

Neuropsychological profiles of children and adolescents with selective eating in the presence or absence of elevated autistic traits

Charlotte A. L. Mawbey

June, 2014

Submitted in partial fulfilment of the requirements for the degree of Doctor in Clinical Psychology (DClinPsy), Royal Holloway University of London.

ACKNOWLEDGMENTS

I would first like to thank my supervisors Dr Kate Theodore, Dr Beth Watkins and Dr Fay Murphy for their trust, support, knowledge and understanding throughout. Thank you for taking the time to listen to my ideas, to read my drafts and for your support through the thesis-related and not-so-thesis-related aspects of the journey.

My sincerest gratitude also to Dr Rachel Bryant-Waugh and members of the specialist feeding team where data was collected, for their unwavering encouragement and enthusiasm for this research and assisting with recruitment.

I would also like to thank the Ravello team, most notably Dr Ian Frampton, for contributing your thoughts and reading my drafts. Also, thanks to Lucy Watson for being my 'go-to' Ravello person. I would also like to thank Dr Naomi Dale for sharing her neuropsychology expertise with me during the interpretation of the results.

On a personal note, I would like to thank my family for their love, support and for always taking such delight in my achievements. To my Mum Valerie, Dad John and Brother Nicholas, I truly appreciate all you have done to be there for me. Thank you also to Nanny Muke, Auntie Sylvie and Uncle Gerald, while you may not have been there in person through this particular journey, you have been in my thoughts throughout.

Thank you also to the rest of my family and friends who have provided such love and encouragement. With particular mentions to Daniel, Meena and Grandma Santaben, whose love and faith did not go unnoticed and should not be left unmentioned.

Last, but by no means least, I would like to thank the young people and their families for participating in this research, without whom this would not have been possible. I hope that this brings us one step closer to beginning to understand selective eating.

ABSTRACT

Selective eating (SE) refers to an individual narrowing their range of preferred foods, resulting in a restricted food intake, high levels of rigidity and food refusal (Bryant-Waugh, 2000). SE is encompassed in the new Diagnostic and Statistical Manual of Mental Disorders 5th Edition (DSM-V) (American Psychiatric Association, 2013) category avoidant restrictive food intake disorder (ARFID). Such difficulties are common in children with an autism spectrum disorder (ASD) (Raiten & Massaro, 1986) and neuropsychological differences have been found in children with ASD (Hill, 2004). This research aimed to be the first to investigate whether a distinct neuropsychological profile exists in children and adolescents with SE and furthermore, whether aspects of the profile vary depending on whether the child or adolescent displays elevated autistic traits. A case series of 10 children between the ages of 8 to 13 years old were recruited. A well-established neuropsychological test battery, the Ravello Profile (Rose, Frampton & Lask, 2012), was modified and administered to assess visuospatial processing, central coherence, executive functions (including cognitive flexibility, inhibition and planning) and theory of mind abilities. The results demonstrated a high degree of variability across the group in terms of visuospatial processing and theory of mind, weak central coherence across all participants and otherwise relatively intact abilities in executive function domains. There were no substantive findings in relation to those children with elevated autistic traits although a trend toward visuospatial processing differences did emerge. This exploratory case series was the first attempt to describe a neuropsychological profile in SE, however the small sample size and high variability in the data meant that a distinct neuropsychological profile did not emerge. The results did however provide an initial indication of possible trends in strengths and weaknesses across neuropsychological domains in SE. These findings have implications for the assessment and treatment of SE difficulties.

LIST OF TABLES

TABLE 1 – Children’s Eating Behaviour Questionnaire parent-rated feeding behaviour	37
TABLE 2 – Demographic information and psychometric comorbidity scores.....	38
TABLE 3 – Test order of measures administered to child participants	49
TABLE 4 – Test order of measures administered to parents of participants	50
TABLE 5 – Descriptive statistics across executive function tasks	76
TABLE 6 – Frequencies of participants falling below, within or above 1sd from the mean.....	91

LIST OF FIGURES

FIGURE 1 – Diagnostic criteria for Avoidant Restrictive Food Intake Disorder	36
FIGURE 2 – Ravello Profiles across all participants	74
FIGURE 3 – Order of construction index and style index scores across participants.....	75
FIGURE 4 – Completion time and number of errors T scores on the letter-number sequencing condition of the Trail Making test.....	77
FIGURE 5 – T Scores for the number of errors produced on the Brixton task	78
FIGURE 6 – T scores for performance across on the category switching condition of the Verbal Fluency test	79
FIGURE 7 – T scores on the Hayling task.....	79
FIGURE 8 – Performance across Hayling sections.....	80
FIGURE 9 – Colour-word interference task T scores on inhibition and inhibition/switching conditions.....	81
FIGURE 10 – Total achievement T scores across participants	82
FIGURE 11 – T scores on the Behaviour Rated Inventory of Executive Function	83
FIGURE 12 – Error rates across the reading the mind in the eyes task	83
FIGURE 13 – Domain raw scores for oral sensory sensitivity on the Sensory Profile.....	84
FIGURE 14 – Composite Z scores across each domain.....	85
FIGURE 15 – Rey-Osterrieth Complex Figure profiles in participants with low autistic traits	87
FIGURE 16 – Rey-Osterrieth Complex Figure profiles in participants with elevated autistic traits.....	87
FIGURE 17 – Frequency of memory profile patterns in participants	88
FIGURE 18 – Cumulative percentile ranges for raw scores on the copy of the Rey-Osterrieth Complex Figure	89
FIGURE 19 – Behaviour Rated Inventory of Executive Function scores across participants with low autistic traits	92
FIGURE 20 – Behaviour Rated Inventory of Executive Function scores across participants with elevated autistic traits	92
FIGURE 21 – Performance on the M&M false belief task across participants with low autistic traits and elevated autistic traits	93

CONTENTS

1.0 INTRODUCTION.....	10
1.1 Introduction to selective eating	10
1.2 Diagnosis and classification of selective eating	11
1.2.1 The diagnostic conundrum	11
1.2.2 DSM-V: the introduction of avoidant restrictive food intake disorder.....	12
1.3 Clinical presentations in selective eating.....	13
1.4 Consequences of selective eating	14
1.4.1 The course of selective eating	14
1.4.2 Physical difficulties associated with selective eating	14
1.4.3 Psychological factors associated with selective eating.....	15
1.4.4 Parental factors associated with selective eating	17
1.5 Prevalence and demographic information	18
1.5.1 Prevalence rates	18
1.5.2 Demographic information	19
1.6 Aetiology	20
1.6.1 The role of genetics	20
1.6.2 Environmental explanations	21
1.6.3 Sensory integration theory.....	22
1.7 Treatment of selective eating difficulties	23
1.8 ASD diagnosis and classification	24
1.9 Comparing selective eating difficulties in children with and without ASD	25
1.10 Neuropsychological research.....	26
1.10.1 Visuospatial processing	27
1.10.2 Central coherence	28
1.10.3 Executive function.....	28
1.10.4 Theory of mind	30
1.10.5 Limitations of neuropsychological research.....	31
1.10.6 Development of neuropsychological test batteries.....	31
1.11 Conclusions	32
1.12 Research design	33

1.13 Hypotheses	33
2.0 METHOD.....	35
2.1 Design.....	35
2.2 Ethical approval.....	35
2.3 Participants	35
2.3.1 Inclusion and exclusion criteria.....	35
2.3.2 Participant demographic information	36
2.3.3 Participant clinical information	36
2.4 Measures.....	39
2.4.1 Visuospatial processing	39
2.4.2 Executive functioning.....	41
2.4.3 Emotional theory of mind.....	44
2.4.4 Assessment of autistic traits	45
2.4.5 Sensory sensitivity.....	45
2.4.6 Assessment of feeding.....	45
2.4.7 Cognitive assessment.....	46
2.4.8 Additional measures	46
2.5 Procedure.....	47
2.6 Ethical considerations.....	48
2.7 Quality control in the case series.....	51
2.8 Data analysis strategy	51
3.0 RESULTS.....	53
3.1 Case-by-case analysis.....	53
3.1.1 Participant 1 (P1).....	53
3.1.2 Participant 2 (P2).....	55
3.1.3 Participant 3 (P3).....	57
3.1.4 Participant 4 (P4).....	59
3.1.5 Participant 5 (P5).....	61
3.1.6 Participant 6 (P6).....	63
3.1.7 Participant 7 (P7).....	65
3.1.8 Participant 8 (P8).....	67

3.1.9 Participant 9 (P9).....	69
3.1.10 Participant 10 (P10).....	71
3.2 Analysis of neuropsychological profiles in relation to Hypothesis 1	73
3.2.1 Ravello Profile.....	73
3.2.2 Domain performance	84
3.3 Analysis of autistic traits in relation to Hypothesis 2.....	86
4.0 DISCUSSION	94
4.1 Summary and interpretation of results	94
4.1.1 Visuospatial processing and central coherence	95
4.1.2 Cognitive flexibility.....	96
4.1.3 Inhibition	97
4.1.4 Planning.....	98
4.1.5 Theory of mind.....	99
4.1.6 Sensory processing	99
4.1.7 Summary of findings related to Hypothesis 1	100
4.2 Summary and interpretation of results in relation to Hypothesis 2	100
4.2.1 Visuospatial processing.....	100
4.2.2 Cognitive flexibility.....	101
4.2.3 Other areas of ability	101
4.3 Strengths and Limitations.....	102
4.4 Implications	105
4.5 Future research	107
4.6 Conclusions	108
5.0 REFERENCES.....	110
6.0 APPENDICES.....	129
Appendix 1 – Summary of examples of neuropsychological research.....	129
Appendix 2 – NHS ethical approval letter	130
Appendix 3 – Royal Holloway university of London ethical approval.....	137
Appendix 4 – The Childhood Autism Spectrum Test	138

Appendix 5 – Children’s Eating Behaviour Questionnaire	141
Appendix 6 – Stait-Trait Anxiety Inventory for Children	144
Appendix 7 – Children’s Obsessive Compulsive Inventory	145
Appendix 8 – Children’s Depression Inventory	146
Appendix 9 – Ranges of clinical interpretation across measures	147
Appendix 10 – Wechsler abbreviated scaled of intelligence.....	148
Appendix 11 – The Rey-Osterrieth Complex Figure	149
Appendix 12 – Rey-Osterrieth Complex Figure memory profile patterns	150
Appendix 13 – Trail Making test.....	151
Appendix 14 – Brixton test.....	152
Appendix 15 – Verbal Fluency test.....	153
Appendix 16 – The Hayling Sentence Completion task.....	154
Appendix 17 – Colour Word Interference test	155
Appendix 18 – The Tower of London test	156
Appendix 19 – Behaviour Rating Inventory of Executive Function	157
Appendix 20 – Reading the mind in the eyes task	158
Appendix 21 – The Sensory Profile	159
Appendix 22 – Parent information sheet and consent form	160
Appendix 23 – Child information sheet and assent form	165
Appendix 24 – Visuospatial processing raw data from the Rey-Osterrieth figure	168
Appendix 25 – Central coherence index raw data.....	170
Appendix 26 – Raw data from tests of cognitive flexibility abilities	171
Appendix 27 – Raw data from tests of inhibition abilities	173
Appendix 28 – Raw data for planning abilities	174
Appendix 29 – Theory of mind raw data.....	175
Appendix 30 – Raw data from the Behaviour Rating Inventory of Executive Function ..	176
Appendix 31 – Sensory Profile raw data.....	177
Appendix 32 – Summary of statistical information used in the Z transformation	178
Appendix 33 – Task Z scores contributing to composite domain scores	179
Appendix 34 – Rey-Osterrieth complex figure copy raw scores in low and elevated autistic traits.....	180
Appendix 35 – Executive function statistics across low and elevated autistic traits.....	181

1.0 INTRODUCTION

1.1 Introduction to selective eating

Feeding difficulties are a common cause for concern in childhood, occurring in around 25-35% of typically developing, and in up to 80% of developmentally delayed children (Ahearn, Castine, Nault & Green, 2001). When such difficulties persist and become clinically significant in terms of their impact on everyday functioning and health, they are described as a paediatric feeding disorder (The Diagnostic and Statistical Manual of Mental Disorders 5th Edition (DSM-V), American Psychiatric Association (APA), 2013). This diagnosis encompasses a heterogeneous group of children who show difficulties characterized by features including poor oral intake, selectivity and rigidity in their eating and pocketing of food in their mouths, instead of swallowing (Addison et al., 2012). Feeding disorders have been found to be associated with long-term consequences for physical and socioemotional development (Wright, Parkindon, Shipton & Drewett, 2007; Jacobi, Schmitz, & Agras, 2008) highlighting the importance of understanding such difficulties in childhood. One of the most prevalent feeding difficulties in childhood is selective eating (SE), which has been described as an individual limiting their food intake to a narrow range of preferred foods, resulting in the consumption of a limited variety and refusal to eat certain foods (Bryant-Waugh, 2000). SE has historically been difficult to classify and define and is described as picky eating, food fussiness and food neophobia, leading to a lack of consensus which has contributed to relatively inconsistent and sparse research in this area (Bryant-Waugh, Markham, Kreipe & Walsh, 2010; Bryant-Waugh & Lask, 1995). However with the recent publication of the DSM-V (APA, 2013) the landscape had now changed with the introduction of a new diagnostic category: Avoidant Restrictive Food Intake Disorder (ARFID) which better classifies SE difficulties.

Despite a plethora of studies investigating the neuropsychological underpinnings of the rigidities observed in related difficulties such as eating disorders, there have been no attempts to date to understand the neuropsychological basis of feeding difficulties such as SE. Furthermore, SE difficulties are common in children with autism spectrum disorder (ASD) (Raiten & Massaro, 1986) and there have been many studies of neuropsychological anomalies in this group (Hill, 2004). It may be that our understanding of the aetiology of clinically significant SE can be informed by the literature on neuropsychological functioning in children and adolescents with

ASD. This is an important avenue of investigation given that rigidity is the core feature in both ASD and SE. The current study therefore aims to explore the neuropsychological profiles of children with clinically significant SE difficulties and whether these vary in children with elevated autistic traits.

This introductory chapter will first describe the diagnosis, classification and clinical presentations in SE, before outlining the consequences of SE, prevalence and demographic information. It will then outline aetiological explanations and how these link to current treatment options. Furthermore, it will review the evidence for SE difficulties in ASD and outline neuropsychological findings from the eating disorder and ASD fields and how these may be extended to inform hypotheses regarding the neuropsychological basis of SE in children who do and do not have elevated autistic traits.

1.2 Diagnosis and classification of selective eating

1.2.1 The diagnostic conundrum

In childhood, feeding difficulties such as SE have been historically difficult to diagnose due to inadequate classification systems (Bryant-Waugh & Lask, 1995). Until recently, using the main diagnostic classification system, the DSM-IV (APA, 1993) children with SE were classified in one of two diagnostic categories. The first being Feeding Disorder of Infancy and Early Childhood, where children were required to experience a feeding disturbance accompanied by a failure to gain weight or weight loss over a minimum period of one month. There are several shortcomings of this criterion however. First, it necessitates a “significant failure to gain weight”, thus excluding children who, despite experiencing significantly entrenched SE, may not struggle to maintain weight due to the nutritional adequacy or high calorific quantity of the foods that they will accept (Bryant-Waugh, 2013). Additionally, the criteria state that feeding disturbances should not be associated with gastrointestinal or medical conditions however these are often related areas of difficulty. For example, children with gastrointestinal illness may have had aversive experiences including vomiting, choking or invasive procedures linked to their mouths and throats such as endoscopies, resulting in rigidity around feeding. Dichotomizing between organic and non-organic difficulties in this population is therefore unhelpful and likely to exclude a group of children who do not meet criteria but present with entrenched feeding disorders, such as SE (Kreipe & Palomaki, 2012). Furthermore, the criteria specify that children must be under

six years old, which excludes a large group of children with clinically significant SE difficulties in middle childhood to adolescence (Bryant-Waugh & Piepenstock, 2008). In a paper reviewing the inadequacy of this pre DSM-V (APA, 2013) criteria, Lask and Bryant-Waugh (2000) propose that SE would be better accounted for alongside existing feeding and eating criteria, but that DSM-IV (APA, 1993) lacked the specificity to achieve this. Indeed, the feeding disorder of infancy and early childhood criteria failed to describe the characteristics of the children who would meet criteria and thus this diagnosis was rarely used (Kenney & Walsh, 2013).

The second DSM-IV (1993) diagnostic category in which selective eaters were historically classified was eating disorder not otherwise specified category (Nicholls, Chater & Lask, 2000). This category acted as an inappropriate placeholder for otherwise unclassifiable feeding difficulties that do not fall neatly within the realm of a typical eating disorder presentation (Jacobi et al., 2008). The consequences of such poor classification for SE for children and their families have been far reaching, most notably in an ongoing controversy about where to access treatment. Whilst a lack of diagnosis in countries that provide free healthcare might result in poorly targeted interventions for SE, in countries that provide health insurance on the basis of a diagnosis, families are likely to have been particularly disadvantaged by the lack of appropriate classification.

1.2.2 DSM-V: the introduction of ARFID

Crucial changes in the DSM-V (APA, 2013) have seen the addition of a new diagnostic category within feeding and eating disorders called ARFID. This has replaced the existing feeding disorder of infancy and early childhood category (Bryant-Waugh, 2013) but also encompasses a range of additional difficulties that were previously unclassifiable using past criteria. ARFID criteria describes feeding disturbances in which there is avoidance of foods based on “sensory characteristics” or “concern about aversive consequences of eating” in conjunction with failure to meet adequate nutritional and/or energy needs in association with weight loss, nutritional deficiency, dependence on enteral feeding (tube feeding) or supplements and/or psychosocial impairment. Crucially, these criteria can be applied to children of all ages, more adequately capturing those with persistent SE in middle childhood and adolescence. This revised classification will undoubtedly renew interest in outlining aetiological factors underlying SE to inform more specific interventions (Kreipe & Palomaki, 2012). It is hoped that the introduction of

a clear diagnostic label such as ARFID will mean that clinically significant SE that was previously unclassifiable will be better assessed and treated (Kenney & Walsh, 2013). This is also likely to stimulate further research in the field, which has been beset to date, by researchers using inconsistent definitions and terminology, resulting in a field where research is in its infancy.

1.3 Clinical presentations in selective eating

Whilst SE is common in toddlerhood and is seen as developmentally appropriate during this phase, it is when these difficulties become entrenched and longstanding, meeting clinically significant ARFID criteria, that more severe presentations requiring intervention, emerge. The ARFID criteria distinguish between children who are selective eaters based on sensory characteristics or based on concerns about aversive consequences of feeding. This fits more neatly with the observed clinical presentations that have been described for SE (Chatoor, 2002).

Many children present with sensory-based sensitivities to the texture and taste of foodstuffs along with high rigidity in the acceptance of different textures and significant neophobia. Such “sensory food aversions” result in difficulties including a child only eating a certain colour, texture or brand. Feeding is often ritualistic in this group and is common in children with ASD (Bryant-Waugh et al., 2010). It is not unusual for children in this group to struggle with the transition between the stages of weaning in infancy, with the result being that a proportion of them become dependent on formula feeding long after this is developmentally appropriate. In such children this has important social and emotional consequences which will be discussed further in section 1.4.3.

Furthermore, children may present with SE in the context of emotional factors, and these selective eaters tend to fall into two subgroups. The first are those who present with a more phobic anxiety-based response to food, which may be due to a conditioned fear response resulting from an aversive experience such as an invasive procedure related to a gastrointestinal illness or trauma after a choking incident (Kreipe & Palomaki, 2012; Dovey, Staples, Gibson & Halford, 2008). This has been described as a “food neophobia” (a fear and avoidance of new foods) which is relieved by new positive food experiences, however the more entrenched this difficulty becomes without attempting new foods, the greater the duration and severity (Jacobi, et al., 2008). As discussed, neophobia in this context is also a core feature of ASD presentations. The second subgroup includes those with food avoidance emotional disorder, which is now encompassed by

ARFID (DSM-V, 2013). Food avoidance emotional disorder is characterized by an inadequate calorie/food intake due to avoidance of food resulting from mood related difficulties.

SE presentations such as those described here are common, but when these become developmentally inappropriate and clinically significant, it is important to consider that there may be distinct aetiologies underlying different presentation patterns, which has implications for different treatment options and outcomes within SE (Bryant-Waugh & Piepenstock, 2008). On this basis, the present sample of selective eaters, represent those with severe and enduring entrenched feeding difficulties which are clinically significant.

1.4 Consequences of selective eating

1.4.1 The course of selective eating

The long-term course of SE is relatively unknown (Kenney & Walsh, 2013), however a key piece of research has suggested that sensory aversions to food can continue into adulthood. The researchers showed in a sample of 120 children who were followed from 2 to 11 years old, that SE is relatively transient with over 50% recovering within two years and more chronic presentations persisting for longer than this. Indeed, 16% of children aged five years or older endorsed more enduring presentations which were more likely to persist into adolescence (Mascola, Bryson & Agras, 2010). It is this smaller proportion of young people with more enduring presentations that may represent those who go on to develop more clinically significant and entrenched difficulties. Thus, whilst SE appears to be a developmentally appropriate phase in early infancy, a proportion of children will develop more entrenched difficulties requiring clinical intervention. However, this research used one question (“is your child a picky eater?”) to establish SE difficulties, which they asked parents. This likely adequately detected SE, however the sample may not be representative of those with clinically significant difficulties that would meet diagnostic criteria for a feeding disorder.

1.4.2 Physical difficulties associated with selective eating

Clinically significant and enduring SE has been linked to long-term consequences in terms of compromising nutritional intake (Dubois, Farmer, Girard, Peterson & Tatone-Tokuda, 2007), highlighting the importance of understanding its aetiology and treatment. Poor nutrition is likely linked to the finding that selective eaters are less likely to consume foods necessary for a

balanced diet including fruits, vegetables and meats (Galloway, Fiorito, Lee & Birch, 2003) and not meet recommended requirements for energy, protein and fat in their diet relative to those without SE (Dubois et al., 2007). Some evidence has contradicted these findings however, suggesting adequate levels of nutrition in SE (see Carruth, Ziegler, Gordon & Barr, 2004). This may be explained in terms of some selective eaters upholding their weight and/or nutritional status by maintaining a limited repertoire of foods that nevertheless meets their calorie and nutritional requirements, causing variability in research findings. Nevertheless, the health implications of SE are clear with selective eaters being less likely to gain weight in the first two years of life, potentially affecting long-term physical and cognitive development (Wright et al., 2007). It does however remain unclear as to the long-term physical consequences of SE that persist into later childhood and become clinically significant, and to date these have not been empirically investigated in this subset of the population.

