.029	0.178	0.328	0.6	0.89	0.192	.	0.968	0.504	0.457	0.003	0.105	0.697	0.095	0.919	0.169
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	all AQ (50 Q.	Correlation C	-.556*	0.071	0.252	-0.394	0.075	-0.093	0.349	0.204	0.293	0.295	0.01	1	0.074	-0.207	0.158	0.207	0.421	0.122	-0.399	-0.08
		Sig. (2-tailed)	0.011	0.765	0.283	0.086	0.753	0.696	0.132	0.388	0.211	0.207	0.968	.	0.757	0.382	0.506	0.381	0.065	0.608	0.081	0.737
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	RBMT.verbal	Correlation C	.468*	.756**	-0.024	-0.111	0.126	.518*	0.327	0.141	-0.32	0.057	0.159	0.074	1	0.159	0.431	.691**	.503*	.740**	0.07	.702**
		Sig. (2-tailed)	0.037	0	0.92	0.642	0.597	0.019	0.16	0.553	0.169	0.812	0.504	0.757	.	0.503	0.058	0.001	0.024	0	0.769	0.001
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	RBMT.Visual	Correlation C	.462*	.538*	0.169	0.07	0.229	0.405	0.137	-0.081	-0.047	-0.281	0.176	-0.207	0.159	1	0.383	0.285	0.234	0.356	.780**	0.25
		Sig. (2-tailed)	0.04	0.014	0.477	0.77	0.332	0.077	0.565	0.736	0.843	0.23	0.457	0.382	0.503	.	0.096	0.224	0.321	0.123	0	0.288
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	RBMT.Spatial	Correlation C	0.427	.510*	-0.011	0.201	.559*	0.268	.645**	0.192	-0.298	0.032	.623**	0.158	0.431	0.383	1	.607**	.453*	.687**	0.259	.588**
		Sig. (2-tailed)	0.061	0.022	0.963	0.395	0.01	0.254	0.002	0.418	0.201	0.894	0.003	0.506	0.058	0.096	.	0.005	0.045	0.001	0.27	0.006
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	RBMT.Prospe	Correlation C	.513*	.618**	-0.112	0.063	.570**	.540*	.552*	0.14	-0.301	0.142	0.374	0.207	.691**	0.285	.607**	1	.586**	.748**	0.164	.774**
		Sig. (2-tailed)	0.021	0.004	0.638	0.791	0.009	0.014	0.012	0.557	0.197	0.551	0.105	0.381	0.001	0.224	0.005	.	0.007	0	0.489	0
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	RBMT.New le	Correlation C	0.227	.627**	0.106	0.092	0.388	0.347	.677**	-0.021	-0.029	0.158	0.093	0.421	.503*	0.234	.453*	.586**	1	.747**	0.14	.528*
		Sig. (2-tailed)	0.335	0.003	0.657	0.698	0.091	0.134	0.001	0.932	0.903	0.507	0.697	0.065	0.024	0.321	0.045	0.007	.	0	0.556	0.017
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	RBMT.delaye	Correlation C	.546*	.797**	-0.131	0.126	.451*	.552*	.669**	-0.077	-0.262	0.024	0.383	0.122	.740**	0.356	.687**	.748**	.747**	1	0.188	.677**
		Sig. (2-tailed)	0.013	0	0.583	0.598	0.046	0.012	0.001	0.747	0.264	0.92	0.095	0.608	0	0.123	0.001	0	0	.	0.427	0.001
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	RBME.Delaye	Correlation C	.581**	0.377	0.245	0.233	0.119	0.18	0.174	-0.054	-0.071	-0.28	0.024	-0.399	0.07	.780**	0.259	0.164	0.14	0.188	1	.475*
		Sig. (2-tailed)	0.007	0.101	0.298	0.322	0.618	0.447	0.464	0.822	0.765	0.232	0.919	0.081	0.769	0	0.27	0.489	0.556	0.427	.	0.034
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	RBMT.Immed	Correlation C	.753**	.617**	-0.038	0.187	0.379	0.353	.579**	0.143	-0.338	0.085	0.32	-0.08	.702**	0.25	.588**	.774**	.528*	.677**	.475*	1
		Sig. (2-tailed)	0	0.004	0.874	0.431	0.1	0.127	0.007	0.548	0.145	0.721	0.169	0.737	0.001	0.288	0.006	0	0.017	0.001	0.034	.
		N	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20