Furthermore, prescribed supplements in the form of fortified formula milks or juices or enteral feeding (where food supplements are delivered via nasogastric tubes through the nose or gastrostomy tubes directly into the stomach) may be necessitated in those children that cannot maintain their weight and nutritional status and who refuse the oral intake of food (Neiderman, Tattersall, Lakatos & Lask, 2000). It is also common for children with clinically significant SE to be dependent on bottle feeds or supplements long after the age at which it is developmentally appropriate. The psychological factors associated with these methods of feeding will be discussed in the following section. However, it is important to note that whilst these consequences of SE are observed clinically and have been described in the literature as consequence of SE, there is no empirical evidence to date to clearly identify how common these physical consequences are in SE. Indeed, it seems likely that these may be more prevalent in young people with severe and clinically entrenched SE, however due to the limited research in this group; this is yet to be coherently established.

1.4.3 Psychological factors associated with selective eating

SE has various long-term psychological and socioemotional factors associated with it. Firstly, enteral feeding often involves highly invasive procedures and there are profound psychological implications associated with these, including stress and fear regarding such medical interventions (Neiderman, Farley, Richardson & Lask, 2001). Furthermore, in adults, enteral feeding has been

linked with self-esteem difficulties including low body-image, avoidance of social situations and psychosocial distress (Roberge et al., 2000). Although it is unclear how applicable these findings may be to children, it follows that similar such effects may be observed in children who are dependent on bottle or formula feeds in terms of these distinguishing them from their peers. This likely has an impact on social inclusion, self-esteem and their sense of self. Indeed, even those selective eaters without enteral feeding tubes report similar such difficulties including limiting time with friends, missing lunchtimes at school and missing social events due to their restrictions (Nicholls, Christie, Randall & Lask, 2001). However, the converse effects may also be true in children with enteral feeding in situ, where these may be depended on by the child as a means of avoiding the trauma of trying new foods, a pattern which is likely to have clinical implications in terms of hindering the tube weaning process in treatment (Tarbell & Allaire, 2002).

Another factor is the established link between SE and behavioural problems, however it remains difficult to determine the direction of causality between these areas. Using the Child Behaviour Checklist (Achenbach, 1991), which assesses behaviour across three domains, researchers have shown that children with SE and those without show no difference in their behaviour in terms of their competency (for example hobbies and participation in sports and friendships). Selective eaters did however show higher rates of internalizing behaviours (for example anxiety/depression, somatic complaints and being withdrawn) and externalizing behaviours (for example, being aggressive and delinquent behaviour) than those without SE. Furthermore, no association was found between SE and eating disorder symptomology including weight control behaviours, suggesting that SE phenomenon was reliably captured (Jacobi et al., 2008). However this was a cross-sectional study, and thus inferences cannot be drawn about the longitudinal relationship between SE and behavioural difficulties from these findings.

In the Copenhagen Child Cohort study (Skovgaard et al., 2005), which is a large-scale follow-up of the development of 1,436 children aged between 5 and 7 years old, semi-structured interviews were employed to examine psychopathology in children at various time points. In further analysis of this data, children with SE were found to display a higher frequency of emotional disorders, behavioural disorders and developmental disorders relative to those without SE (Micali et al., 2011). However this research did not clarify whether difficulties preceded or emerged following

SE onset. Indeed, in the case of developmental disorders, the former is likely to be true, as these would be present from birth, preceding SE onset.

Some researchers have focused on whether or not childhood SE is a precursor for an eating disorder in adolescence. Key evidence has emerged from the 1970 British Cohort Study (Butler & Bynner, 1997) which followed up 11,260 babies to thirty years of age. Further analysis of this data revealed four predictors of anorexia nervosa development in adolescence, including early feeding difficulties and under-eating in later childhood (Nicholls & Viner, 2009). However, these results make links between heterogeneous early feeding difficulties and anorexia nervosa and do not specifically implicate SE as a precursor, so should be regarded tentatively. Furthermore, this research relied on self-reported incidences of ED symptomology with no standardised measure to reliably establish the presence of an eating disorder, thus calling into question the validity of these findings. These findings do support an earlier longitudinal study of children between 1 and 20 years old which showed that SE in childhood was a significant risk factor for the development of bulimia nervosa in adolescence (Marchi & Cohen, 1990). In summary, there appears to be a trend towards early feeding difficulties relating to later eating disorder symptomology, however in the literature to date, these difficulties are poorly defined and based on retrospective reports. Further research to understand childhood feeding difficulties and their possible role as precursors in eating disorder development will be vital in informing early interventions if a link exists, or in relaying parental concerns about possible risks, if one does not.

It is important to note, that throughout the studies described in this section, there is a lack of consistency and clarity in the severity and clinical significance of the SE difficulties experienced in the young people investigated. These findings should therefore be viewed tentatively in terms of their applicability to all selective eaters, however it seems likely that these difficulties would be found in more severe presentations that meet ARFID diagnostic criteria.

1.4.4 Parental factors associated with selective eating

SE is associated with significant parental anxiety arising from the difficulties associated with ensuring that their child is receiving a nutritionally adequate diet and maintains good health (Zero to Three, 2005). In this context parental distress may arise in several key areas, for example, parents of children with SE report spending excessive amounts of time trying to get professional

acknowledgement of the presence of a feeding difficulty, reflecting a time of reported high levels of anxiety (Spalding & McKeever, 1998). Another related source of parental distress is that associated with the introduction of enteral feeding, which has been linked to high levels of parent reported stress (Spalding & McKeever, 1998). However, this research was based on qualitative interviews of just two mothers and it is clear that large sample studies would provide a more representative view of the emotional impact of SE, and enteral feeding resulting from this, on parents.

Furthermore, SE has been associated with increased familial stress with a highly negative impact on family functioning (Goh, 2012). This is particularly evident at mealtimes, where the behavioural difficulties associated with SE, such as escape behaviour or tantrums, can cause these to become a stressful and negative experience with higher incidences of reported arguments between parents over feeding practices (Jacobi, Agras, Bryson & Hammer 2010; Timimi, Douglas & Tsiftopoulou, 1997). In line with these findings, researchers have also found that negative mealtime experiences in many cases have led to parents no longer challenging their child to try new foods (Timimi et al., 1997). Thus, SE appears to have a significant impact on parental stress, and critically, parents' capacity to challenge their child to be less restrictive in their eating. This has important clinical implications for understanding possible maintaining factors in SE.

1.5 Prevalence rates and demographic information

1.5.1 Prevalence rates

The lack of a standard definition for SE has meant that it has been studied in a range of age groups, with various different ways of assessing and defining it. This has resulted in considerable variation in the prevalence estimates that have been established to date, which have ranged from 7.3% - 50% depending on the criteria used (Micali et al., 2011; Carruth et al., 2004). The lower of these estimates came from the Copenhagen Child Cohort Study (Skovgaard et al., 2005), which defined SE using items from a factor analysis on questions from two established eating behaviour questionnaires: The Children's Eating Behaviour Inventory and the Children's Eating Behaviour Questionnaire (Archer, Rosenbaum & Streiner, 1991; Wardle, Guthrie, Sanderson & Rapoport, 2001). These items included a limited variety in a child's diet, strong dislikes for certain foods, refusal to accept new foods and demands for foods to be specially prepared. This thus encompassed a wide range of eating behaviours relevant to SE, however these may not

necessarily be specific to this group. Less stringent definitions have also been used, providing slightly higher prevalence estimates in different age groups. For example, when SE was defined as a child “always eating different meals to the rest of the family” prevalence rates range from 14% (in two year olds) to 16% (in four year olds) across a large sample of 2,103 children (Dubois et al., 2007).

Higher prevalence estimates have been shown in large population studies with an estimated 50% of children from 4 to 24 months old in a sample of 3,022 children (Carruth et al., 2004). This research though focused on the ‘early childhood’ age group in line with the DSM-IV (APA, 1993) criteria, which may have biased results by including a proportion of children who may have exhibited developmentally age-appropriate SE. This research was therefore not representative of older children, questioning the reliability of such prevalence estimates. Furthermore, a less stringent criterion for determining the presence of SE was used where parents were asked “is your child a picky eater?” without defining this. Subjective parent ratings in this case were therefore based on their perceived definition of SE.

To date there is no empirical evidence that has attempted to delineate the prevalence of SE in those with more developmentally appropriate SE difficulties to those with clinically significant entrenched SE that is impairing and requires intervention. The prevalence estimates therefore vary due to these methodological and diagnostic inconsistencies, however it does appear that a proportion of children so experience a more severe and enduring SE difficulty, and that these are likely to make up a subgroup within the large sample studies investigated, however accurate prevalence rates of this subgroup are yet to be determined.

1.5.2 Demographic information

SE has been shown to be common in both genders and across ethnicity and socioeconomic status (Carruth et al., 2004), however this demographic information was based on a toddler sample. In an older sample of 240 school aged children (mean age 9.2 years), where SE was found to be present in a third of children and this was irrespective of gender, social class or ethnic background (Rydell, Dahl & Sundelin, 1995). Therefore SE appears to be a universal difficulty and is found across various countries in which research has been conducted (Li, Shi, Wan, Hotta & Ushijima,

2001; Goh, 2012), although further research is needed to establish whether this may vary depending on the severity and clinical significance of SE.

1.6 Aetiology

Various aetiological explanations of SE have been proposed, and whilst not an exhaustive list, genetic, environmental and sensory processing explanations will be discussed here.

1.6.1 The role of genetics

Food aversions are considered to serve an evolutionary function in protecting one against ingesting poisonous foods (Birch, Gunder, Grimm-Thomas & Lang, 1998). Such aversions are likely accentuated by gastrointestinal reactions to poisonous foods such as vomiting (Tseng & Biagioli, 2009; Golding et al., 2009). Furthermore, the aversion often shown to bitter tastes (Desor, Maller & Andrews, 1975) may be an innate predisposition against tastes that could indicate the presence of toxins. These adaptive reactions thus ascertain good health and their inheritance likely served as a beneficial evolutionary protective function. Food aversions during early years are therefore an adaptive and typical developmental phase, however in a modern environment where foods are generally safe to eat, this can lead to a more limited diet than might be necessary to ensure safety.

Indeed in SE, children are often averse to foods that are nutritionally healthy and non-aversive from an evolutionary perspective. Instead, they often favour starchy, sugary and fatty foods such as chicken nuggets or chocolate, at the expense of consuming healthier options like fruits and vegetables (Cooke, Carnell & Wardle, 2006). This may be explained in terms of an innate predisposition towards certain tastes, such as sweet tastes, as they would indicate a high calorie count which would be evolutionarily adaptive. Indeed, neonates present a universal facial expression indicating a preference for sweeter tastes (Beauchamp & Moran, 1982). Taken together, these findings suggest a genetic disposition to become averse to certain qualities of food, rejecting them even though they may be healthy.

A study examining the determinants of food neophobia in infants compared monozygotic twins (who share all their genes) with dizygotic twins (who share on average 50% of their genes) (Cooke, Haworth & Wardle, 2007). In a large sample of 5,390 twins aged 8 to 11 years old the

researchers investigated the contribution of genetics, shared environmental factors (which are aspects of the environment that are necessarily shared between children in the same family) and non-shared environmental factors (which are aspects of the environment which are different between children in the same family). They estimated that 78% of the variance in food aversion was accounted for by genetic factors, that 22% of the variance was explained by non-shared environmental factors and that shared environmental factors had no effect. These results suggest that despite sharing parents, homes, lifestyles and culture, that these factors were likely experienced differently between each twin within a twin set and that genetics played a significant role in the development of food aversion. However, twin studies such as this are heavily criticised in not taking into account the unique experience that merely being a twin creates that is different to that of a singleton childhood (Martin, Boomsma & Machin, 1997). This limits the generalisability of these findings to selective eaters that do not have a twin (Bouchard & McGue, 2003). Nevertheless, Cooke et al., (2007) demonstrated that food aversion is a largely heritable trait, but that different types of environmental factor are also heavily implicated in the development of such difficulties.

1.6.2 Environmental explanations

Environmental factors play an important role and may act as a trigger to feeding rigidity in those with a genetic predisposition. Developmentally, young infants maintain a liquid diet until six months of age at which time a transition begins where they move on to solids and liquids other than milk (Coulthard, Harris & Fogel, 2014). This process creates new oral sensory experiences (Carruth et al., 2004; Morris, 1989) and has been identified as a sensitive period for learning about food (Cashden, 1994). Sensitive periods are hypothesised to exist across development for a range of different abilities and represent a time where the brain is at an optimal stage of neuroplasticity for learning and developing particular skills (Lillard, 2008). While some researchers have argued that introducing solid foods around this time may increase the likelihood of SE (Shim & Kim, 2011), others have suggested that repeated exposure to initially disliked flavours during this stage allows for the development of preferences for these tastes early on (Maier, Chabanet, Schaal, Issanchou & Leathwood, 2007). The development of adaptive responses such as these may be explained by learning theorists in terms of the repeated presentation of food providing an opportunity for exposure and sensitization to stimuli that were initially experienced as aversive (Marks, 1975). Accordingly, this leads to the extinction of initial

aversions and the behavioural sequelae of these (Waters, McDonald & Koresko, 1972). Furthermore, classic behavioural theorists may suggest that positive reinforcement (Skinner, 1938) in which infants and children are praised for trying a range of new foods, will lead to an increased likelihood of similar such behaviour in future instances.

These findings suggest that the introduction of environmental stimuli, in this instance food, is key in promoting variety in a child's feeding repertoire and providing the opportunity to overcome negative responses to initially aversive tastes. Indeed, in typical development this weaning period prepares a child for the following months of rapid taste development (Sullivan & Birch, 1994) with the acceptance of a wider range of foods (Coulthard, Harris & Emmett, 2009). It therefore follows that disruption during this period may affect the learning processes taking place and the likelihood that a child will develop maladaptive feeding difficulties such as SE.

Several environmental factors may act as a disruptive influence. For example, parental factors have been implicated where children whose mothers who have restricted diets themselves are more likely to be selective eaters (Tan & Holub, 2012). It may be that children imitate negative behavioural responses to food that they observe their parents engage in through modelling (Bandura, 1977). Furthermore, there are increased SE difficulties in children whose mothers pressurise them to eat (Galloway et al., 2003), a behaviour that is likely driven by parental concerns about the nutritional status of their child (Gregory, Paxton and Brozovic, 2010). Factors such as these likely link to mealtime stress and conflict around food, with the consequence of having a negative effect on the experience of feeding, causing increased rigidity. This is likely further reinforced by parents cooking meals including only preferred foods. In a behavioural analysis of 12 children presenting with feeding difficulties the negative reinforcement provided by the opportunity to escape from foods was found to be a primary maintaining factor in SE (Piazza et al., 2003a). Thus SE may be maintained by a range of environmental factors, in particular the opportunity for a child to avoid challenging their difficult thoughts and behaviours in relation to foods to develop more adaptive responses.

1.6.3 Sensory Integration Theory

Research has shown that children with SE exhibit higher taste sensitivity to bitter tastes relative to non-selective eaters (Golding et al., 2009). It is therefore clear that the sensory experience in

feeding could make a significant contribution to the formation of aversive experiences that might result in difficulties such as SE. Sensory Integration Theory has been applied to feeding difficulties and is highly relevant in understanding aspects of why a child may become more restrictive in their feeding (Ayres, 1979). This theory postulates that one may struggle to combine input from different senses at any one time due to poor sensory modulation, where one cannot adjust their responses to the nature and intensity of different stimuli (Schaaf & Davies, 2010). This may mean that the sensory experience associated with eating certain foods is likely to be overwhelming and experienced as aversive in some individuals (Farrow & Coulthard, 2012). The behavioural responses to aversive experiences are likely to be linked to a sensory defensiveness which is either an under-responsive or over-responsive reaction to sensory stimuli (Wilbarger, 1984) resulting in overt behaviours such as those associated with SE (Cermak, 2001). Clinically, these may be observed in mealtimes as gagging on food, spitting it out or refusing food (Case-Smith & Humphry, 2005). This hypothesis fits with findings that suggest that selective eaters are more sensitive to bitter tastes, which they may find more overwhelming to their senses (Golding et al., 2009).

Crucially, the sensory integration hypothesis fits with research to suggest a higher incidence of sensory difficulties in ASD, where a higher prevalence of clinically significant SE difficulties are also observed (Golding et al., 2009; Crane, Goddard & Pring, 2009).

1.7 Treatment of selective eating difficulties

Sensory integration theory has led the way for the development of sensory integration therapy, which is recommended for clinically significant feeding difficulties (Case-Smith & Humphry, 2005; Baranek, 2002; Cermak, 2001; f & Lane, 1991). This approach stems from the hypothesis that SE results from an inability to respond adaptively to difficulties in processing sensory information and so therapy targets the processing deficits and not the observed behaviour (Kimball, 1999). This approach can be criticised for being reductionist in discounting the anxiety response and learning aspects of maladaptive feeding behaviour and as yet there have been no empirical randomized control trials conducted to establish the effectiveness of this treatment (Addison et al., 2012).

More empirical evidence does however exist in the context of behavioural interventions for SE, which are based on the assumption that environmental factors maintain SE. There is strong empirical support for interventions based on the principles of operant conditioning where reinforcing positive feeding behaviour is seen as key to change (Volkert & Piazza, 2012; Cooper et al., 1995; Piazza et al., 2003b). A related behavioural intervention known as escape extinction (where children are prevented from escaping feeding experiences) has also been shown to be effective in challenging the negative reinforcement that escaping mealtimes can provide in maintaining entrenched SE difficulties (Ahearn, Kerwin, Eicher, Shantz & Swearingin, 1996; Reed et al., 2004).

Indeed, in a study that investigated the relative contributions of two behavioural intervention strategies including escape extinction with sensory integration theory, it has been shown that the behavioural aspects of this intervention led to greater improvement in food acceptance and a decrease in maladaptive behaviour around mealtimes (Addison et al., 2012). However these findings were based on case studies of two children, limiting the generalisability of the findings. Furthermore, both interventions were applied (first sensory, then behavioural), and it is therefore difficult to disentangle which intervention was most effective or whether the combination was beneficial. Given the strong arguments for both behavioural and sensory difficulties in SE and the finding that feeding anxiety in SE is mediated wholly by sensory sensitivity (Farrow & Coulthard, 2012), indicating a complex interplay between these factors, it may be that an integrative treatment approach is warranted.

Thus, understanding SE and its different aetiologies appears prudent in the selection of successful interventions adapted to a child and their presenting difficulties.

1.8 ASD diagnosis and classification

SE difficulties are so prevalent in ASD that these once constituted part of the diagnostic criterion for an ASD diagnosis (Raiten & Massaro, 1986) and is now better captured in the new DSM-V (APA, 2013) criterion. This has reduced the previous DSM-IV (APA, 1993) diagnostic categories of autistic disorders, Asperger's disorder and pervasive developmental disorder not otherwise specified to one overarching diagnostic term "Autism Spectrum Disorder". Furthermore, the previous 'triad of impairments' (impaired social reciprocity, impaired language/communication

and restricted and repetitive interests) have been combined and modified to “social/communication deficits” and “fixated interests and repetitive behaviours” (Vivanti et al., 2013). Importantly, the latter of these includes unusual sensitivity to sensory stimuli, which was lacking from DSM-IV (APA, 1993), but remains one of the hallmarks of ASD. Researchers have estimated that 90% of individuals with ASD exhibit sensory difficulties (Leekham, Nieto, Libby, Wing & Gould, 2007) and that 85% experience difficulty in this area into adulthood (Billstedt, Gillberg & Gillberg, 2007). It is a combination of the sensory difficulty and rigidity seen in ASD, which are now better established in DSM-V, that may be hypothesized to underlie difficulties with SE.

1.9 Comparing selective eating difficulties in children with and without ASD

ASD has therefore been associated with feeding difficulties, particularly in the context of sensory rigidity (Raiten & Massaro, 1986). However, children with ASD have been reported to exhibit a high prevalence of gastrointestinal difficulties with 24% of a sample of 137 children showing at least one chronic symptom (Molloy & Manning-Courtney, 2003). Such difficulties could also lead to aversive feeding experiences and the development of fear-based food refusal in this group (Kenney & Walsh, 2013). To disentangle different aetiological factors underlying SE presentations, research has begun to compare clinically significant SE in children with and without developmental difficulties, including ASD. A study of children with ASD (N=472, age range=9 to 9.5 years old) found that they consume a significantly narrower range of food, suggesting more rigid feeding patterns compared to controls (Schreck, Williams & Smith, 2004). However, this research compared caregiver reports where results may be skewed by subjective secondary reports that may have been biased by the stressful experience of living with a child with SE, furthermore, this research was based on reported feeding behaviours and not cases where a clinical diagnosis of a feeding disorder had been made.

This trend has been replicated however, with one study finding that over 50% of children with developmental difficulties and ASD showed limited food acceptance, expulsion and disruptive behaviour (Ahearn et al., 2001). However, this was a mixed sample of children with pervasive developmental disorder (not otherwise specified) and ASD and did not distinguish between these, resulting in a highly heterogeneous in terms of the nature of developmental difficulties. Furthermore, the authors presented food in a way that was likely to be unfamiliar to participants

(one bite of each food). The findings are therefore difficult to disentangle, particularly in light of the fact that rigidity in response to novel situations such as this are common in ASD and that even typically developing children without SE are also likely to reject novel foods presented in a new way (Birch & Marlin, 1982). Also, due to the lack of comparison with a control group it is unclear whether there is a significant effect between those with and without an ASD diagnosis with SE, or indeed whether these participants met criteria for a clinically significant SE difficulty.

In research overcoming the limitations of these studies, a sample of children was recruited across three groups: typically developing, ASD and early onset eating disorder. An adapted DSM-IV (APA, 1993) classification (from Nicholls, Lynn & Viner, 2000) was utilized to ensure greater sensitivity to the inclusion of those with SE in the early onset eating disorder group. There was no evidence to suggest higher ASD rates in children with early onset eating disorder, however there were higher rates of elevated autistic traits in this group, which encompassed resistance to change, compulsive behaviours and self-injury (Pooni, Ninteman, Bryant-Waugh, Nicholls & Mandy, 2012). The overlap in eating disorder and ASD symptomology makes it difficult to delineate the contribution of each in SE but does highlight the core feature of rigid patterns of behaviour in both presentations. This research raises questions about the aetiological factors underpinning feeding rigidity in those with autistic traits. There is a large body of research highlighting neuropsychological differences that may underpin the rigidity observed in ASD (Hill, 2004), which may extend to, and explain the difficulties seen in SE in this group to a degree. However, 45% of typically developing children experience SE difficulties in the absence of and ASD (Bentovim, 1970) and as yet there has been no research to identify the neuropsychological underpinnings of such difficulties.

1.10 Neuropsychological research

This research represents the first attempt to explore the neuropsychological basis of SE, where there is currently a distinct lack of previous research. In the absence of this, the plethora of similar such studies in the eating disorder literature is highly relevant to SE research in two ways. First, in facilitating the development of test batteries that are sensitive to the strengths and difficulties found in feeding and eating disorders that could be well applied in SE, for which there are no established test batteries. Second, the eating disorder literature provides a basis from which to

hypothesise about areas of strength and difficulty in the neuropsychological functioning of individuals with related feeding and eating disorders, including those with SE.

The investigation of the neuropsychological underpinnings in different feeding and eating disorders is particularly crucial with changes in the DSM-V (APA, 2013) criteria for anorexia nervosa, which no longer require a body image disturbance for a diagnosis to be given. This feature had previously allowed for differential diagnoses to be made between anorexia nervosa and SE and in the absence of this defining characteristic, understanding the neural and neuropsychological basis underlying different feeding and eating disorders will have crucial implications for their diagnosis, assessment and treatment (Thomas, Hartmann & Killgore, 2013).

Another area highly relevant in contributing to hypotheses about neuropsychological functioning in SE comes from the ASD literature given the high comorbidity between these difficulties. There is therefore great merit in beginning to describe the neuropsychological profiles of children with these SE difficulties in order to begin to unravel their underpinnings.

On this basis the proceeding section will summarise the neuropsychological literature emerging from the eating disorder and ASD fields, from which hypotheses about neuropsychological profiles in SE may be informed. For a summary overview of the literature see Appendix 1.

1.10.1 Visuospatial Processing

Visuospatial processing is an area shown to be impaired in adults with anorexia nervosa (Kington, Szmukler, Andrewes, Tress & Desmond, 1996). One of the key tasks to assess this ability is the Rey-Osterrieth Complex Figure Test (ROCF) (Osterrieth, 1944; Rey, 1941), which requires individuals to remember a shape and draw it from memory (Thompson, 1993). In neuropsychological research in childhood anorexia nervosa using this test, impairments have been shown, which is a finding that has been consistently replicated (Stedal, Rose, Frampton, Landro & Lask, 2012; Rose, Davis, Frampton & Lask, 2011).

In contrast, visuospatial functioning has been found to be normal or superior in individuals with ASD (Caron, Mottron, Rainville & Chouinard, 2004) and this has been described as an islet of

preserved ability among other neuropsychological deficits in the ASD population (Ozonoff, Pennington & Rogers, 1991).

1.10.2 Central Coherence

Frith (1989) coined the term central coherence to describe a cognitive tendency to favour the extraction of meaning from a coherent whole instead of focusing on specific aspects of detail. Weak central coherence) is described as the tendency to focus on detail at the expense of the bigger picture (Happé & Booth, 2008) and this has been found to be an area of weakness across adults with a variety of eating disorder presentations, however results are inconclusive as to whether this means stronger local processing (Lopez, Tchanturia, Stahl & Treasure, 2008). These findings have also been replicated in children with anorexia nervosa (Stedal et al., 2012).

There is a wealth of evidence to indicate weak central coherence in ASD, where difficulties have been found in pronouncing homographs outside of context (Happé, 1997) and better performance on tasks that benefit from processing details in a stimulus as opposed to a whole, for example the Embedded Figures Test (Shah & Frith, 1983).

Weak central coherence is particularly relevant in SE as it could be hypothesised that biases toward processing detail may heighten the perceptual experience of feeding for a child. It may be for example that there is a focus on details of a food bolus such as small differences in texture or taste that may otherwise go unnoticed in those without SE difficulties. This may serve to create an aversive experience and encourage selectivity of preferred foods, which are more uniform and thus acceptable.

1.10.3 Executive function

Executive function (EF) is an umbrella term to describe higher order abilities such as planning, inhibition, attention and working memory. These abilities work independently of the environment in order to guide behaviour (Stuss & Levine, 2002). Executive impairments were first observed in patients with frontal lobe damage and the concurrent behavioural difficulties (such as repetitive behaviour and socially inappropriate behaviour) observed in this group have been likened to those found in ASD (Damasio & Maurer, 1978; Duncan, 1986; Ozonoff, Rogers & Pennington, 1991).

Furthermore, EF impairments have also been broadly implicated in anorexia nervosa research (Tenconi et al., 2010). The present research will focus on cognitive flexibility, inhibition and planning abilities which will be discussed here.

Cognitive flexibility

Set-shifting is an EF requiring flexibility in switching between multiple tasks, mind sets and operations (Miyake et al., 2000). Impairments are likely to present clinically in increased rigidity as observed in perseverative errors and stereotypical behaviours (Roberts, Tchanturia, Stahl, Southgate & Treasure, 2007). Set-shifting difficulties have been suggested as a risk factor in the development of eating disorders in adults and this may link to the rigidities and perfectionism seen in AN (Tchanturia, Campbell, Morris & Treasure, 2005; Southgate, Tchanturia & Treasure, 2005). A systematic review of 15 studies has shown that cognitive flexibility is consistently found to be impaired in anorexia nervosa (Roberts et al., 2007) and there is emerging evidence to suggest that in childhood anorexia nervosa, whilst EF broadly remain intact, set-shifting has emerged as an area of distinct difficulty (Stedal et al., 2012). This childhood anorexia nervosa research applied a gold standard neuropsychological test battery developed for AN in young people, known as the Ravello Profile which will be discussed further in section 1.10.6. However, a constraint of this research was the lack of a comparative control group, although normative comparisons were made to overcome this.

Set-shifting impairments are also well established in ASD, which is particularly evident in switching between thoughts and behaviours in accordance with contextual and situational changes (Hill, 2004; Ozonoff, 1997; Hughes, Russell & Robbins, 1994). This likely accounts for the rigid and perseverative aspects of ASD presentations and may also explain the high prevalence of SE in autism.

Inhibition

Response inhibition is described as the ability to suppress information that may interfere with a task (Dagenbach & Carr, 1994). There is mixed evidence regarding the presence of inhibition impairments in adults with anorexia nervosa with some researchers reporting no difficulties (Gillberg et al., 2010) and others reporting significant impairments (Brewerton, Frampton &

Lask, 2009). No impairments have been found in childhood anorexia nervosa samples however (Rose, Frampton & Lask, 2012; Stedal et al., 2012).

Inhibition has been found to be impaired in adults with ASD (Burgess & Shallice, 1997) with inconsistent findings in child ASD research. For example, impairments have not been found relative to controls on classic tests of inhibition such as the Stroop task (Ozonoff & Jensen, 1999), but on contemporary tasks which demand a greater everyday rationale such as the “go-/no-go” task however, impairments have been observed (Ozonoff, Strayer, McMahon & Filloux, 1994). Whilst the evidence is inconclusive, the observed difficulties are thought to contribute to perseverative behaviour in ASD (Hill, 2004), again possibly linking to a tendency to become stuck in rigid and repetitive patterns of behaviours. This may also contribute to SE in such groups, where there may be a difficulty inhibiting a rigid food preference.

Planning

Tasks of planning abilities have been heavily criticised for employing multiple EF abilities, limiting the ability to delineate the unique contribution that planning impairments may make in poor task performance (Wolfe & Bell, 2004). In the limited child research to date however, there are no indications of an impairment in planning in anorexia nervosa (Rose et al., 2012; Stedal et al., 2012).

In ASD however, planning abilities have been shown to be consistently impaired in relation to typically developing children as well as those with other developmental disorders including Tourette syndrome, suggesting that this is a distinct difficulty in ASD (Ozonoff et al., 1991; Ozonoff & Jensen, 1999; Ozonoff, 1997).

1.10.4 Theory of Mind

Theory of mind is described as the ability to make inferences about the mental states of others in order to make predictions about their behaviour (Premack & Woodruff, 1978). Theory of mind is an area of impairment in adults with anorexia nervosa (Russell, Schmidt, Doherty, Young & Tchanturia, 2009; Tchanturia et al., 2004), however the generalisability of these findings is limited, as is the childhood anorexia nervosa literature to date. Across other areas of ability adult

findings appear generally consistent to those in childhood anorexia nervosa, and it follows from this research that theory of mind may be a weakness in child samples also.

Theory of mind impairment has however been linked to the social and communicative difficulties observed in ASD (Baron-Cohen, Tager-Flusberg & Cohen, 1993). Prefrontal Cortex abnormalities are thought to underlie ToM difficulties which have been further associated with executive dysfunction in ASD (Gilbert, Bird, Brindley, Frith & Burgess, 2008). This suggests that these areas are highly interlinked, although the exact nature of their relationship is unclear. Whilst theory of mind does not appear to directly relate to feeding difficulties, its link with EF is an important consideration when attempting to establish a coherent neuropsychological profile in children with SE difficulties, particularly those with ASD.

1.10.5 Limitations of neuropsychological research

Neuropsychological evidence in anorexia nervosa and ASD, such as the research discussed here, is somewhat limited in that a broad range of neuropsychological tests have been applied across studies and because the samples have been heterogeneous, including varying levels of severity (Tchanturia et al., 2005). In spite of these limitations, areas of particular strength and difficulty within the neuropsychological domain have emerged in anorexia nervosa in the adult literature and increasingly in child populations (Rose et al., 2011; Tchanturia et al., 2004). In the ASD literature the same has been shown in adult and child samples (Hill, 2004).

Nevertheless, the neuropsychological assessment of children with anorexia nervosa using tools developed for adults means that they are likely insensitive to the developmental nature of the skills they aim to assess in a younger population. This has emphasised the need for a targeted neuropsychological test battery to assess feeding and eating disorders in childhood.

1.10.6 Development of neuropsychological test batteries

The aforementioned Ravello Profile (Rose et al., 2011) is a novel neuropsychological test battery that covers the assessment of functioning across domains of interest in anorexia nervosa. Based on a plethora of neuropsychological findings from the adult field, the Ravello Profile was created to serve as a minimum range of tests to assess areas of neuropsychological strength and weakness in anorexia nervosa.

The Ravello Profile was first applied in a case series of nine children and adolescents (aged 12 to 16 years old) with anorexia nervosa. This research showed that as a group there was a high level of variability in the neuropsychological profiles that emerged, but despite this, specific deficits in visuospatial memory, cognitive flexibility, cognitive inhibition and central coherence were observed (Rose et al., 2012). The small sample size utilised may have been too small to establish a coherent neuropsychological profile, however this important exploratory design facilitated the identification of discrete specific deficits within participants, effects which a large scale comparative study may have obscured.

The following large-scale application of the Ravello Profile in a sample aged 9 to 27 years old (N=155) demonstrated a neuropsychological profile of similar strengths and weaknesses in anorexia nervosa (Stedal et al., 2012). Here, anorexia nervosa participants showed good Verbal Fluency but poor visuospatial processing, weak central coherence and a deficit in one EF domain – set-shifting, indicating cognitive inflexibility. These findings reflect those in adults and suggest a strong and enduring neuropsychological component in eating disorder, though it remains unclear whether these findings extend to those with SE.

1.11 Conclusions

SE difficulties are common and developmentally appropriate during early childhood (Tseng & Biagioli, 2009). However in a small but significant proportion of children, severe and enduring SE difficulties become entrenched and resistant to change with far-reaching consequences for a child's nutrition, long-term physical, cognitive, behavioural and socio-emotional development (Dubois et al., 2007; Jacobi et al., 2008). Several theories have sought to understand the aetiology of SE difficulties, which have been informed by research from the ASD field given the high prevalence of SE in children and adolescents with ASD. However, it remains the case that a large proportion of typically developing children experience SE in the absence of an ASD diagnosis (Bentovim, 1970), although it has been suggested that such individuals may present with elevated autistic traits (Pooni et al., 2012).

To date there has been no investigation into the neuropsychological basis of SE difficulties, despite attempts to delineate a neuropsychological profile in related eating disorders.

Furthermore, in the SE literature to date, there has been no discernible attempt to adhere to a strict inclusion criteria based on diagnostic guidelines for ARFID, in order to ensure reliability of findings in the context of a subgroup of selective eaters with clinically significant, entrenched SE difficulties. The research reviewed suggests overlapping areas of neuropsychological deficit across ASD and eating disorders in terms of theory of mind (Gilbert et al., 2008; Russell et al., 2009), EF and central coherence (Lopez et al., 2008; Rose et al., 2012; Ozonoff et al., 1994). Although differences have been shown in visuospatial processing which is found to be impaired in eating disorders but spared in ASD populations (Rose et al., 2011). Given the comorbidity between SE and ASD, it is unclear whether these findings may extend to children with SE and elevated autistic traits or indeed whether there is a distinct neuropsychological profile in SE as an isolated phenomenon. The present study thus aimed to find whether there is a distinct neuropsychological profile that is shared in children and adolescents with SE. In order to overcome methodological issues identified in previous research and to provide a reliable picture of difficulties experienced in young people with entrenched clinically significant SE difficulties, participants were recruited from a specialist feeding disorder service and thus represented the subgroup of selective eaters experiencing clinically significant impairment in the context of their feeding disorder. Furthermore, the current study aimed to investigate whether there are aspects of the SE neuropsychological profile that vary depending on whether the child or adolescent displays elevated autistic traits

1.12 Research Design

In order to address the following hypotheses, a case series design was utilised in which a series of participants were described in terms of their neuropsychological profiles. This was deemed a useful design given the success of the initial application of the Ravello Profile in a similar such case series, representing the first attempt to describe an anorexia nervosa sample in a similar such way (Rose et al., 2011).

1.13 Hypotheses

1) There will be a distinct neuropsychological profile across children and adolescents with SE difficulties across the domains of cognitive flexibility, planning, inhibition, central coherence, visuospatial processing and theory of mind.

2) There will be differences in the neuropsychological profiles of children and adolescents with elevated autistic traits in terms of more marked impairments on tasks of cognitive flexibility and stronger performance on visuospatial processing.

2.0 METHOD

2.1 Design

The present study utilised a case series design which was a replication and modification of Rose et al., (2011) and applied the well-established Ravello Profile battery of assessments alongside additional measures relevant to a selective eating (SE) population. A series of 10 children were recruited from an inner London specialist feeding and eating disorders service. This sample size was agreed upon based on guidance from Schwartz and Dell (2010) who identified that this is the minimum expected sample size in case series designs.

2.2 Ethical approval

Ethical approval was sought and obtained through the NHS National Research Ethics Service (see Appendix 2) and the Royal Holloway University of London Ethics Committee (see Appendix 3).

2.3 Participants

2.3.1 Inclusion and exclusion criteria

The inclusion criteria for participants required that they be between the ages of 8 years and 0 months to 16 years and 11 months old. Each participant was required to meet clinical diagnostic criteria for avoidant restrictive food intake disorder (ARFID) in the context of a SE difficulty (see Figure 1). This diagnosis was made at assessment by the assessing clinician in the recruitment service.

Furthermore, in order to complete tasks successfully, families were required to have English as a first language and an adequate level of communication ability necessary to complete the test battery.

Additionally, the exclusion criteria specified that participants should not have an active feeding tube in situ, as receiving nutrition through a feeding tube would likely have a significant impact on hunger and feeding patterns. This may thus artificially induce a pattern of food selectivity that may not stem from a core difficulty in this area and otherwise resolve in the absence of tube feeds.

2.3.2 Participant demographic information

Ages of participants ranged from 8 years and 2 months old to 13 years and 5 months old (mean 9 years and 3 months). Eight male and two female participants were included.

Diagnostic Criteria for ARFID (based on the DSM-V) (APA, 2013)

1. An eating or feeding disturbance (e.g., apparent lack of interest in eating or food; avoidance based on the sensory characteristics of food; concern about aversive consequences of eating) as manifested by persistent failure to meet appropriate nutritional and/or energy needs associated with one (or more) of the following:
 - Significant weight loss (or failure to achieve expected weight gain or faltering growth in children)
 - Significant nutritional deficiency.
 - Dependence on enteral feeding or oral nutritional supplements.
 - Marked interference with psychosocial functioning.
2. The disturbance is not better explained by lack of available food or by an associated culturally sanctioned practice.
3. The eating disturbance does not occur exclusively during the course of anorexia nervosa or bulimia nervosa and there is no evidence of a disturbance in the way in which one's body weight or shape is experienced.
4. The eating disturbance is not attributable to a concurrent medical condition or not better explained by another mental disorder. When the eating disturbance occurs in the context of another condition or disorder, the severity of the eating disturbance exceeds that routinely associated with the condition or disorder and warrants additional clinical attention.

Figure 1 – Diagnostic criteria for ARFID

2.3.3 Participant clinical information

Four participants had an existing diagnosis of an autism spectrum disorder (ASD) as diagnosed using formal diagnostic measures in either a Tier 3 or Tier 4 Child and Adolescent Mental Health Service. Two participants were currently under consideration for an assessment of social and communication difficulties. Levels of autistic traits were determined using the Child Autism Spectrum Test (Scott, Baron-Cohen, Bolton & Brayne, 2002) (see Appendix 4) on which a conservative cut-off for elevated autistic traits was made for the purpose of this research. The

lowest score of a participant with a confirmed diagnosis of ASD was 13, and this was thus utilized as threshold for ‘elevated autistic traits’. Six participants scored 13 or above. Four participants scored below this, showing ‘low autistic traits’ and all scored markedly lower (below 9 points) on this measure.

In order to ascertain a minimum level of SE phenomenon in participants, the Children’s Eating Behaviour Questionnaire (Wardle et al., 2001) (see Appendix 5) was administered. All participants showed markedly high scores on the food fussiness scale, indicating high levels of SE behaviour across participants in the sample (see Table 1).

Table 1 – Children’s Eating Behaviour Questionnaire CEBQ parent-rated feeding behaviour scores

	FR	EF	EOE	SR	SE	DD	FF	EUE
P1	5	9	4	16	14	9	28	11
P2	6	4	3	19	20	3	30	16
P3	14	11	9	15	9	7	27	12
P4	5	5	4	25	12	4	28	4
P5	7	9	5	15	11	6	29	12
P6	11	12	8	16	12	6	28	15
P7	10	14	5	10	11	8	21	4
P8	5	5	4	20	20	4	30	12
P9	9	5	3	17	4	4	25	12
P10	9	5	5	17	14	4	30	8

Notes: FR = Food responsiveness; EF = Enjoyment of food; EOR = Emotional over eating; SR = Satiety responsiveness; SE = Slowness in eating; DD = Desire to drink; FF = Food fussiness; EUE = Emotional under eating.

Three participants had additional pre-existing diagnoses (reported by parents), including obsessive compulsive disorder (OCD) and two medical disorders (see Table 2). Of particular note is P6, who had previously experienced a brain tumour and had received neurosurgery to resect

Table 2 – Demographic information and psychometric comorbidity scores

	Age	Gender	IQ	Additional diagnoses	Total CDI T score	STAIC Trait T Score	STAIC State T Score	CHOCI Total Raw Score	CAST
P1	9y11m	Male	114	Ectodermal Dysplasia ASD (under investigation)	73*	68*	56	11	14*
P2	9y1m	Male	103	ADD/ADHD (under investigation)	75*	51	48	9	9
P3	13y5m	Male	120	OCD	58	87*	84*	36*	0
P4	8y9m	Male	90	ASD	64*	57	33	4	24*
P5	8y10m	Female	125	None	43	40	46	21*	3
P6	8y2m	Female	139	Pilocytic Astrocytoma	42	31	33	9	5
P7	8y9m	Male	126	ASD	53	47	56	17*	13*
P8	10y9m	Male	130	ASD	42	36	37	10	17*
P9	10y3m	Male	90	ASD	65*	25	25	3	20*
P10	9y3m	Male	117	ASD (under investigation)	52	67*	33	9	13*

Notes: * = Score above clinical threshold; FSIQ = Full Scale Intelligence Quotient; ASD: Autism Spectrum Disorder; ADHD: Attention Deficit Hyperactivity Disorder; OCD: Obsessive Compulsive Disorder; CDI = Children’s Depression Inventory; STAIC = State-Trait Anxiety Inventory for Children; CHOCI = Children’s Obsessive Compulsive Inventory; CAST: Child Autism Spectrum T

this. The placement of P6's tumour led to symptomology including a four year history of vomiting after every food intake, resulting in a highly rigid feeding pattern, likely linked to the aversive experience of frequent daily vomiting across a significant number of years. This case highlights to complex contributory history that some selective eaters may have with wide ranging factors likely underpinning their feeding rigidity.

Additionally, comorbidity was assessed using the State-Trait Anxiety Inventory for Children (Spielberger, Gorsuch, Lushene, Vagg & Jacobs, 1983) the Children's Obsessive Compulsive Inventory (Shafran et al., 2003) and the Children's Depression Inventory (Saylor, Finch, Sprito & Bennett 1984) (Appendices 6, 7 and 8 respectively). Clinical ranges for impairment across tasks can be found in Appendix 9. The data is summarised in Table 2 and shows that three participants met scores above threshold for OCD symptomology, four above threshold for depression symptomology, three met criteria for significant levels of trait anxiety and one met criteria for states anxiety.

Participant's cognitive abilities were measured in terms of their intelligence quotient (IQ) using the Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999) (Appendix 10) and IQ scores across the group ranged from 'average' to 'very superior'.

2.4 Measures

A range of measures were utilized which constitute the well-established Ravello Profile. Here, the neuropsychological tests will first be outlined covering the areas of visuospatial processing, central coherence, executive function (EF) (to include cognitive flexibility, inhibition and planning) and theory of mind. The additional assessments for comorbidities, cognitive abilities and sensory processing will also be outlined.