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

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

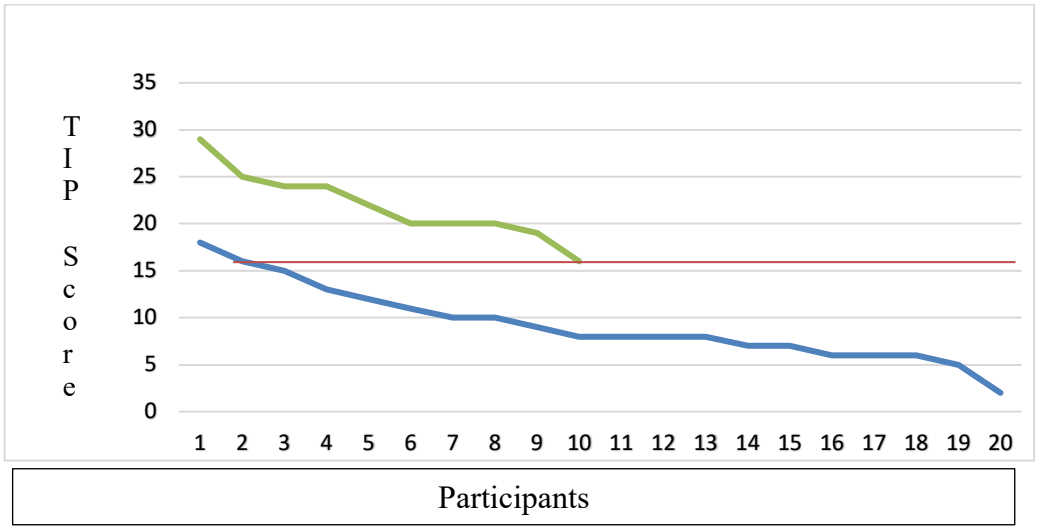
Appendix U- Results compared to normative test results

TIP participant's results and TIP normative data

18 of 20 autistic participants' TIP scores were below a 15.3 cut-off. This cut-off score is used to indicate ideational dysfunction in 8-year-olds (May-Benson, T. A. & Cermak, 2007).

All autistic participants' scores were lower than those of the non-autistic participants in the TIP pilot (Figure A). The neurotypical participants in the pilot test scored a mean of 21.9 with SD 3.69. All autistic participants scored below the pilot group mean. The autistic group's mean was 9.25, with an SD of 3.9. The histogram of results in the TIP showed good sample distribution.

Figure A *TIP scores from study and pilot test*



Blue line = Study Participants TIP score

Grey line = TIP Pilot (not autistic) TIP score

Red line = TIP cuff for ideational dysfunction in 8-year old's

TEA autistic participants' results and TEA normative data

The TEA scores achieved by the autistic participants were compared to the normative scores (Table A). None of the autistic participants' scores reached the normative ceiling point. Results show that some autistic participants scored lower than the normative mean in some subtests but above the normative mean in others. This is discussed in Chapter 6 (6.2.1). The scores showed that few participants scored within the normal range, supporting that this group reflects the difficulties in attention found in other autism research (as discussed in Chapter 2, 2.4.5.3).

***Table A**, Percentage of participants who scored above, below or average compared to TEA normative means.*

Sub Test of TEA	average	below average	above average
Sub test 4a	5%	50%	45%
Sub test 4b	15%	20%	65%
Sub test 7	5%	55%	40%
Sub test 8	20%	50%	30%

RBMT-3 autistic participants results and RBMT normative data

When comparing the autistic participants' RBMT-3 scores to the RMBT-3 normative data (Table B), the results supported the finding that autistic memory profiles have peaks and troughs in ability across test items, as seen in (Jambaqué et al., 2007; Kazui et al., 2005; Wilson, Barbara A. & Ivani-Chalian, 1995). The memory deficits noted within the study mirror findings of other autism studies that have used the RBMT-3 (Boucher, J., 1988; Habib, Abdullah et al., 2019; Kercood et al., 2014b; Millward et al., 2000; Wang, Y. et al., 2017).

Table B *Percentage of participants who scored above, below or average compared to RBMT-3 norms.*

Subtest of RBMT-3	average	below average	above average
Verbal Memory	10%	65%	25%
Visual Memory	20%	60%	20%
Spatial Memory	0%	40%	60%
Prospective Memory	20%	60%	20%
New Learning	0%	45%	55%

When evaluating the memory scores against the standardised percentiles, six participants scored below the 5th percentile. Of these low scores, most of them linked to tests of delayed recall (61%) as opposed to immediate recall (33%) and delayed recognition (6%). This is discussed further in Chapter 6, 6.2.2, in relation to association in memory recall.

AQ autistic participants results and AQ normative data

The AQ total mean for the autistic group (25.92) was lower than the mean from the autistic sample used within the AQ validity studies (35.8) but higher than the means from the non-autistic sample (16.4) noted within the AQ validity study (Table C) (Baron-Cohen et al., 2001)

The mean of the autistic participants' AQ-Imagination scores (mean 4) was lower than the normative AQ data for the autistic sample (mean 6.4) and the non-autistic sample (mean 2.3) (Baron-Cohen, et al., 2001). The mean of the participant's AQ-attention switching scores (mean 6.1) was lower than the normative AQ data for the autistic sample (mean 8) but higher than the non-autistic sample (mean 3.9)

(Baron-Cohen, et al., 2001). The significance of this on the generalisability of the result is discussed in Chapter 6, 6.6.1.

Table C *Raw data from TIP and AQ*

	Study autistic participants' AQ mean	**AQ Normative autism mean**	**AQ Normative non-autistic mean**
AQ total	25.92	35.8	16.4
AQ imagination	4	6.4	2.3
AQ attention Switching	6.1	8	3.9