2.4.1 Visuospatial Processing

The Rey-Osterrieth Complex Figure (Osterrieth, 1944; Rey, 1941)

The Rey-Osterrieth Complex Figure measures visuospatial processing abilities and allows for relevant data to be collected in order to calculate a central coherence index (CCI) to assess central coherence abilities. During the task participants were presented with a complex line drawing of a geometric shape with both global features and detailed local features (see Appendix 11). They were initially asked to copy the figure exactly (copy condition). They then underwent three trials.

In the first two trials participants were required to draw the same geometric figure from memory immediately (immediate recall) and then after a 20-30 minute delay respectively (delayed recall). Each of the 18 elements were scored on a two-point system where elements were given a higher score based on whether they were accurately drawn and correctly placed. These were then converted to a T score on each trial using standardised norms.

In the final condition (recognition) participants were given a series of elements including 12 which were included in the original figure and 12 distracter items, and they were required to identify the elements that were in the original figure. This was scored in terms of the number of items that were correctly identified, and the total score was converted to a T score using standardised norms. These conditions allowed for the assessment of incidental visuospatial memory in that participants were not informed beforehand that they would be completing a memory task. The three T scores across immediate recall, delayed recall and recognition were used in the Ravello Profile as an indication of visuospatial abilities (see Appendix 9 for a description of the ranges used for clinical interpretation of the scores).

The pattern of performance across these trials was used to assign a “memory profile pattern” for each participant. This allowed for a description of the type of memory profile that each participant displayed in terms of how they retrieve and recognise visuospatial information. For example, a “normal” pattern would reflect a participant scoring in the ‘average’ range with T scores above 40 on both the immediate and delayed recalled trials with little or no slope between these scores, suggesting optimal performance within the ‘average’ range. An “attention” pattern would reflect a more impaired memory profile with scores across immediate, delayed and recognition trials all below a T score of 25 in the ‘impaired’ range with little slope between these. This would reflect a participant scoring consistently in the ‘impaired’ range with no benefit of recognition cues, reflecting poor attention on this task. A “retrieval” pattern would reflect a pattern whereby participants showed a showed roughly equivalent immediate and recognition scores, reflecting good recall of information immediately and with cues, but lower delayed recall. These patterns allow for an indication of a participant’s memory retrieval pattern in the context of visuospatial memory (a full description of profile patterns can be found in Appendix 12).

During the copy condition, the investigator numbered the order in which participants drew each of the elements. Replicating the procedure of Rose et al., (2011), the CCI (Booth, 2006), was calculated using this information based on the Meyers and Meyers Rey Complex Figure scoring system (Meyers & Meyers, 1995). This involved calculating two scores that illustrated a participant's approach to the order of construction which was assessed by calculating an Order of Construction Index score and also construction style which was assessed by calculating a Style Index score. The former was calculated by taking the first third of all complete elements drawn and assigning them a weight which indicated the importance of the element, that is, higher scores were assigned for global elements and lower scores for local elements. The mean weight was taken, providing the order of construction index and the proportion of the order of construction index score was calculated by dividing the order of construction index by 3.3. The order of construction index could range from 0 to 3.3, where higher scores reflected that more global elements were prioritized in early stages of drawing. The latter was calculated by scoring each of the global elements drawn on a three-point system based on whether they were completed in a continuous, fragmented or completely separate manner. Higher scores were awarded for continuous drawings as this indicated stronger coherence. The mean weight was taken providing the style index and the proportion of the style index was taken by dividing this by 2. The style index could range from 0 to 2, with higher scores indicating greater continuity in drawings. The proportion scores were added together to give the CCI which could range from 0 to 2, with higher scores reflecting a more coherent style using more global elements in early copying and indicating that these were completed in a more continuous manner, thus giving an indication of central coherence abilities.

2.4.2 Executive Function (EF)

Cognitive Flexibility

The Trail Making (test from the Delis-Kaplan EF System (Delis, Kaplan & Kramer, 2001))

The Trail Making test is a visuo-motor sequencing task which assesses cognitive flexibility. There are five conditions, four of which act as baseline conditions (condition 1 – visual scanning, condition 2 – number sequencing, condition 3 – letter sequencing, condition 5 – motor speed) (see Appendix 13). These conditions establish whether there are difficulties with attention, motor speed or basic sequencing abilities for both numbers and letters. Condition 5 (number-letter sequencing) is the experimental condition in which participants used a pencil to alternately

connect 25 circled numbers and letters in ascending and alphabetical order. They first completed a short practice trial before proceeding to the test trial.

Completion times were recorded and converted to T scores using standardised norms, indicating performance across all five conditions. The T score for condition 4 (number-letter sequencing) was utilised as a measure of cognitive flexibility in the Ravello Profile. Error analyses were also completed.

The Brixton task (Burgess & Shallice, 1997)

The Brixton Task is a rule-attainment task in which participants were shown a series of pages in turn, each with ten circles (divided into two rows of five) (see Appendix 14). One circle in each set of ten was shaded and changed location on each consecutive page according to a given rule, which itself changed several times throughout the presentation. Participants were required to predict the location of the shaded circle based on previous presentations. The total number of errors was then calculated and converted to a T score using standardised norms which was utilised in the Ravello Profile as a measure of cognitive flexibility on this task.

The Verbal Fluency test from the Delis-Kaplan EF System (Delis et al., 2001)

The Verbal Fluency test assessed the ability to provide verbal responses according to rules within a one minute time period (see Appendix 15). In the first condition (letter fluency) the participant was required to generate as many words beginning with a specific letter as possible. In the second condition (category fluency) participants generated as many words from a specific semantic category as possible. In the third condition (category switching) participants were required to alternate between generating words from two semantic categories. The first two conditions acted as assessments of baseline abilities relevant to the switching task, in order to delineate the effects of possible underlying baseline impairments on switching. The total correct responses and total switching accuracy were recorded in the category switching condition. These were converted to scores using standardised norms and the accuracy score was utilised in the Ravello Profile as a measure of cognitive flexibility.

Inhibition

The Hayling Sentence Completion task (Burgess & Shallice, 1997)

The Hayling Sentence Completion task assessed inhibition abilities and consisted of two parts (see Appendix 16). In section A, participants completed a sentence with congruent verbal responses, which allowed for recording of baseline initiation speed. In section B, sentences were completed with incongruent verbal responses, which allowed for assessment of verbal inhibition of the correct response. The number of errors made on section B were also recorded and referred to as section C. An overall score was calculated based on section A, B and C, and this was converted to a T score using standardised norms and utilised in the Ravello Profile to represent inhibition abilities.

The Colour-Word Interference test from the Delis-Kaplan EF System (Delis et al., 2001)

The Colour-Word Interference test assessed inhibition by requiring generation of a novel response instead of an over learned verbal response. Condition 1 (colour naming) and condition 2 (word reading) were baseline conditions to assess basic abilities in naming colours and reading words, skills that if impaired, might affect performance on the experimental condition of interest. In the experimental condition, condition 3 (inhibition) participants were required to say the coloured ink a colour name was written in, whilst inhibiting the pre-potent response of reading the colour name itself. In condition 4 (inhibition/switching) participants were required to switch between reading the colour name word and labelling the colour that a word was printed in (see Appendix 17).

Time taken to complete each condition was recorded as well as error rates. Raw scores were converted to T scores using standardised norms and the score obtained in condition 3 (inhibition) was utilised to represent inhibition abilities in the Ravello Profile.

Planning

The Tower of London test from the Delis-Kaplan EF System (Delis et al., 2001)

This task was utilised to assess planning abilities (see Appendix 18). During this task participants were presented with a series of 9 pictures of a board with three pegs on, with an arrangement of discs on one of the three. They were then presented with a peg/disc set like that in the picture and the discs were placed according to the manual on each trial by the investigator. Participants were then required to move the discs in order to produce the arrangement that was presented to them in the stimulus picture. They were asked to do this in the lowest number of moves possible. They

were required to adhere to two rules including that only one disc could be moved at a time and that a larger disc could not be placed atop a smaller disc. A total achievement score was calculated for each item based on the number of moves taken to complete it, and these were summed. The overall score was then converted to a T score using standardised norms, and this was utilised in the Ravello Profile as an indication of planning abilities.

Parent-rated EF abilities

Behaviour Rating Inventory of EF (BRIEF) (Gioia, Isquith, Guy & Kenworthy, 2000)

The BRIEF (see Appendix 19) is an 86-item parent-completed questionnaire that was used to assess EF abilities across inhibition, shifting, emotional control, initiation, working memory, planning/organization/ organization of materials and monitoring. This was included to provide an assessment of whether any EF difficulties not detected using the neuropsychological tasks may be present and impact everyday functioning. This was provided to parents to complete whilst their child was undergoing testing.

2.4.3 Emotional Theory of Mind

Reading the Mind in the Eyes Task (Child Version) (Baron-Cohen, Wheelwright, Spong, Schill & Lawson, 2001)

During this task participants were presented with a picture of a human's eyes and asked to choose which of four adjectives displayed around the picture best described the mental state of the person whose eyes were shown (see Appendix 20). The adjectives used were both affective and non-affective mental state terms and so this was not merely considered a test of emotion recognition. Participants were first given a practice trial to ensure that they understood the task before proceeding with 28 test items in which the position of the correct answer was randomized on each trial of the test.

M&M false belief task (Perner, Firth, Leslie & Leekham, 1989)

This is a simple pass/fail task that was used to assess the ability to understand that one's own mental state may be different to another. Participants were asked what they expected to find in an M&M box. They were then shown that there were coins in it, not M&M's and asked what another person may guess when asked. Children fail if they specified that others would guess coins, which would suggest a difficulty distinguishing their own understanding from that of another.

This provided a practical alternative to the Reading the Mind in the Eyes task that was not related to emotion detection. Children were scored on a pass/fail basis.

2.4.4 Assessment of autistic traits

Child Autism Spectrum Test (Scott et al., 2002)

The Child Autism Spectrum Test was administered to determine the level of autistic traits in a participant (see Appendix 4). This is a 37-item parent-completed questionnaire which covers areas of difficulty associated with autistic features such as social behaviour and communication preferences. Scott et al. (2002) established cut-off scores in an initial pilot study in which they showed that 13 children with Asperger Syndrome obtained an average score of 21.08 (range 15-31) compared to 37 typically developing children who obtained an average score of 4.73 (range 0-13). In the main study in which the Child Autism Spectrum Test was administered to 1150 children, they concluded that the Child Autism Spectrum Test was a sensitive measure to identifying children with social and communication difficulties. A cut-off of 15 points was established with higher scores representing a higher number of autistic traits. However, in the present research the minimum score obtained by a participant with an ASD diagnosis was 13, which was markedly higher than the next lowest scores in those without an ASD. As such a conservative cut-off of 13 was used (see Appendix 9).

2.4.5 Sensory sensitivity

Given the predominant sensory difficulties seen in selective eaters and the predominance of selectivity around texture and taste (Bryant-Waugh et al., 2010) a measure of sensory processing was included in the test battery.

The Sensory Profile (Dunn, 1999)

The Sensory Profile is a 125-item questionnaire covering areas of sensory processing, modulation and behaviour and emotional responses. This questionnaire was completed by parents of children aged 3 to 10 years of age. Participants above 10 years old were not administered this questionnaire due to a lack of comparability between scales developed across different age groups (see Appendix 21).

2.4.6 Assessment of feeding

The Children's Eating Behaviour Questionnaire (Wardle, et al., 2001)

This is a 35-item parent-rated questionnaire assessing the eating styles observed in a child. This was assessed on eight scales (food responsiveness, enjoyment of food, emotional overeating, desire to drink, satiety responsiveness, slowness in eating, emotional under eating and fussiness). Parents were required to rate the frequency of their child's feeding behaviour on a 5-point scale ranging from never (1) to always (5) (see Appendix 5).

2.4.7 Cognitive assessment

Wechsler Abbreviated Scales of Intelligence (Wechsler, 1999)

The Wechsler Abbreviated Scales of Intelligence is a standardized test to assess intellectual abilities in 6 to 89 year olds. It was utilised to obtain an IQ in each of the children assessed. This is an abbreviated version of full IQ scales and for the purposes of this research two subtests were administered including one verbal subtest (Vocabulary) and one non-verbal subtest (Matrix Reasoning), to provide a full scale IQ (FSIQ). The Vocabulary subtest required participants to define up to 31 words presented to them, for example "what is a cow?". The Matrix Reasoning subtest required participants to view a grid with a pattern on with one piece missing. They were then given a row of pictures which represented possible pieces that could fit into the grid to complete the picture and they were required to pick the one that they felt would achieve this (see Appendix 10).

2.4.8 Additional measures

A series of additional measures to assess levels of symptomology in three possible areas of comorbidity (anxiety, OCD and depression) were also administered. These self-report questionnaires were administered in order to assess for other common difficulties that may have factored into a participant's performance on the tasks presented.

Stait-Trait Anxiety Inventory for Children (Spielberger et al., 1983)

This is a self-report questionnaire with 20 items to assess for current anxiety levels and 20 items to assess for anxiety in how a young person usually feels. This was suitable for children aged between 8 and 14 years old (see Appendix 6).

Children's obsessive compulsive inventory (Shafran et al., 2003)

This is a questionnaire designed to assess symptoms related to OCD. It contained 19 items plus impact on life questions with regards to compulsions and 13 items with impact on life questions with regards to obsessions. This questionnaire is suitable for young people aged 8 to 16 years old (see Appendix 7).

Children's Depression Inventory (Saylor et al., 1984)

This is a 27-item self-report questionnaire suitable for young people between the ages of 8 and 17 years old. This was utilized to assess for symptoms of low mood/depression in each of the participants assessed (see Appendix 8).

2.5 Procedure

Participants who had been assessed and/or who had been offered treatment by a specialist feeding and eating disorders service were identified. The open case list, as it stood on the day of participant selection included 54 patients. First, participants were short-listed for recruitment based on the initial criteria that they had been assessed by a clinician in the team as meeting DSM-V (APA, 2013) criteria for ARFID in the context of SE. Inclusion and exclusion criteria were then applied in order to select patients that met criteria for the study, leaving a recruitment pool of 15 patients.

This shortlist included patients awaiting a triage or multidisciplinary team assessment, awaiting treatment and those in treatment in the service. During recruitment, those individuals who had impending triage or multidisciplinary team assessments were approached first. Those who were awaiting/who had started treatment were then recruited in order of their date of assessment, starting with those assessed most recently to ensure that those who had received minimal input in terms of treatment were recruited first. Of these, 12 were recruited; however two families withdrew due to medical reasons and time commitments.

The assessing or treating clinician initially discussed the project with families before providing them with information sheets and consent forms. Parental forms were designed specifically for adults (see Appendix 22) whilst child forms were designed specifically for children (see Appendix 23). Families were asked to take the information away for review or the discussion was

handed over to the Chief Investigator with the consent of the family, if available in clinic. Families provided consent for the Chief Investigator to contact them seven days later via telephone to discuss their interest in participating further, ask any questions and book an assessment appointment.

Families who consented attended their appointment. This was arranged at the family's convenience, which was usually on the same day as their next routine clinic appointment. If a clinic appointment was not scheduled within this time, families were invited to attend a one-off research assessment appointment; this was the case for two participants.

The Ravello Profile and additional questionnaires were then administered in the test order found in Table 3 and Table 4 to the young person or their parent. The testing period took between one and a half hours and two and a half hours. The average time taken to complete an assessment was approximately two hours, including breaks and an initial introduction period.

2.6 Ethical considerations

Several ethical issues were considered prior to data collection. The first was the issue of consent/assent. Given the age of the participants recruited, informed consent was obtained from legal guardians as well as from participants to acknowledge their agreed involvement in the project. Information sheets and consent forms (see Appendix 22 and 23) were designed to be user friendly and engaging to the children being recruited, in order to work towards facilitating their understanding of their involvement in the project. The second issue was the length of testing and the fact that participants would be separated from their guardians for the length of the test period. To overcome this, they were given regular breaks to see their guardian and informed that they could request these at any time. It was also vital to engagement and continued optimal levels of performance that in cases where participants were particularly concerned about being separated from their guardian, parents were invited to be present. This was the case for five participants and in this instance parents were seated behind the child so as not to distract them whilst they were engaged in tasks.

The third consideration was managing agitation or distress during testing. It was important to have a clear plan for this in order to minimize the length of any period of distress. These

Table 3 – Test order of measures administered to child participants

Test Number	Test Name	Completed by
1	Reading the mind in the eyes	Child
2	Rey-Osterrieth Complex Figure Test (copy condition)	Child
3	Verbal Fluency (condition 1)	Child
4	Rey-Osterrieth Complex Figure Test (immediate recall)	Child
5	Verbal Fluency (conditions 2 and 3)	Child
6	Hayling	Child
7	Wechsler Abbreviated Scale of Intelligence– Vocabulary (interrupt at 25 minutes for Rey- Osterrieth Complex Figure Test delayed recall if necessary)	Child
8	Rey-Osterrieth Complex Figure Test (delayed recall)	Child
9	Rey-Osterrieth Complex Figure Test (recognition)	Child
10	Wechsler Abbreviated Scale of Intelligence – complete vocabulary subtest if necessary	Child
11	Trail Making	Child
12	Colour-word Interference	Child
13	Brixton	Child
14	Wechsler Abbreviated Scale of Intelligence – Matrix Reasoning	Child
15	Tower	Child
16	M&M false belief task	Child
17	Stait-Trait Anxiety Inventory for Children	Child
18	Children’s Depression Inventory	Child
19	Children’s Obsessive Compulsive Inventory	Child

Table 4 – Test order of measures administered to parents of participants

Test Number	Test Name	Completed by
1	Behaviour Rating Inventory of Executive Function	Parent
2	Sensory Profile	Parent
3	Children’s Eating Behaviour Questionnaire	Parent
4	Child Autism Spectrum Test	Parent

difficulties were initially managed in the room by the Chief Investigator and parents were sought or asked to remain in the testing room to relieve anxiety where necessary, as discussed. Furthermore, assessments were arranged in clinic and only when a responsible member of the clinical team was available should any risk issues arise. There were no occasions in which participants became significantly distressed.

A fourth issue was confidentiality. All information was kept confidential except for where a risk was identified. This limit to confidentiality was outlined and agreed to in the information sheets and consent forms and families were reminded of this at the start of their assessment. Given the nature of the tests administered it was not expected that there would be an opportunity for disclosure of clinically important or risk information, however several participants did endorse the suicidal ideation item on the Children’s Depression Inventory and this was managed by discussing the results with the young person and their guardian before handing information immediately on to the treating clinician, who was always available given that assessments were scheduled around existing clinical appointments.

A fifth issue was last minute changes in testing locations to suit presenting difficulties. One participant was particularly distracted by the toys located in the testing room during the introduction and so the room was cleared before testing commenced. Furthermore, heating levels were high in the rooms available for testing which was not conducive to testing P1, whose medical condition meant that he had poor internal control of temperature. The room was therefore changed before testing began. This flexibility was important for testing in optimal conditions and

meant that participants were in the most comfortable environment possible. On reflection, discussions around these issues may have been helpful before testing had begun, but this may have caused confounding effects of providing medical information to the researcher that could have influenced their administration and scoring.

Finally, due to the use of established standardised norms and the fact that the study was largely a replication of a previous procedure, service user input was not requested prior to data collection. Participants were however asked at the end of their interview whether and how they would like to be informed of the study outcomes in order to obtain feedback about their preferences for dissemination.

2.7 Quality control in the case series

In order to ensure an adequate sample size, a literature search was undertaken which generated a recommended sample size of 10 or above (Schwartz & Dell, 2010) thus a sample size of 10 was chosen to adhere to this and ensure quality in the case series.

Furthermore, attempts were made where possible to minimise bias. For example by administering tests in a set order and in a standardised way. This included ensuring that tests were organised according to manual recommendations, for example not conducting any perceptual tasks between the Rey-Osterrieth Complex Figure Test copy condition, and recall conditions, in order to avoid this interfering with visuospatial memory. Furthermore, a second rater (who was an established member of the Ravello Profile group) also assessed the Rey-Osterrieth Complex Figure Test drawings that were produced and the scores were discussed and a consensus made based on a review of the manual recommendations, for each participant. The same procedure was conducted in terms of determining consensus over the memory profile patterns that were produced on this task.

To ensure that quality standards in the analysis and interpretation of data were met, this was shared and discussed with the team who constructed the Ravello Profile in order to ensure that high standards had been met in the procedure and analysis of data.

2.8 Data analysis strategy

Given that the aim of the present research was to be the first to describe a SE sample, group mean comparisons were not felt to be useful as these eliminate variability in samples. In describing selective eaters, the present study aimed to include this variability in order to provide a valid snapshot of the characteristics of this population, thus implicating the case series a useful design for this purpose (Schwartz & Dell, 2010). Furthermore, in a comparison of the utility of a neuropsychological case series approach versus a group comparison approach in investigating data from 22 participants with ASD, researchers showed that group analyses were less informative. They concluded that case series descriptions allowed for detection of within and between participant variability in performance, that group analyses did not detect (Towgood, Meuwese, Gilbert, Turner & Burgess, 2009). Thus, case series are vital in understanding the significant levels of neuropsychological heterogeneity at an individual level (Willcutt, Sonuga-Barke, Nigg & Sergeant, 2008).

The present research adhered to guidelines not to conduct group comparison analyses (for example between those with low autistic traits or elevated autistic traits) so as not to make causal inferences during interpretation, as these are not reliable analyses in such designs (Kooistra, Dijkman, Einhorn & Bhandari, 2009). In order to address the hypotheses, cases were initially described on a case-by-case basis before trends in performance T scores across tests were described across the group. Z transformations were then calculated across tests and combined to provide broader domain scores (for example, cognitive flexibility). In line with the procedure adopted in Rose et al., (2011) and Stedel et al., (2012), this allowed for performance to be assessed in relation to standardised norms in the absence of a control group. Finally, the profiles of those with low autistic traits and elevated autistic traits were explored and emerging trends were reported.

3.0 RESULTS

The following chapter will be divided into three sections: the first will describe the sample on a case-by-case basis, highlighting each participant's performance across each of the areas of assessment. The second will aim to describe the selective eating (SE) group overall in order to address the first hypothesis and the third will further consider whether there are any trends present in terms of performance across different levels of autistic symptomology, to address the second hypothesis.

3.1 Case-by-case analysis

Summary tables of raw data across each task for all participants can be found in Appendices 24 to 31.

3.1.1 Participant 1 (P1)

Demographics, diagnoses and comorbidities

P1 was a White British male aged 9 years and 11 months old, with an 'average' full scale intelligence quotient (FSIQ) of 114 (performing at the 82nd percentile; 95% confidence interval (CI):106-120). He had a diagnosis of ectodermal dysplasia. He was currently undergoing an autism spectrum disorder (ASD) assessment and his Child Autism Spectrum Test score of 14 indicated elevated autistic traits. On administered comorbidity measures he exceeded the clinical threshold on the children's depression inventory and on the trait anxiety aspect of the state-trait anxiety inventory for children (T=73 and T=68 respectively).

Neuropsychological profile

P1's Ravello Profile (see Figure 2, in section 3.2.1) indicated performance largely within the 'average' range. He showed a particular strength in terms of his recognition of elements on the Rey Osterrieth Complex Figure task of visuospatial memory and in terms of his planning abilities. He demonstrated difficulties on the Central Coherence Index (CCI), indicating weak central coherence.

Visuospatial Processing

On the Rey Osterrieth Complex Figure, P1's poor raw score of 22 (cumulative percentile = ≤ 1) indicated poor visuospatial copying of elements which may have effected encoding of the information. His pattern of performance across trials of immediate recall (T=55), delayed recall (T=46) and recognition of elements (T=70) formed a 'Retrieval Memory Profile' pattern (please see Appendix 12 for profile descriptions), indicating that his immediate recall and recognition of elements were stronger in relation to poor retrieval of information on the delayed recall trial.

Central Coherence Index

P1's Order of Construction Index (which may range from 0-3.3) was 2.3, indicating that of the first third of elements copied, he drew more global elements. On the Style Index (which may range from 0 to 2) he scored 0.5, indicating a preference for local over global processing of visual elements. The order of construction index and style index proportions were summed to provide a CCI of 0.95 (T=28), indicating weak central coherence.

Executive Functions

Cognitive Flexibility

Across tasks of cognitive flexibility P1 performed in the 'average' range on the sequencing trial of the Trail Making test (T=57), the overall Brixton performance score (T=50) and on the switching total correct responses (T=47) and total switching accuracy (T=43) aspects of the Verbal Fluency test. On the Verbal Fluency test he did however show a difficulty on the percentage switching accuracy score, which took into account the number of incorrect switches. Here his score was 46.2%, in the 'impaired' range (T=27). Furthermore, P1 performed in the 'high average' range for baseline category fluency (T=63). A contrast analysis between this and his switching performance indicated that his switching, whilst in the 'average' range was more impaired than might be expected given his fluency scores (contrast T score=33).

Inhibition

P1 performed in the 'average' range across conditions assessing inhibition abilities (Hayling total score T=50 and Colour Word Interference test inhibition score T=50 and inhibition/switching score T=53). There were no difficulties observed on additional aspects of these tasks.

Planning

P1's planning abilities as assessed on the Tower test was in the 'superior' range (T=67). No further difficulties were observed.

Parent-reported EF abilities

Parent-reported executive function (EF) abilities on the behaviour rating inventory of executive function (BRIEF) indicated areas of clinically significant difficulty (where T>65) on shifting, emotional control, planning and organization and monitoring (see Figure 11, section 3.2.1). Validity scale calculations showed no negativity bias and good consistency in parental ratings.

Theory of Mind

P1 passed the M&M False belief task indicating intact theory of mind abilities. He did however produce a high number of errors (39.3% error rate) on the Reading the Mind in the Eyes task, suggesting difficulty in the area of inferring mental state and affect.

Sensory Processing

The parent-reported Sensory Profile indicated a 'probable difference' (raw score=40) on oral sensory processing and a 'definite difference' on behavioural outcomes of sensory processing (raw score=16). On overall factor clusters a 'probable difference' in terms of oral sensory sensitivity was observed.

3.1.2 Participant 2 (P2)

P2 was a White British male aged 9 years and 1 month old with an 'average' FSIQ of 103 (performing at the 58th percentile; 95% CI: 96–110). No comorbid difficulties were identified however he was under consideration for an assessment in the context of attention and hyperactivity deficits. P2 scored 9 on the Child Autism Spectrum Test, indicating low autistic traits. On comorbidity measures he demonstrated clinically significant depressive symptomology on the Children's Depression Inventory (T=75).

Neuropsychological profile

P2's Ravello Profile (see Figure 2, in section 3.2.1) indicated particular difficulty in terms of his visuospatial processing and CCI in which he scored in the 'impaired' range. He also showed 'impaired' performance on the Trail Making and Colour-Word Interference tasks. He did

however perform in the 'average' range on the remaining tasks of planning, cognitive flexibility and inhibition, with a particular strength in the 'superior' range on the Brixton test. This uneven profile thus shows high variability between and within domains.

Visuospatial Processing

On the Rey-Osterrieth Complex Figure Test, P2's copy raw score of 17.5 (cumulative percentile = ≤ 1) was in the 'impaired' range indicating poor visuospatial copying and encoding of elements. His pattern of performance across Rey-Osterrieth Complex Figure Test trials formed an 'Attention Memory Profile' pattern with 'impaired' performance of T scores under 25 on all trials.

Central Coherence Index

P2's order of construction index was 1.8, indicating that he tended toward initially copying global elements. His style index was 1.2, demonstrating a tendency towards a continuous style in drawing elements. The CCI remained low at 1.1 (T=33), indicating that overall he showed weak central coherence.

Executive Functions

Cognitive Flexibility

On two of the three cognitive flexibility tasks, P2 showed relatively intact abilities with performance in the 'superior range' (T=70) on the Brixton task and in the 'low average' range on the Verbal Fluency category switching total correct responses (T=37) and in the 'average' range (T=47) on total switching accuracy. His overall percentage switching accuracy, which took into account incorrect switches indicated 'average' performance (T=57).

P2 performed in the 'impaired' range on the sequencing condition of the Trail Making test (T=23), however contrast analyses revealed that a baseline impairment in visual scanning may have contributed to this effect (contrast T Score = 53).

Inhibition

Inhibition abilities appeared to be an area of relative difficulty for P2, where he scored in the 'moderate average' range (T=43) on the Hayling task. Further analysis revealed a particular

difficulty in the ‘poor’ range (scaled score=3) on section A, indicating difficulties initiating responses which may have contributed to this overall poor score.

P2 also performed in the ‘impaired’ range on inhibition (T=20) and in the ‘poor’ on inhibition/switching (T=33) aspects of the Colour-Word Interference test. This was not found to be attributable to any impairment in baseline abilities assessed.

Planning

P2’s planning abilities were in the ‘average’ range (T=47) on the Tower test. Further analysis revealed a weakness in the ‘impaired’ range (T=20) on the ratio of rule violations per item, suggesting that some aspects of the task were challenging for him.

Parent-reported EF abilities

Parent-report EF abilities on the BRIEF indicated clinically significant difficulties across all areas with the exceptions of shifting, planning and organizing and organization of materials (see Figure 11, section 3.2.1). Validity calculations indicated no negativity bias and acceptable consistency in parental ratings.

Theory of Mind

P2 failed the M&M False belief task indicating poor theory of mind abilities. He also produced a high number of errors (60.71% error rate) on the Reading the Mind in the Eyes task, suggesting difficulty in the area of inferring mental state and affect, however his performance may have been affected by attentional difficulties.

Sensory Processing

The Sensory Profile scores indicated that P2 had a ‘definite difference’ in oral sensory processing (raw score =36) and in terms of emotional/social responses and behavioural outcomes of SP (raw scores = 51 and 15, respectively). P2 showed a ‘probable difference’ on the oral sensory sensitivity factor cluster. These results suggested a difficulty with sensory processing in the context of oral functioning.

3.1.3 Participant 3 (P3)

P3 was a British male aged 13 years and 5 months old with a FSIQ of 120 in the ‘high average’ range (performing at the 91st percentile; 95% CI: 111–126). He had a diagnosis of Obsessive Compulsive Disorder (OCD) but no other diagnoses. His Child Autism Spectrum Test score of 0 indicated low autistic traits. On comorbidity measures he scored in the clinically significant range on the State-Trait Anxiety Inventory for Children (state T=84 and trait T=87) and on the children’s obsessive compulsive inventory (raw score=25). His high anxiety levels may therefore have affected performance across tasks.

Neuropsychological profile

P3’s Ravello Profile (see Figure 2, in section 3.2.1) indicated ‘average’ performance across all tasks of cognitive flexibility, inhibition and planning. His visuospatial processing abilities were a relative weakness for him with delayed recall in the ‘impaired’ range. He also showed a difficulty with ‘impaired’ performance on the CCI.

Visuospatial Processing

P3’s copy raw score of 32.5 (cumulative percentile = >16) showed unimpaired performance and thus an opportunity for encoding of visuospatial information. His performance ranged from ‘mildly impaired’ (T=37) on immediate recall, to ‘mildly to moderately impaired’ (T=30) on delayed recall and ‘below average’ (T=40) on recognition, suggesting difficulties in visuospatial processing. This formed a ‘Retrieval Memory Profile’ pattern.

Central Coherence Index

P3’s OCI was 2.3 indicating a tendency to copy elements with global features early on, however his SI of 0.8 indicated a tendency towards copying in a fragmented style. The CCI supported this, showing weak central coherence (CCI=1.1, T=33) and thus a difficulty in processing elements more globally.

Executive Functions

Cognitive Flexibility

P3 performed consistently within the ‘average’ range across cognitive flexibility aspects of tasks (Trail Making: T=53; Brixton: T=43; Verbal Fluency accuracy and total correct responses: T=47 for both and percentage switching accuracy T=50).

Inhibition

Performance on the Hayling (T=43) and Colour-Word Interference (inhibition: T=47 and inhibition/switching: T=47) was in the ‘average’ range. A difficulty on the Hayling Section A (scaled score=3) indicated a possible impairment in response initiation.

Planning

P3’s planning abilities were found to be intact (Tower score T=60).

Parent-reported EF abilities

No areas of difficulty were identified across EF domains on the BRIEF. Validity calculations revealed no negativity bias and consistent ratings by parents.

Theory of Mind

P3 passed the M&M False belief task indicating good ToM abilities. His low error rate (10.71%) on the Reading the Mind in the Eyes task suggested no difficulty in inferring mental state or affect.

Sensory Processing

The Sensory Profile was not completed for P3 due to his age being above cut-off.

3.1.4 Participant 4 (P4)

P4 was a white British male of 8 years and 9 months old, with an ‘average’ FSIQ of 90 (performing at the 25th percentile; 95% CI: 83–98). P4 had an ASD diagnosis and his Child Autism Spectrum Test score of 24, reflected high elevated autistic traits. On comorbidity measures he scored in the clinical range for depressive symptomology (T=64).

Neuropsychological profile

P4’s Ravello Profile (see Figure 2, in section 3.2.1) indicated ‘average’ performance across all areas with particular areas of difficulty represented by scores more than 1.5sd from the mean on the CCI domain and on the Trail Making and Tower tests, suggesting difficulty with some aspects of cognitive flexibility and planning.

Visuospatial Processing

P4's copy raw score was 21.5 (cumulative percentile = 2-5), indicated difficulties in initially copying and possible encoding visuospatial information. His performance was 'below average' on immediate and delayed recall (where T=44 and T=40, respectively) and in the 'above average' range (T=55) on the recognition trial, forming a 'Retrieval Memory Profile' pattern.

Central Coherence Index

P4's order of construction index was 1.6, indicating a relatively even approach to prioritising the drawing of global and local elements early on. His style index was 1.2 and demonstrated a slight tendency toward a continuous drawing style. However, overall P4's CCI was found to be an area of weakness (1.08, T=32), suggesting poor global processing.

Executive Functions

Cognitive Flexibility

P4's cognitive flexibility was found to be in the 'average' range on the Brixton test (T=50) and across the Verbal Fluency trials (category switching total correct responses T=47, total switching accuracy T=47 and percentage switching accuracy T=43). On the Trail Making test, he performed in the 'impaired' range for number-letter sequencing (T=27), however contrast analyses indicated that this performance was likely affected by poor baseline abilities in visual scanning (contrast T score = 50), number sequencing (contrast T score = 57) and letter sequencing (contrast T score = 57). Thus, overall his cognitive flexibility was relatively intact, with a particular difficulty on the Trail Making task possibly explained by additional underlying difficulties.

Inhibition

P4's performance on inhibition tasks was generally within acceptable bounds where he scored in the 'low average' range (T=37) on the Hayling task and on the inhibition and inhibition/switching conditions of the Colour-Word Interference task (T=43 on both). A difficulty in response initiation was detected on Section A of the Hayling task, where he scored in the 'abnormal' range (scaled score=2).

Planning

P4's planning abilities on the Tower test were in the 'poor' range (T=30). Encompassed by this overall score was a particular difficulty in terms of the ratio of rule violations per item (T=20).

Parent-reported EF abilities

The BRIEF parent-report indicated difficulty across all areas of EF. A particular area of difficulty was reported in shifting (T=84), with more borderline difficulties observed in organization of materials (T=67) (see Figure 11, section 3.2.1). The validity scales showed parental scoring was within acceptable bounds for negativity and inconsistency.

Theory of Mind

P4 failed the M&M False belief task indicating poor theory of mind abilities. His high error rate (39.30%) on the Reading the Mind in the Eyes task suggested particular difficulties in inferring mental state and affect.

Sensory Processing

On the parent-rated Sensory Profile P4 showed a 'definite difference' in oral sensory processing (raw score = 30) and in terms of emotional/social responses and behavioural outcomes of sensory processing (raw score = 49 and 14, respectively). On the factor clusters, P4 showed a 'definite difference' on oral sensory sensitivity (raw score = 15). These results suggested a difficulty with sensory processing in the context of oral functioning and a difference in the behavioural outcomes of sensory processing.

3.1.5 Participant 5 (P5)

P5 was a White British female aged 8 years and 10 months old, with a 'superior' FSIQ of 125 (performing at the 95th percentile; 95% CI: 116–130). She scored 3 on the Child Autism Spectrum Test, indicating low autistic traits. On comorbidity measures no clinically significant difficulties were identified.

Neuropsychological profile

P5's Ravello Profile (see Figure 2, in section 3.2.1) indicated performance in the 'average' range on tests of cognitive flexibility and planning, as well as one inhibition task. She performed in the

‘impaired’ range indicating greater difficulty in visuospatial processing, central coherence and on the Hayling test of inhibition.

Visuospatial Processing

P5 scored a copy raw score of 17 (cumulative percentile = >16) indicating good copying skills and thus adequate encoding of information. She performed in the ‘mildly to moderately impaired’ range on immediate recall and recognition (where T=30 and T=33, respectively) and in the ‘moderately impaired’ range (T=29) for delayed recall.

Central Coherence Index

P5’s order of construction index was 2.25 indicating copying of global elements early on and her style index was 0.7 indicating a fragmented style in her copying. The CCI was 0.98 (T=29), highlighting weak central coherence.

Executive Functions

Cognitive Flexibility

P5 performed in the ‘low average’ range (T=40) on the Trail Making sequencing trial, in the ‘high average’ range (T=57) on the Brixton task, and in the ‘average’ range on switching total correct responses (T=50), switching accuracy (T=53) and percentage switching accuracy (T=43) of the Verbal Fluency test. These scores indicated no difficulties in the area of cognitive flexibility.

Inhibition

P5 showed a difficulty represented by ‘poor’ performance on the Hayling test (T=30). This may be best explained by a particular difficulty in response initiation which was in the ‘impaired’ range (scaled score=1) on section A. She performed in the ‘high average’ range (T=60) on inhibition and inhibition/switching of the Colour-Word Interference task, respectively. Together these findings suggested no difficulty in response inhibition.

Planning

P5’s planning abilities on the Tower test were ‘high average’ (T=60).

Parent-reported EF abilities

The parent-reported BRIEF (see Figure 11, section 3.2.1) indicated no difficulties with EF abilities within the clinical range, supporting her EF task performance. Parental scoring validity analysis revealed no negativity bias and acceptable rating consistency.

Theory of Mind

P5 passed the M&M False belief task indicating intact theory of mind abilities. Her low error rate (17.86%) on the Reading the Mind in the Eyes task suggested good abilities in inferring mental state and affect.

Sensory Processing

The Sensory Profile report indicated a ‘definite difference’ in the area of oral sensory processing (raw score=34). She also showed a ‘definite difference’ in the oral sensory sensitivity factor cluster (raw score=23). Her emotional/social responses and behavioural outcomes of sensory processing were in the ‘typical difference’ range (raw score = 71 and 29, respectively).

3.1.6 Participant 6 (P6)

P6 was a White British female aged 8 years and 2 months old, with a ‘very superior’ FSIQ of 139 (performing at the 99.9th percentile; 95% CI: 129–144).

P6 had a complex medical history of an esophytic medullary pilocytic astrocytoma. This was detected following a four year history of intractable vomiting which led to difficulties with selectivity in feeding. Following the resection of this tumour with neurosurgery, P6 remained rigid in her food preferences, which was hypothesised to be related to the traumatic experiences of vomiting the majority of her meals over a significant time period.

She scored 5 on the Child Autism Spectrum Test, indicating low autistic traits.

Neuropsychological profile

P6’s Ravello Profile (see Figure 2, in section 3.2.1) demonstrated ‘average’ performance on tasks of cognitive flexibility, planning and visuospatial processing. She likewise performed in the ‘average’ range with a strength on the Rey-Osterrieth Complex Figure Test recognition trial. She

showed a particular difficulty on the Hayling subtest of inhibition and performance below the average range on the CCI, highlighting these as difficulties for her.

Visuospatial Processing

P6's Rey-Osterrieth Complex Figure Test copy raw score was 26 (cumulative percentile = >16) indicating good copying and encoding of information. She performed in the 'average' range (T=53) for immediate recall and in the 'above average' range for delayed recall (T=63) and recognition (T=62). This pattern formed a 'Normal Memory Profile' pattern. Thus, she showed strong visuospatial abilities.

Central Coherence Index

P6's order of construction index was 2.3, indicating copying of more global features early on and her style index was 1 demonstrating a fragmented copying style. The CCI was further calculated as 1.2 (T=37), indicating weak central coherence.

Executive Functions

Cognitive Flexibility

P6's cognitive flexibility task performance indicated no difficulties in this domain, with scores in the 'average' range for Trail Making sequencing abilities (T=43), in the 'high average' range (T=57) on the Brixton and in the 'average' range on the Verbal Fluency total correct responses and switching accuracy (T=53 and T=43 respectively). However, her percentage switching accuracy was 'impaired' (T=23). Thus, whilst she produced a high number of accurate switches, this was in the context of a high number of inaccurate ones, suggesting a subtle difficulty on this task.

Inhibition

P6's Hayling performance was in the 'poor' range (T=30), which was likely underpinned by 'impaired' performance on Section A, suggesting impaired initiation abilities (scaled score=1). Her Colour-Word Interference test performance was 'average' for inhibition and inhibition/switching (T=57 on both). Thus, it is likely that this represents a trend toward intact inhibition abilities.

Planning

P6's planning abilities as assessed on the Tower test were in the 'average' range (T=57).

Parent-reported EF abilities

P6 was rated as having clinically significant initiation difficulties (T=65) which fits with the initiation difficulties detected on the Hayling test, with no concerns across other areas (see Figure 11, section 3.2.1). Validity analysis indicated no negativity biases and acceptable consistency of ratings.

Theory of Mind

P6 passed the M&M False belief task indicating intact theory of mind abilities. Her low error rate (25%) on the Reading the Mind in the Eyes task suggested good abilities in inferring mental state and affect.

Sensory Processing

On the Sensory Profile P6 scored in the 'definite difference' range for oral sensory processing (raw score=36) and the oral sensory sensitivity factor cluster (raw score=22). She showed a 'probable difference' on emotional/social responses (T=61) and in the 'typical range' for behavioural outcomes of sensory processing (T=24). This suggested a difficulty with oral sensory processing.

3.1.7 Participant 7 (P7)

P7 was a White British male aged 8 years and 9 months old with a 'superior' FSIQ of 126 (performing at the 96th percentile; 95% CI: 117–131). He had a diagnosis of ASD which was supported by elevated autistic traits detected on the Child Autism Spectrum Test (raw score=13).

Neuropsychological profile

P7's Ravello Profile (see Figure 2, in section 3.2.1) demonstrates that he showed a particular area of difficulty in the 'impaired' range on the Hayling test, but performed in the 'average' range for the Colour-Word Interference test, suggesting variable performance on inhibition tasks. He otherwise performed in the 'average' to 'high average' range across all other domains, with the exception of a particular difficulty on the CCI.

Visuospatial Processing

P7's Rey-Osterrieth Complex Figure Test copy raw score was 27 (cumulative percentile = >16) indicated good copying abilities and opportunity for encoding. He scored in the 'above average' range on immediate recall and recognition (T=53 and T=55, respectively) and in the 'average' range for delayed recall (T=49). This pattern formed a 'Retrieval Memory Profile' pattern.

Central Coherence Index

P7's order of construction index was 2.3 indicating that he drew more global elements early on. His style index was 0.5, showing a tendency to draw in a fragmented manner. P7's CCI score of 0.95 (T=28), indicated weak central coherence.

Executive Functions

Cognitive Flexibility

P7 performed in the 'average' range across all cognitive flexibility tasks where he performed in the 'average' range on the Trail Making sequencing test (T=47), Brixton task (T=50) and on the switching total correct responses (T=53) and switching accuracy (T=57) aspects of the Verbal Fluency test. His percentage switching accuracy score was in the 'low average' range (T=40).

Inhibition

P7's Hayling performance was 'impaired' (T=17). This was likely contributed to by an impairment (scaled score=1) in response initiation on section A. On the Colour-Word Interference test he showed a strength, performing in the 'superior' range for inhibition (T=67) and inhibition/switching (T=67).

Planning

P7's planning abilities as assessed on the Tower test were 'high average' (T=63).

Parent-reported EF abilities

No difficulties of clinical significance were identified on the BRIEF (see Figure 11, section 3.2.1). Validity calculations indicated no negativity bias or lack of consistency in responding.

Theory of Mind

P7 passed the M&M False belief task indicating intact theory of mind abilities. His high error rate (32.14%) on the Reading the Mind in the Eyes task suggested difficulty in inferring mental state and affect.

Sensory Processing

P7 scored in the ‘definite difference’ range on oral sensory processing (raw score=27), emotional/social responses (raw score=39) and behavioural outcomes of sensory processing (raw score=12). He scored in the ‘definite difference’ range for the oral sensory sensitivity factor (raw score=24), suggesting oral sensory processing difficulties.

3.1.8 Participant 8 (P8)

P8 was a White British male aged 10 years and 9 months old with a FSIQ in the ‘very superior’ range of 130 (performing at the 98th percentile; 95% CI:121–135). He had an existing ASD diagnosis which was detected on the Child Autism Spectrum Test, which indicated elevated autistic traits (raw score=17).

Neuropsychological profile

P8’s Ravello Profile (see Figure 2, in section 3.2.1) indicated ‘average’ performance across all tasks, with a particular strength on the Verbal Fluency test in the ‘high average’ range and difficulty on the CCI and Trail Making test where he performed in the ‘impaired’ range.

Visuospatial Processing

P8’s copy raw score of 26.5 (cumulative percentile=>16) indicated intact copying and thus encoding of visuospatial information. His immediate recall and recognition were ‘above average’ (where T=54 and T=55, respectively) and his delayed recall was ‘below average’ (T=48). This formed a ‘Retrieval Memory Profile’ pattern.

Central Coherence Index

P8’s order of construction index was 1.7 indicating that he prioritized relatively equal numbers of global and local elements early on. His style index was 1, showing no bias toward either a

fragmented or continuous drawing style. The CCI was further calculated as a score of 1 (T=30), indicating weak central coherence.

Executive Functions

Cognitive Flexibility

P8's performance on the Trail Making sequencing condition was 'impaired' (T=20), which contrast analyses revealed may be linked to a baseline impairment on visual scanning (contrast T score=43). No difficulties were observed on the Brixton task (T=63) or for category switching total correct responses (T=57), switching accuracy (T=47) or percentage switching accuracy (T=50) on the Verbal Fluency test.

Inhibition

No difficulties were observed across inhibition tasks where P8 scored in the 'average' range (T=50) on the Hayling and on the inhibition condition of the Colour-Word Interference test (T=43). He scored in the 'low average' range on the inhibition/switching trial of the Colour-Word Interference test (T=40).

Planning

P8's overall achievement score on the Tower test was in the 'average' range (T=47).

Parent-reported EF abilities

The BRIEF parent ratings indicated difficulty in shifting and emotional control, resulting in clinically significant impairment in the broader area of Behavioural Regulation (T=71) and also in initiation (T=69) (see Figure 11, section 3.2.1). The validity analysis indicated acceptable levels of consistency but an 'elevated' score for negativity bias in ratings, suggesting that these may not be valid ratings.

Theory of Mind

P8 failed the M&M False belief task indicating difficulties in theory of mind abilities. His high error rate (39.30%) on the Reading the Mind in the Eyes task suggested difficulty in inferring mental state and affect.

Sensory Processing

On the Sensory Profile P8 scored a ‘definite difference’ in oral sensory processing (raw score=30), in emotional/social responses (raw score= 42) and in behavioural outcomes of sensory processing (raw score =21). He also showed a ‘definite difference’ on the oral sensory sensitivity domain (raw score=16). This indicated sensory processing difficulties in the context of oral functioning.

3.1.9 Participant 9 (P9)

P9 was a White British male of 10 years and 3 months old, where his FSIQ of 90 was in the ‘average’ range (performing at the 25th percentile; 95% CI: 83–98). He had a diagnosis of ASD and elevated autistic traits were detected on the Child Autism Spectrum Test (raw score=20). No other diagnoses were identified, however he did score in the clinically significant range on the Children’s Depression Inventory (T=65).

Neuropsychological profile

P9’s Ravello Profile (see Figure 2, in section 3.2.1) showed that he had particular difficulties represented by ‘impaired’ performance on the visuospatial processing trials, the CCI and the Trail Making and Hayling tests. He performed in the ‘average’ range across all other tasks.

Visuospatial Processing

P9’s Rey-Osterrieth Complex Figure Test copy score of 9.5 (cumulative percentile= ≤ 1) indicated impaired copying and encoding of visuospatial information. Across immediate and delayed recall trials, P9 scored in the ‘moderately impaired’ range (where T=27 and T=25, respectively) and in the ‘mildly impaired’ range (T=35) on the recognition trial. This formed a ‘Retrieval Memory Profile’ pattern.

Central Coherence Index

P9’s order of construction index was 1.3, indicating that he initially drew more local elements. His style index was 1 based on having drawn only 1 global element in a fragmented manner. The CCI score of 0.9 (T=27), indicated a weak central coherence.

Executive Functions

Cognitive Flexibility

P9 showed 'impaired' performance on the Trail Making sequencing condition (T=27), however contrast analyses indicated that performance was likely affected by impairment in the baseline abilities of letter sequencing and motor speed (contrast T scores = 57 and 50, respectively). His performance on remaining tasks showed no difficulties where he scored in the 'average' range (T=50) on the Brixton task and on the category switching total correct responses (T=53), switching accuracy (T=53) and percentage switching accuracy (T=57) aspects of the Verbal Fluency test.

Inhibition

P9's Hayling performance was in the 'low average' range (T=37), a score which was likely affected by 'poor' performance in initiation abilities on section A (scaled score=3). His performance on the Colour-Word Interference test was also in the 'average' range across inhibition and inhibition/switching conditions (T=47 and T=53, respectively).

Planning

P9's planning abilities, as assessed using the Tower test, were in the 'average' range (T=50).

Parent-reported EF abilities

The BRIEF parent-report (see Figure 11, section 3.2.1) indicated difficulty in the clinically significant range across all areas except for emotional control. The validity analysis indicated negativity and consistency of the parent-rated responses were within the 'acceptable' range.

Theory of Mind

P9 failed the M&M False belief task indicating difficulties in theory of mind abilities. His high error rate (42.80%) on the Reading the Mind in the Eyes task suggested difficulty in inferring mental state and affect.

Sensory Processing

On the Sensory Profile P9 showed a 'definite difference' in oral sensory processing (raw score=34), in emotional/social responses (raw score=45) and behavioural outcomes of sensory

processing (raw score=12). A ‘definite difference’ was observed on the oral sensory sensitivity factor cluster (raw score=24).

3.1.10 Participant 10 (P10)

P10 is a White British male aged 9 years and 3 months old with a FSIQ of 117 in the ‘high average’ range (performing at the 87th percentile; 95% CI: 109–123). He had a diagnosis of ASD which was supported by his elevated Child Autism Spectrum Test score of 13. No other diagnoses were identified however he did meet criteria for trait anxiety on the Stait-Trait Anxiety Inventory for Children (T=67).

Neuropsychological profile

P10’s Ravello Profile (see Figure 2, in section 3.2.1) demonstrated ‘average’ performance on the recognition Rey-Osterrieth Complex Figure Test trial, the Brixton and Colour-Word Interference test. He showed high variability across other domains, with difficulty on the Trail Making, Verbal Fluency and Hayling tests. His planning abilities were just inside the average range.

Visuospatial Processing

P10’s Rey-Osterrieth Complex Figure Test copy raw score of 17 (cumulative percentile= ≤ 1) suggesting an impairment in copying and thus encoding of visuospatial information. On immediate and delayed recall P10 scored in the ‘mild to moderately impaired’ range (where T=35 and T=29, respectively) and on the recognition trial, in the ‘above average’ range (T=54). This best met criteria for a ‘Retrieval Memory Profile’ pattern.

Central Coherence Index

P10’s order of construction index was 2.3, indicating that he initially drew more global elements. His style index was 0.6, showing a bias towards a fragmented drawing style. His CCI score of 1 (T=30), indicated weak central coherence.

Executive Functions

Cognitive Flexibility

P10’s Trail Making performance was in the ‘poor’ range on the Trail Making sequencing condition (T=33), however contrast analyses indicated that this was likely affected by a baseline

letter sequencing difficulty (contrast T score of 57). He showed no further difficulties, performing in the ‘moderate average’ range (T=50) on the Brixton task and in the ‘average’ (T=37) and ‘low average’ (T=37) ranges respectively for category switching total correct responses and total switching accuracy on the Verbal Fluency test. His percentage switching accuracy, taking into account incorrect switches also, was shown to be ‘poor’ (T=33), suggesting a possible difficulty in this area.

Inhibition

P10’s Hayling performance was in the ‘impaired’ range (T=20). Further investigation revealed that he made an ‘abnormal’ number of errors (scaled score=2) on section C and scored in the ‘impaired’ range on response initiation on section A (scaled score=1). Performance on the Colour-Word Interference task was also in the ‘average’ range on inhibition (T=53) and inhibition/switching (T=47).

Planning

P10’s planning abilities, as assessed on the Tower test, were in the ‘low average’ range (T=40). This was likely underpinned by a weakness in the ‘impaired’ range (T=27) for his move accuracy ratio, suggesting that he made a substantially higher number of moves than were necessary.

Parent-reported EF abilities

The BRIEF parent-report (see Figure 11, section 3.2.1) indicated difficulty in the clinically significant range on working memory, planning/organization, organization of materials and monitoring. P10 thus scored in the clinical range on the Metacognition index (T=69). His overall global executive composite also fell in the clinically significant range (T=67). The validity analysis indicated that negativity and consistency were within acceptable bounds for parental scoring.

Theory of Mind

P10 failed the M&M False belief task indicating difficulties in theory of mind abilities. His high error rate (32.14%) on the Reading the Mind in the Eyes task suggested difficulty in inferring mental state and affect.

Sensory Processing

On the Sensory Profile P10 showed a ‘definite difference’ in oral sensory processing (raw score=35) and on the oral sensory sensitivity cluster (raw score=21). He scored in the ‘typical’ range for emotional/social responses (raw score=71) and behavioural outcomes of sensory processing (raw score=23). These results suggested difficulty with sensory processing in the context of oral functioning.

3.2 Analysis of neuropsychological profiles in relation to Hypothesis 1

This section will be divided into two main areas. The first will present performance across the SE group overall and, where relevant, discuss additional trends in aspects of task performance not captured by the core Ravello Profile scores, for example error rates. The second will then present domain composite Z scores where performance across the domains of visuospatial processing, CCI, cognitive flexibility, inhibition, planning and theory of mind will be described across the SE group in relation to standardised age matched norms.

3.2.1 Ravello Profile

Figure 2 shows the Ravello Profiles generated across all 10 selective eaters. This emphasises areas where group performance tended toward homogeneity which was particularly evident on the CCI. The graph also indicates possible trends in areas of strength on the Brixton and Verbal Fluency tasks. There was greater variability and heterogeneity in performance on the Rey-Osterrieth Complex Figure Test, Trail Making and Tower tasks and on both tests of inhibition.

Visuospatial Processing

Performance on the Rey-Osterrieth Complex Figure Test of visuospatial processing was considerably variable across the group with scores ranging from the ‘average’ to ‘impaired’ ranges (see Figure 2). A trend emerged in which eight out of 10 participants exhibited a ‘retrieval memory profile’ pattern across ROCF trials, whereby performance was generally stronger on the recognition trial than on the delayed recall trial. This indicated that visuospatial information was encoded, immediately recalled, but not adequately retrieved during the delayed recall trial. However, with the assistance of cues, elements were adequately recognized on the recognition trial. Two participants did not produce this retrieval pattern, which may be explained in terms of their distinct presenting difficulties that distinguished them from the rest of the group. P2 for

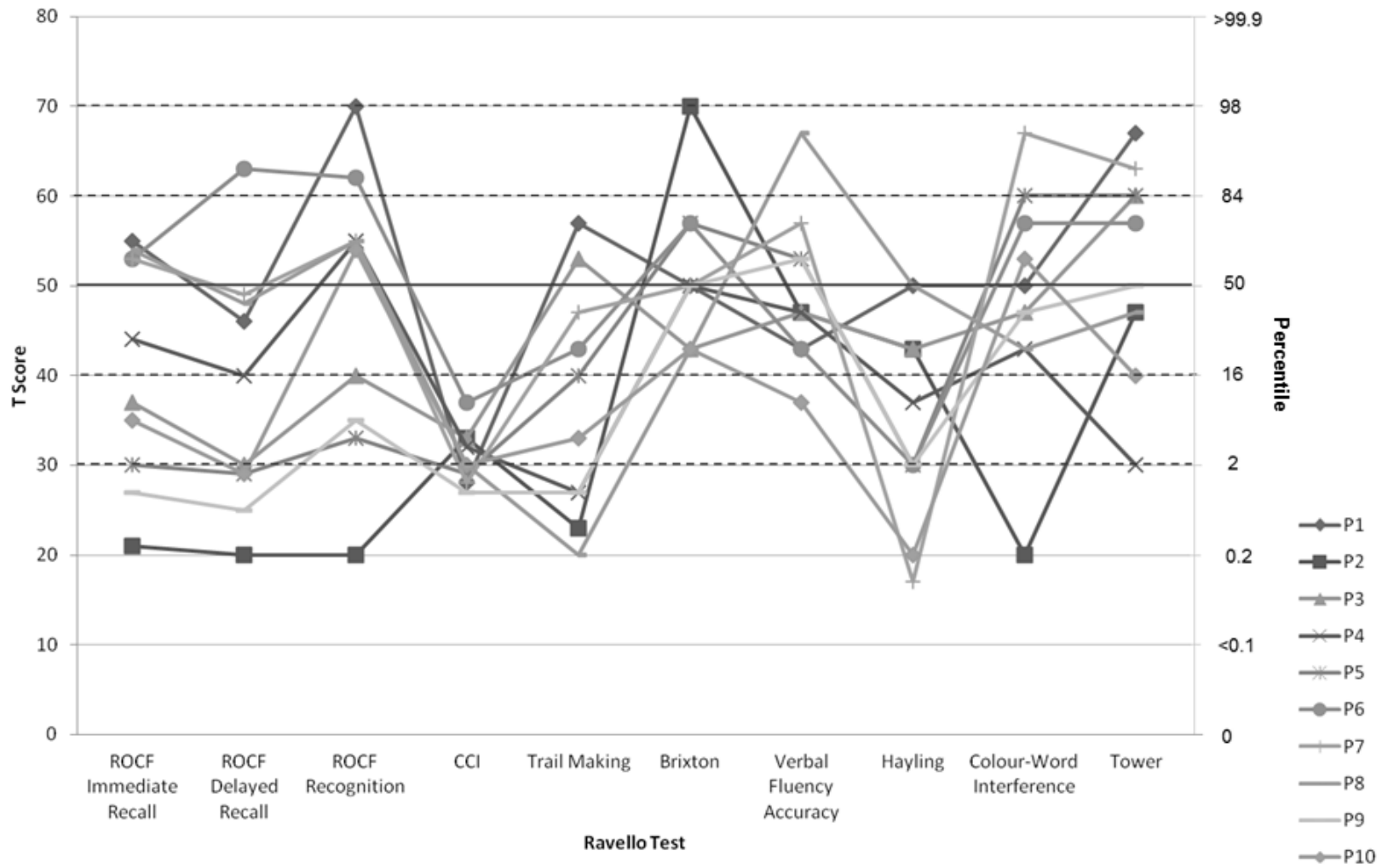


Figure 2 – Ravello Profiles across all participant

example, exhibited an ‘attention memory profile’ which is likely related to his attentional difficulties that were to be clinically assessed. P6 demonstrated a ‘normal memory profile’ which may be due to her history of a lack of impairment outside of a brain tumour and resection, and her SE difficulty mainly existing within this context.

Further analysis of the copy trial, indicated that participant’s raw scores, which demonstrate the quality in terms of accuracy and placement of elements, were variable across the group. Five participants performed below the 5th cumulative percentile, showing impaired initial visuospatial encoding of information and five participants performed equal to or above the 16th cumulative percentile, indicating strong visuospatial encoding of information (see Figure 18 in section 3.3).

Central coherence

The CCI was calculated using the order of construction index and style index (Meyers & Meyers, 1995). Across the group there was a tendency on the order of construction index to initially copy more global features as opposed to local features in the early stages of drawing, with eight of the 10 participants scoring in the higher half of the 0-3.3 scoring range on this measure, which reflects this tendency (see Figure 3).

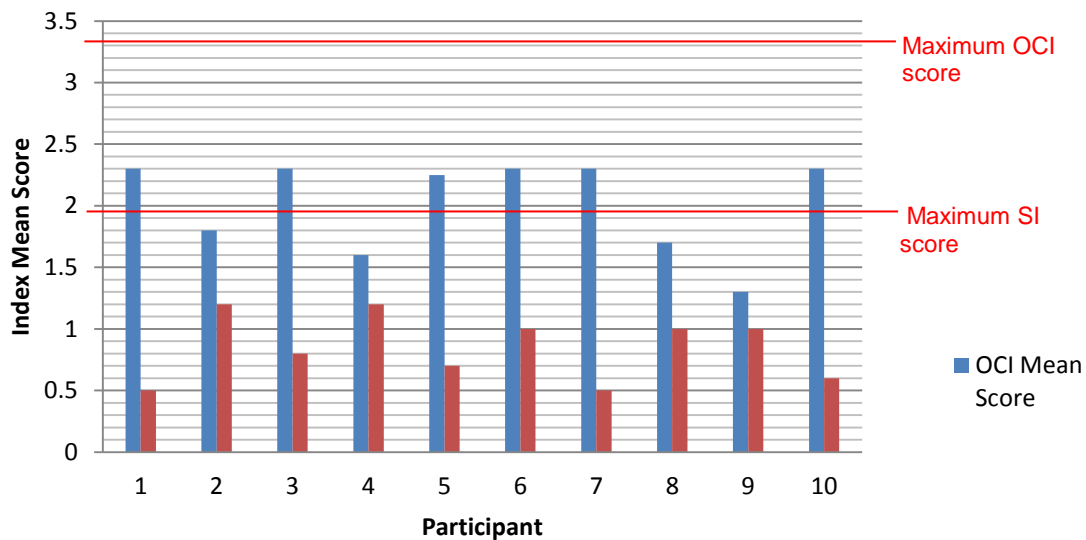


Figure 3 – OCI and SI scores across all participants

On the style index, which assessed the degree of continuity in drawings, five participants scored below 1 on the 0-2 scale, indicating a more piecemeal approach to drawing the elements. Two

participants, scored above this, suggesting a more continuous manner and three participants scored 1, indicating that there was neither tendency to draw in either a fragmented or continuous manner (see Figure 3).

The CCI abilities in nine out of 10 participants were below 1.5sd below the mean, suggesting that there was a tendency not to engage in global processing of information. One participant, P6, showed marginally better performance on this measure, performing below 1sd below the mean, also suggesting weak central coherence, but to a lesser degree.

Executive Functioning

Table 5 shows the mean scores for EF performance across the SE group. The high standard deviation (sd) values indicate that scores were highly spread around the mean for all EF abilities, with lower levels of spread on the Brixton and Verbal Fluency tasks, which would suggest a lesser degree of variability in the areas of cognitive flexibility captured by these tasks.

Table 5 - Descriptive Statistics across EF tasks

	N	Minimum	Maximum	Mean	Standard Deviation
TM sequencing	10	20	57	37	12.92
Brixton	10	43	70	51.3	8.35
VF switching accuracy	10	37	67	49.4	8.47
Hayling overall performance	10	17	50	35	11.58
CWI inhibition	10	20	67	48.7	12.68
Tower overall performance	10	30	67	52.1	11.45

Notes: TM: Trail Making test; VF: Verbal Fluency test; CWI: Colour Word Interference test; N: Sample size; SD: Standard deviation

Cognitive Flexibility

On the Trail Making sequencing task there was a high level of variability in scores with half of participants performing below 1.5sd under the mean, indicating impaired cognitive flexibility (see Figure 4).

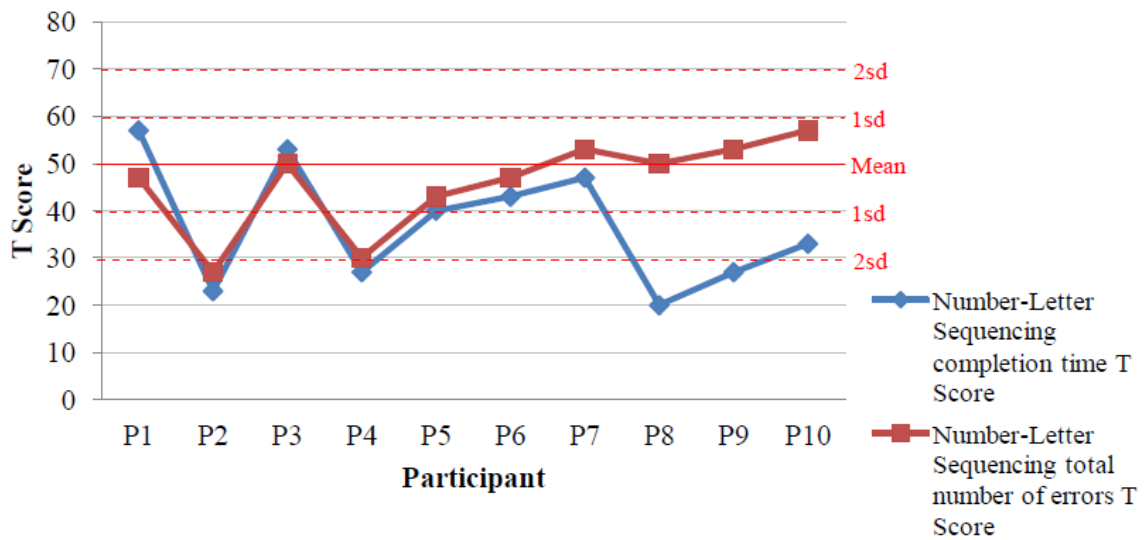


Figure 4 – Completion time and number of errors T scores on the letter-number sequencing condition of the Trail Making test

Single case contrast analyses indicated that impairment in these participants may be best explained by difficulties in underlying baseline abilities. Error analyses indicated better performance across the group, with only P2 and P4 performing in the impaired range. Thus these results reflected a pattern where accuracy generally remained high across the group, despite the task taking longer than might be expected for half of participants.

On the Brixton task of cognitive flexibility, the SE group overall showed no difficulties with performance falling within 1sd of the mean in all cases except for P2, who performed 2sd above the mean, reflecting a strength on this task (see Figure 5) this could again be contributed to by his uneven neuropsychological profile that is likely linked to attentional difficulties. This suggested intact cognitive flexibility across selective eaters on this test.

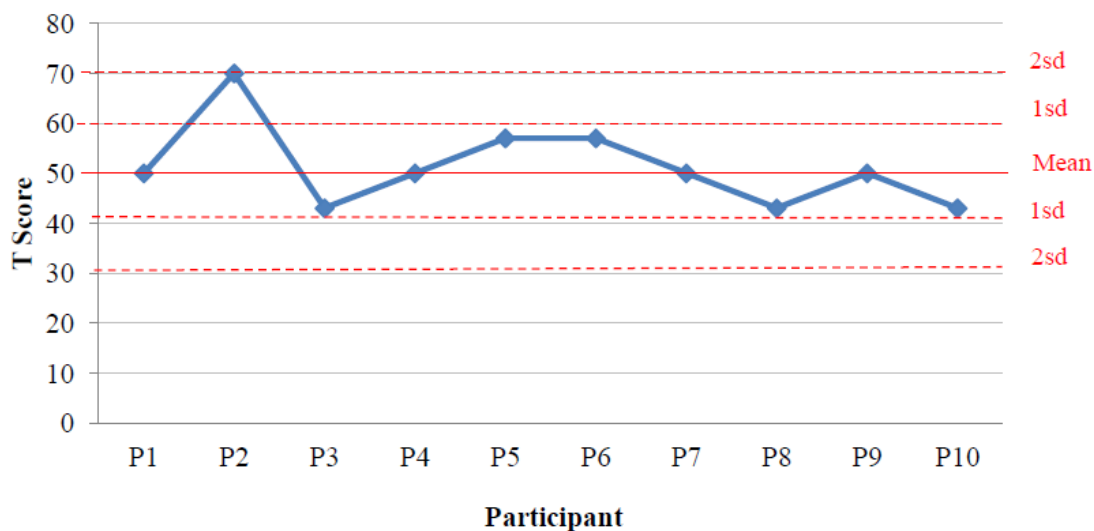


Figure 5 – T Scores for the number of errors produced on the Brixton task

Finally, Verbal Fluency performance was generally within the average range in terms of category switching with the exceptions of P8 who showed a strength on this task (T=67) and P10 who showed a relative weakness (T=33). This was consistent with scores indicating that the number of category members produced was also in the ‘average’ range across all participants (see Figure 6).

Each participant’s percentage accuracy score was also calculated to take into account the number of correct category switches in the context of the total number of switches made (these were converted to T scores, which are displayed in Figure 6). On this measure seven participant’s scores were lower than indicated on the primary accuracy T score utilised in the Ravello Profile and there was greater variability across the group, suggesting that this may be more sensitive to subtle deficits in this condition. Nevertheless, six participants’ scores still remained in the ‘average’ range but the remaining four participants performed in the ‘impaired range’. This thus suggested that when taking into account both accurate and inaccurate switches, a greater level of impairment in some participants was uncovered on this task, but the high variability across the group makes interpretation of this difficult.

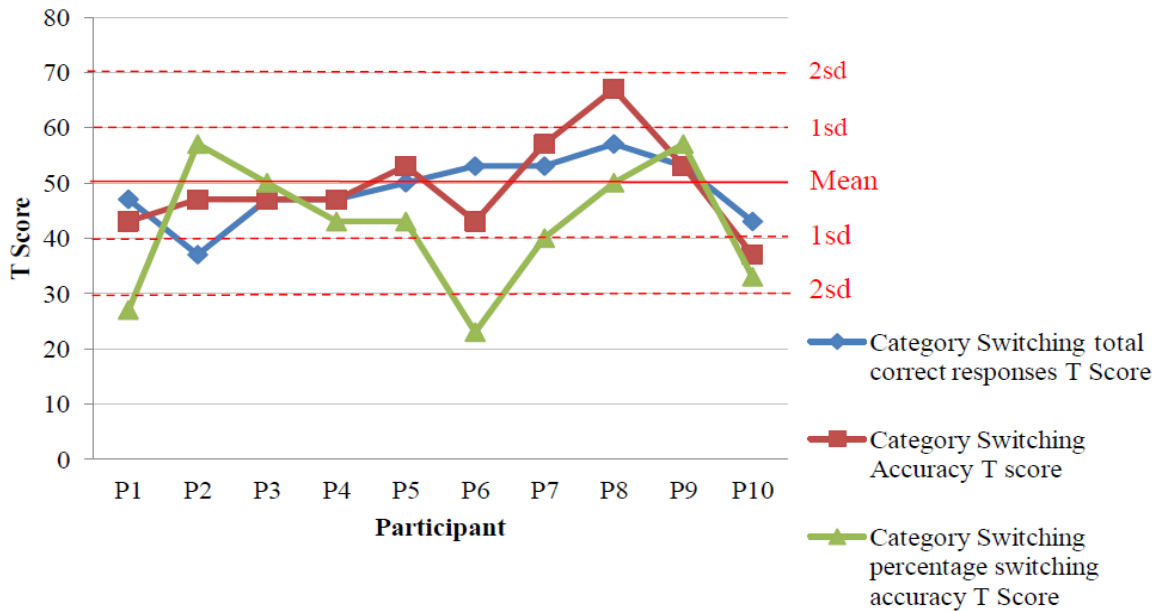


Figure 6 – T scores for performance on the category switching condition of the VF test

Inhibition

On the Hayling test participant's scores for the overall scaled score (which was then converted into an equivalent T score) were highly variable across the group, with four participants scoring within the 'average' range, four scoring in the 'impaired' range and one participant performing just under 1sd below the mean (see Figure 7). This variability in findings suggested no consistent pattern in inhibition abilities across this task.

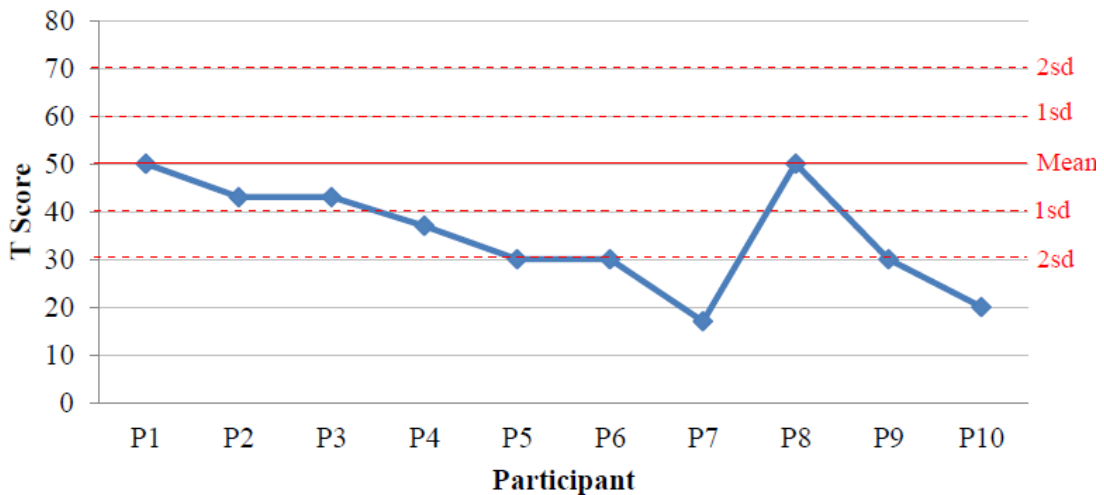


Figure 7 – T scores on the Hayling task

To better understand this variability, further analyses were conducted across the three Hayling subsections from which the overall score was calculated. On section A, participants were required to employ initiation skills which were found to be a difficulty across all participants, where the highest scores were ‘low average’ (scaled score of 4) for P1 and P8 and all other participants scored scaled scores of 3 or below (reflecting performance in the ‘poor’ to ‘impaired’ range) (see Figure 8).

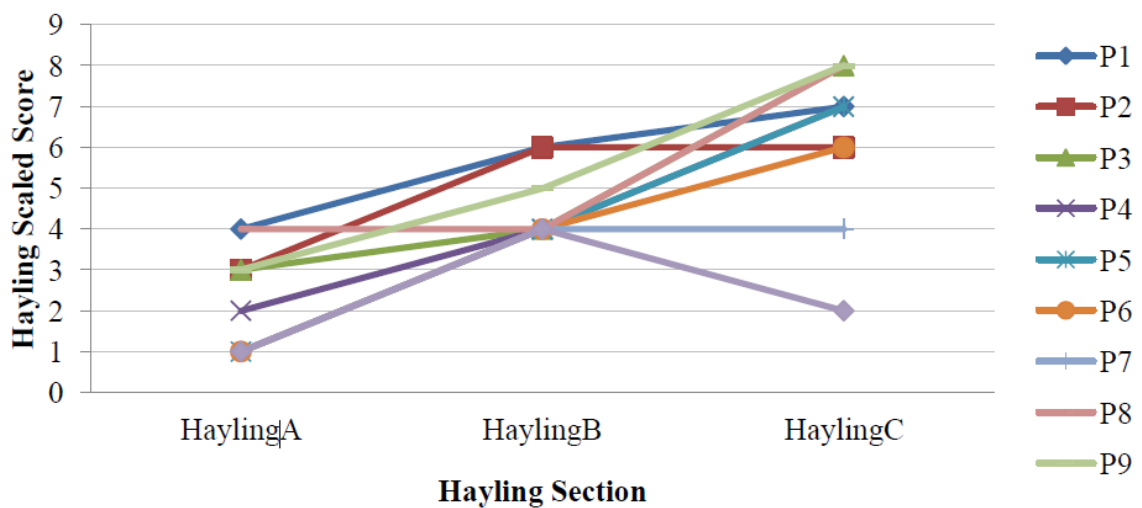


Figure 8 – Performance across Hayling sections

For inhibition abilities, which were employed in section B, performance was variable but largely within the ‘average’ range, suggesting fewer difficulties in this area. However, there was greater variability in performance in the number of errors (ranging from scaled scores of 2 to 8) in this section (as measured by section C), which likely demonstrated subtle inhibition difficulties in some participants. These results thus suggest that response initiation was an area of difficulty for all participants, with greater variability in inhibition across the group.

On the Colour-Word Interference task performance was generally within the average range across inhibition and inhibition/switching conditions. Two exceptions were P2 who showed impaired performance below 1sd under the mean on both conditions, and P7 who showed a relative strength on both conditions (see Figure 9).

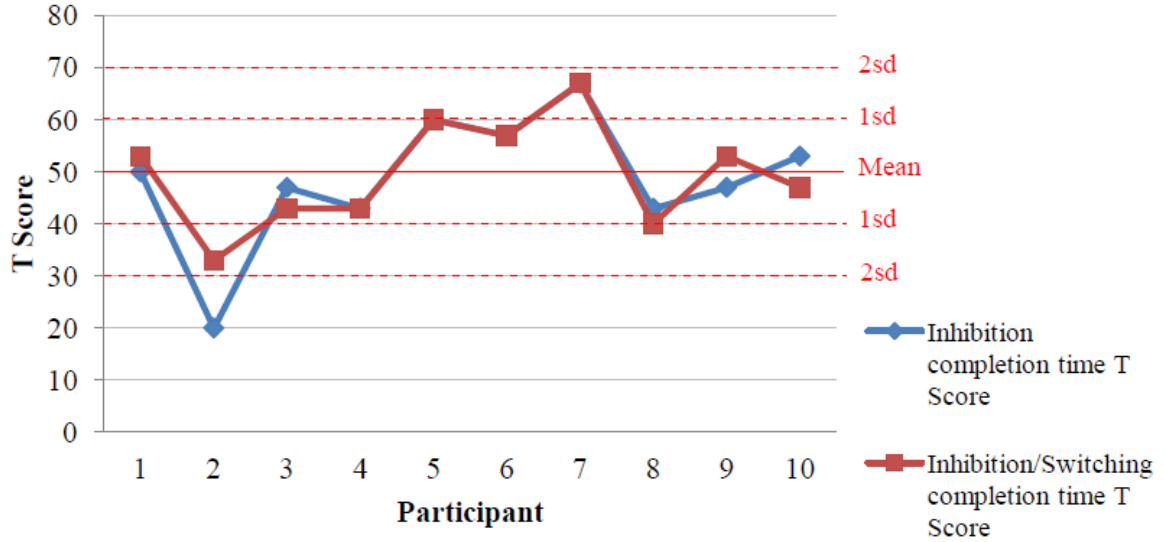


Figure 9 – Colour-Word Interference T scores on inhibition and inhibition/switching conditions

Further error analysis indicated performance within the ‘average’ range on the inhibition condition, with the exception of P2 (T=30), who demonstrated a high number of errors below 2sd from the mean. On the inhibition/switching condition a greater number of errors were shown under 1sd below the mean for P2, P4, P8 and P10 (where T = 23, 27, 33 and 40, respectively) whilst the remaining participants performed in the ‘average’ range (see Appendix 27). This variability therefore limited clarity in these results, but suggested that in the inhibition/switching condition, the greater task burden resulted in a higher number of errors in some participants.

Planning

Planning abilities, as assessed on the Tower test were broadly within the average range, with the exception of P4 who showed a relative weakness and scored 2sd from the mean (T=30) (see Figure 10).

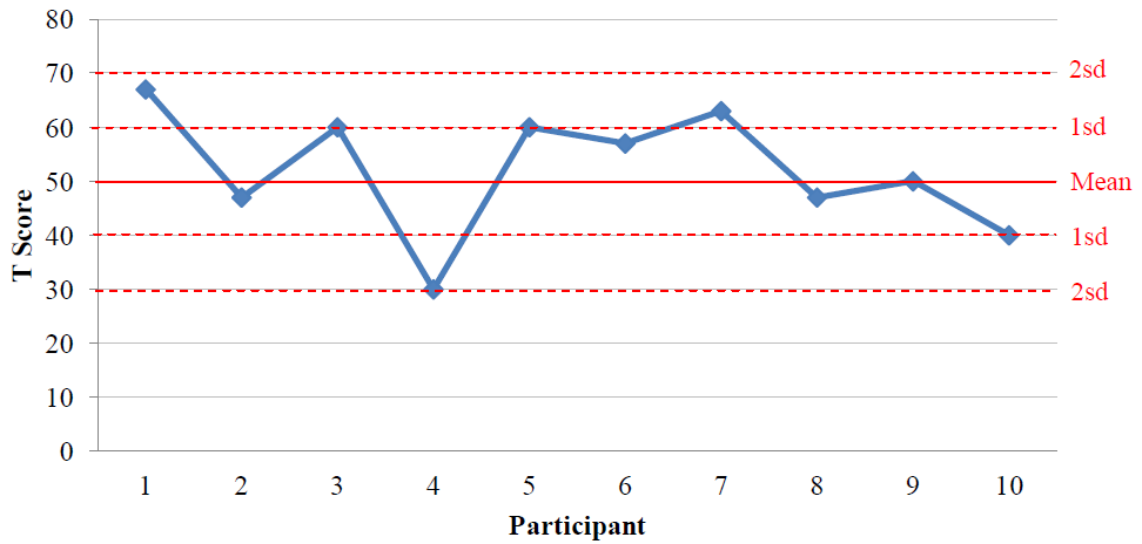


Figure 10 – Total achievement T scores across participants

Further analysis indicated that P2 and P4 made an ‘impaired’ number of rule violations per item (T=20 for both), but otherwise all remaining participants showed a trend toward a number of rule violations in the ‘average’ range. Thus, participants showed good planning abilities across the group, with one participant performing outside of this range on the overall achievement scores produced.

Parent-Reported EF

The parent-rated BRIEF questionnaire was rated for all participants. The results (see Figure 11) indicated that overall there was high variability across domains. The domains where most participants met threshold criteria for EF difficulties were initiation and monitoring, where five participants scored ≥ 65 in each instance. The area where the fewest participants were rated as experiencing difficulty was inhibition (P2 and P4). Otherwise, four participants were scored as being above threshold for clinical difficulties on each of the BRIEF domains. These participants were different on each domain, indicating a high level of variability (see Figure 11). These findings support the trend towards difficulties with initiation that were identified in the Hayling analysis. They also support the variability seen in inhibition, shifting and planning abilities.

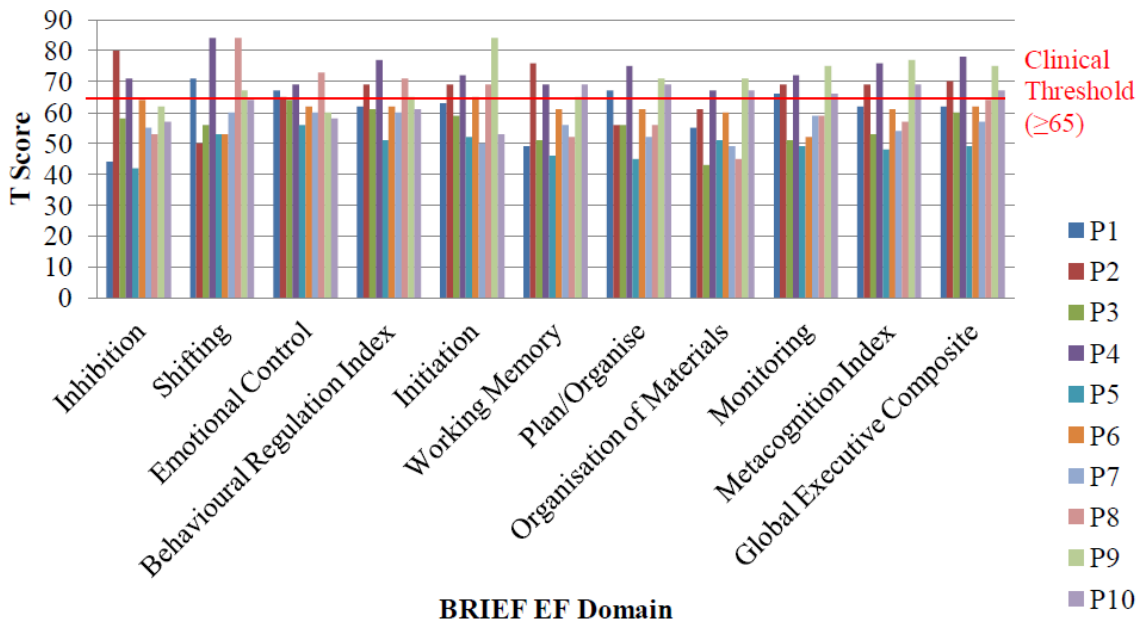


Figure 11 – T Scores on the BRIEF

Theory of Mind

On the M&M False Belief task half of participants failed, showing no consistent trend in theory of mind difficulties in this group of selective eaters. On the Reading the Mind in the Eyes task (see Figure 12), there was high variability where three participants produced an error rate under 30% and all other participants produced error rates above this.

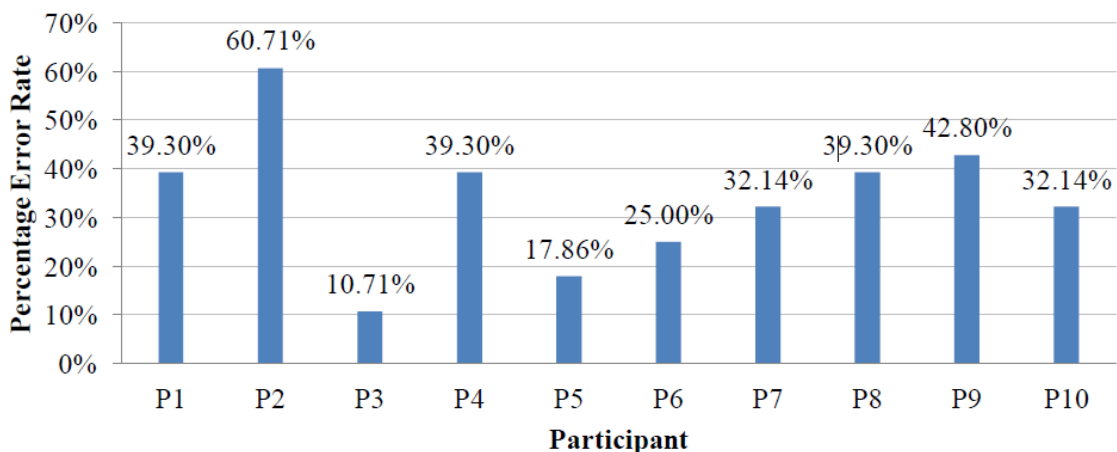


Figure 12 – Error rates across the Reading the Mind in the Eyes Task

There was one extreme score of 60.71% which was made by P2 and may be explained by his attentional difficulties. These results show high variability in the ability to infer mental state and affect in this group

Sensory Processing

Figure 13 shows that across the nine participants whose parents were administered the Sensory Profile, all participants showed difficulties in the area of oral sensitivity (where lower scores indicate greater difficulty) which would not be expected in the general population. Of these, seven participants scored in the ‘definite difference’ range and two scored in the ‘probable difference’ range.

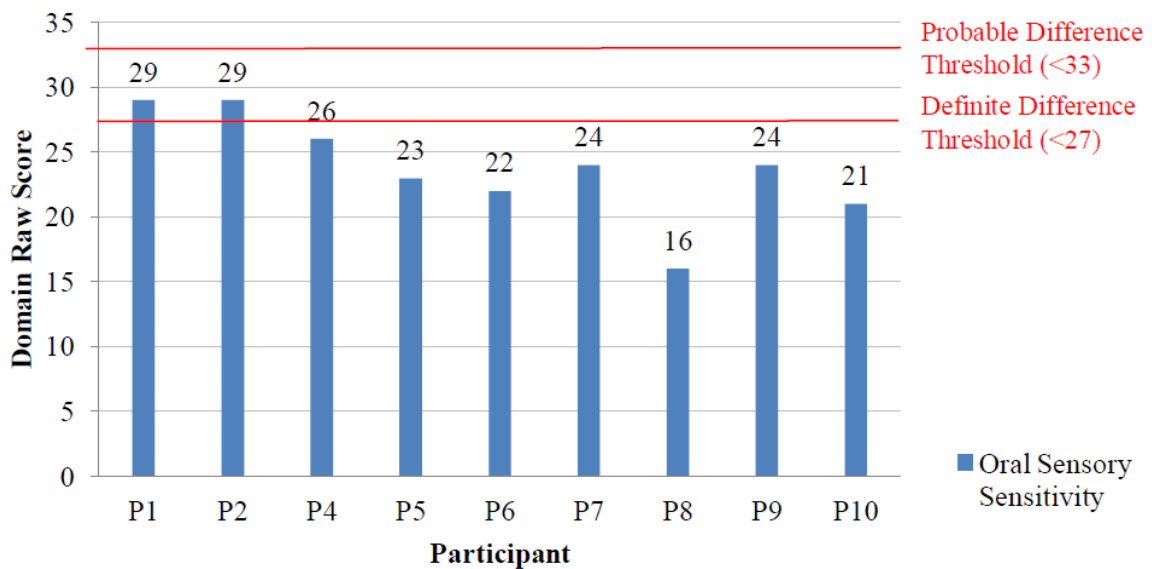


Figure 13 – Domain raw scores for Oral Sensory Sensitivity on the Sensory Profile

3.2.2 Domain performance

To determine performance across the key domains of visuospatial processing, cognitive flexibility, inhibition, planning and theory of mind, a composite Z score was calculated, in line with the analysis conducted by Rose et al. (2012). This analysis facilitated various subtests within a domain to be aggregated and thus provided an overall domain composite score for performance in each domain where there was more than one subtest. In the cases where there was high variability across subtests within a domain, this allowed for a clearer picture to emerge of performance in terms of overall functional abilities within that area. Means and standard

deviations used in the Z transformations were obtained from various sources (see Appendix 32). Z scores across tasks can be found in Appendix 33.

The Hayling and Brixton tasks were omitted from Z transformations as there were no appropriate existing age-matched norms available. These omissions ensured consistency in the analysis and thus allowed for a more reliable picture of performance in this context. Furthermore, given that the CCI score (representing the central coherence domain) was based on one standalone score, no aggregated Z score calculation was needed to add any additional information at this stage about functional abilities in this area above and beyond the aforementioned analyses.

Figure 14 demonstrates performance across the SE group across each of the domains assessed showing a high level of variability in results. In terms of visuospatial processing, half of the sample performed below a Z score of -1, suggesting difficulties in this ability relative to norms. The remaining participants scored around the mean in relation to established norms, thus a high level of variability emerged.

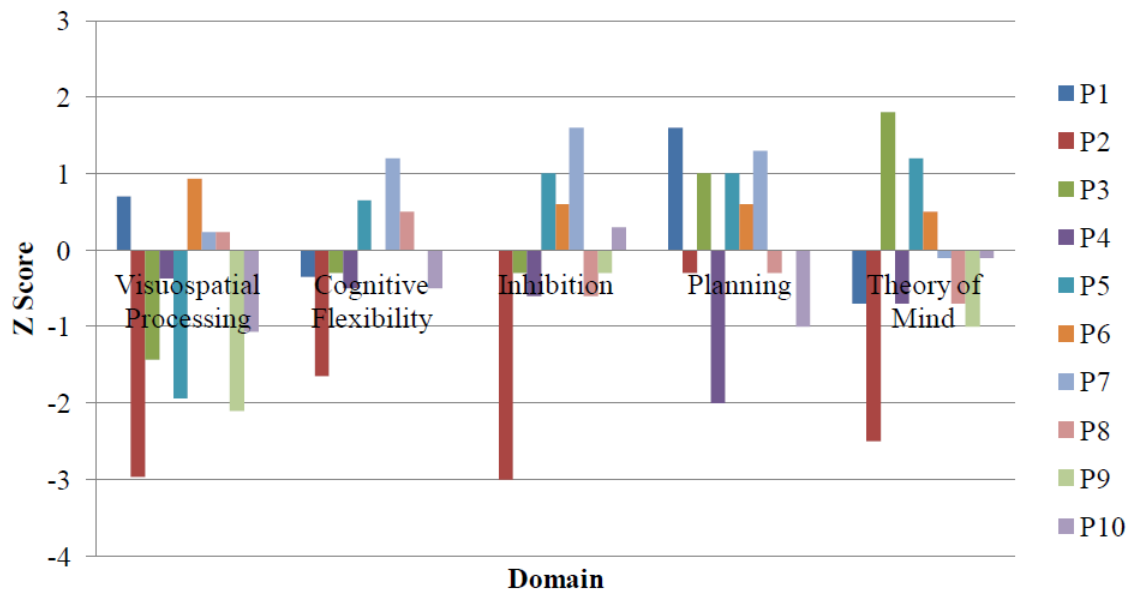


Figure 14 – Composite Z scores across each domain

In terms of cognitive flexibility and inhibition, performance was generally represented by Z scores in the range of -1 to 1, which showed ‘average’ performance around the mean. P2 was the

exception in both domains, where he showed relative difficulty in relation to the rest of the sample and as well as established norms. Furthermore, P7 showed relative strengths in these domains.

In terms of planning performance, four of the group showed a relative strength and two participants showed a relative weakness in this ability in relation to the mean performance of age-matched norms. The remaining participants performed around the mean. Thus whilst performance was variable across the group, there was a trend towards average or superior performance in relation to standardized norms.

Finally, on the theory of mind domain performance was assessed using the sample mean and standard deviation of a group of 33 8 to 12 year olds on the Reading the Mind in the Eyes task (Baron-Cohen et al., 2001). Performance was highly variable across the group with two participants showing performance with Z scores ≤ -1 and two participants with scores ≥ 1 . Remaining participants were all within the average range, with a trend toward performing below the mean, thus theory of mind abilities were relatively variable.

3.3 Analysis of autistic traits in relation to Hypothesis 2

To address the second hypothesis, the data was further defined by classifying participants that displayed low autistic traits or elevated autistic traits, as assessed using their parent-rated Child Autism Spectrum Test. Performance across varying levels of autistic traits will be further discussed here.

Visuospatial Processing

Figures 15 and 16 display performance in participants with low autistic traits and elevated autistic traits across the three ROCF trials. These show that the range of impairment in participants with elevated autistic traits was spread from under 2sd below the mean to performance within 1sd above the mean, showing high variability in scores. Participants with low autistic traits were less spread, with three of the four participants scoring below 1sd under the mean. The fourth participant was an outlier in the group (P6) and this is likely to reflect her unique presentation in terms of her clinical history of a brain tumour, and thus possible neurological and neuropsychological differences.

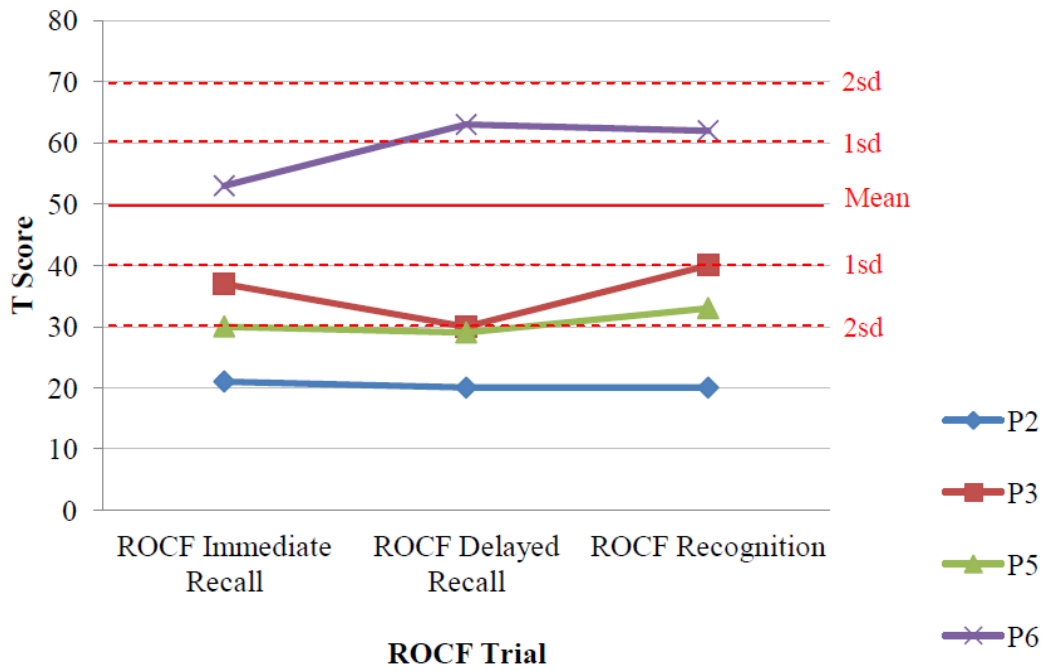


Figure 15 – ROCF profiles in participants with low autistic traits

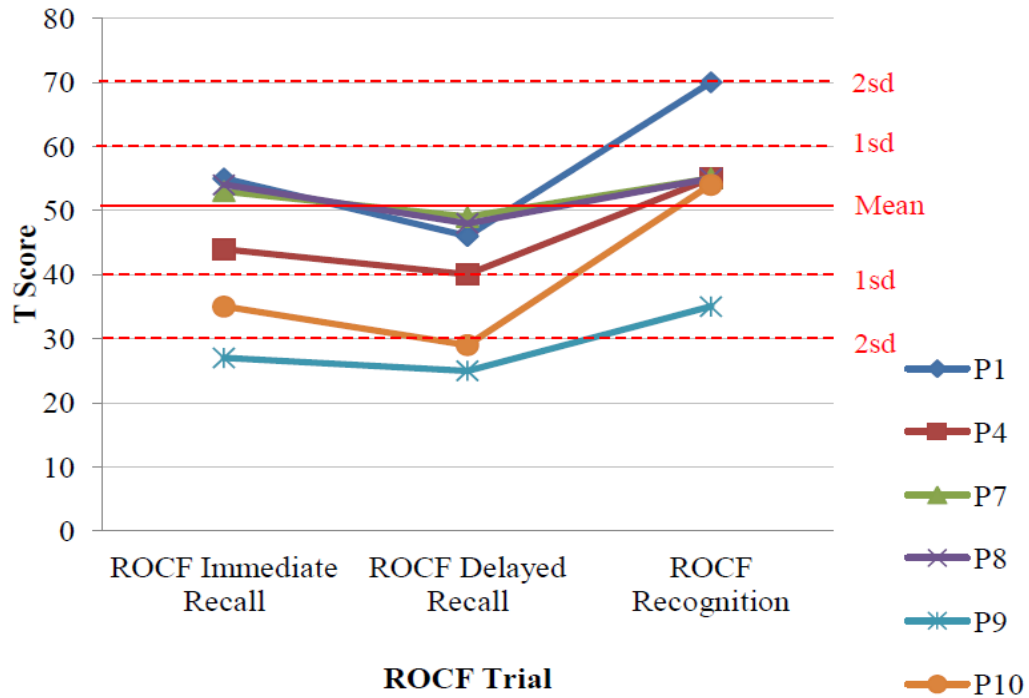


Figure 16 – ROCF profiles in participants with elevated autistic traits

There were also differences in the types of memory profile pattern produced, where all six participants with elevated autistic traits demonstrated a retrieval memory profile pattern, and those with low autistic traits displayed higher variability with three different memory profile patterns produced (see Figure 17). There was thus a trend towards those selective eaters with elevated autistic traits showing a distinct pattern of retrieval of visuospatial information.

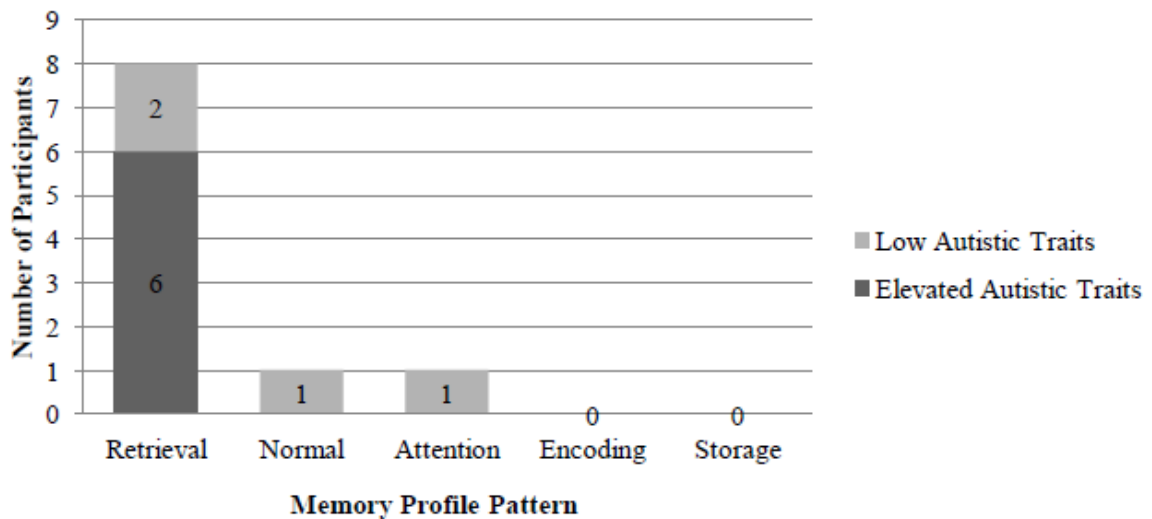


Figure 17 – Frequency of memory profile patterns in participants

Finally, when considering the copy trial, in which visuospatial information was first copied and encoded by participants, there was a clear distinction in the accuracy and placement of the figures copied. Figure 18 demonstrates that five participants showed impaired performance (<5 cumulative percentile range) and five participants showed performance in the expected range (>16 cumulative percentile range). Of those in the ‘impaired’ range, four had elevated autistic traits and the remaining participant was P2, who consistently showed impaired performance, likely due to his attentional difficulties. Of those performing above the 16th cumulative percentile, three participants had low autistic traits along with two participants with elevated autistic traits. This indicated a trend toward those with low autistic traits performing within normal limits in terms of copying, and thus encoding, of visuospatial information, whilst those with elevated autistic traits showing greater variability, trending toward more impaired copying and encoding.

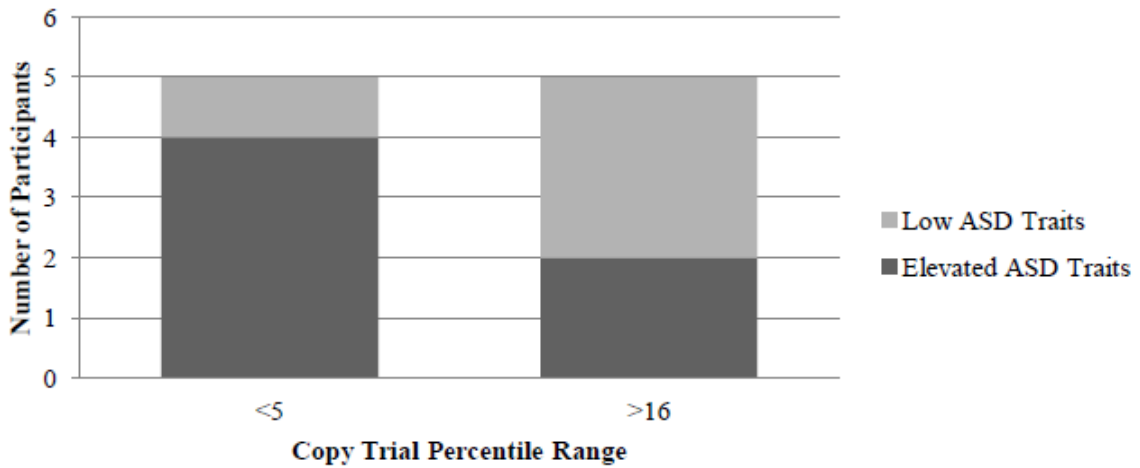


Figure 18 – Cumulative percentile ranges for raw scores on the copy of the ROCF

This effect was supported by analysis indicating a 2.84 mean difference in the copy T scores produced in those participants with low autistic traits (mean=23.25, sd=7.4) relative to those with elevated autistic traits (mean=20.41, sd=6.4), however the high spread in scores in each group indicated by the high sd values limit the interpretation of this data (see Appendix 34).

Central Coherence

There were no observed trends in the CCI between participants with low autistic traits or elevated autistic traits.

Executive Functioning

Mean T scores were calculated across participants with low autistic traits and elevated autistic traits (see Appendix 35). On the tasks of cognitive flexibility there was relatively even performance across all participants on the Brixton and Verbal Fluency tasks. However, on the latter there was greater variability in scores in elevated autistic traits participants (sd=10.29) relative to those with low autistic traits (sd=3.50). On the Trail Making test, participants with elevated autistic traits showed a trend toward higher mean scores (mean=39.33, sd=15.19) than those with low autistic traits (mean=33.50, sd=9.43), suggesting poorer performance, however the high spread in scores in both levels of autistic traits make interpretation difficult.

On the tasks of inhibition, the descriptive statistics were inconclusive, showing higher mean performance in the elevated autistic traits participants relative to the low autistic traits participants on the Hayling test (mean=41, sd=9.07 and mean=26, sd=9.20 respectively) and the opposite effect on the Colour-Word Interference test (mean=46.17, sd=14.27 and mean=52.50, sd=10.50 respectively).

Finally, on the Tower test of planning abilities, the elevated autistic traits participants demonstrated higher mean performance (mean=56.33, sd=7.94) relative to those with low autistic traits (mean=45.75, sd=14.10), but there was much greater variability in the scores in the latter participants, limiting interpretation.

Given the high variability in the mean T score statistics for EF abilities across participants with both low autistic traits and elevated autistic traits a more detailed investigation of the frequencies of participants scoring within, above and below 1.5sd from the mean was conducted. Table 6 displays this information.

On tasks of cognitive flexibility there were no clear trends in the data between participants with low autistic traits or elevated autistic traits, with the exception of the Trail Making sequencing completion time, where there was a trend towards more participants with elevated autistic traits showing difficulty (scoring ≤ 1.5 sd below the mean), relative to those with low autistic traits (four of six participants compared to one of four participants). In terms of inhibition abilities, on the Colour-Word Interference test those with low autistic traits performed in the average and impaired ranges (≤ 1.5 sd) whereas those with elevated autistic traits performed in the average and superior (≥ 1.5 sd) ranges. This trend may however be due to chance due to the low participant numbers. Furthermore, on the inhibition/switching task, a trend emerged whereby four of 10 participants produced higher error rates below 1sd from the mean. Of these, three showed elevated autistic traits (P4, P8 and P10). The remaining participant was P2, who likely performed in this range due to attentional difficulties. This effect was not present on the inhibition only condition and may indicate that when more than one EF is employed, selective eaters with elevated autistic traits were more likely to be affected in terms of accuracy, but not speed relative to those with low autistic traits. On the Hayling, all participants scored in the average range, with the exception of P7 and P10 which may be linked to their elevated autistic traits.

Table 6 – Frequencies of participants falling below, within or above 1sd from the mean

Test variable (T score)	Low autistic traits			Elevated autistic traits		
	≤1.5sd below the mean	Within 1sd of the mean	≥1.5sd above the mean	≤1.5sd below the mean	Within 1sd of the mean	≥1.5sd above the mean
TM sequencing completion time	1	3	0	4	2	0
TM sequencing errors	1	3	0	1	5	0
Brixton	0	3	1	0	6	0
VF switching total correct responses	0	4	0	0	6	0
VF switching accuracy	0	4	0	0	5	1
VF switching percentage accuracy	1	3	0	2	4	0
Hayling total performance	2	2	0	3	3	0
CWI inhibition total time taken	1	3	0	0	5	1
CWI inhibition/switching total time taken	1	3	0	0	5	1
Tower total achievement	0	4	0	1	4	1

Notes: TM: Trail Making test; VF: Verbal Fluency test; CWI: Colour Word Interference test; SD: Standard deviation

On the planning domain there was greater spread in terms of the number of elevated autistic traits participants scoring above and below the mean relative to those with low autistic traits, thus suggesting greater variability in this skill in those with elevated autistic traits.

BRIEF

As an overall group, no clear trends emerged on the BRIEF, however when distinguishing the profiles of participants with low autistic traits it was clear that of the four low autistic traits participants, three of them obtained scores mainly below cut-off. The only outlier was again P2, whose variability and difficulties above cut-off are likely explained by his possible attentional

difficulties (see Figure 19). Of the six participants with elevated autistic traits, only one scored consistently below cut-off for clinically significant difficulties (see Figure 20). In summary, the results suggested higher rates of scores above clinical cut-off in those with elevated autistic traits.

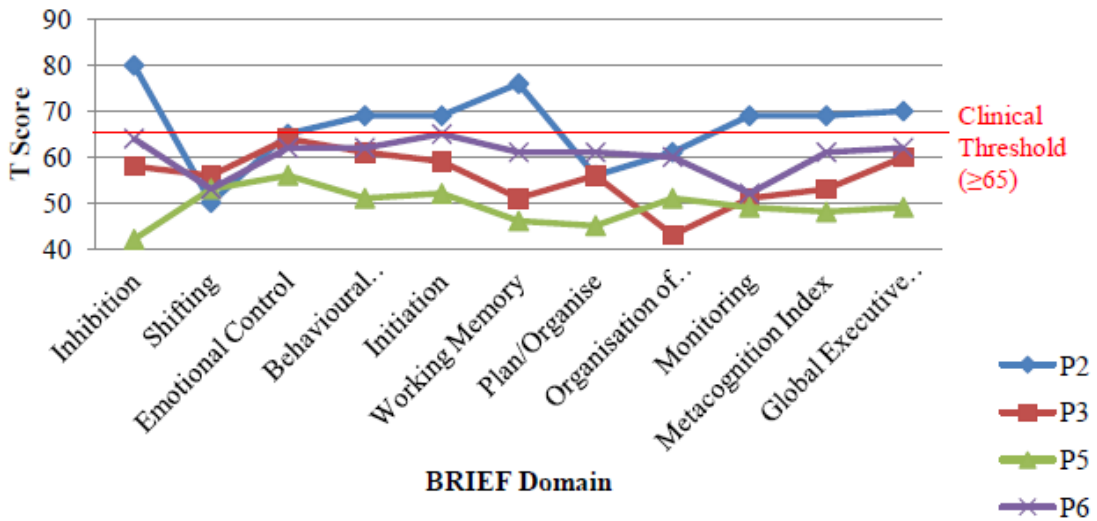


Figure 19 – BRIEF scores across participants with low autistic traits

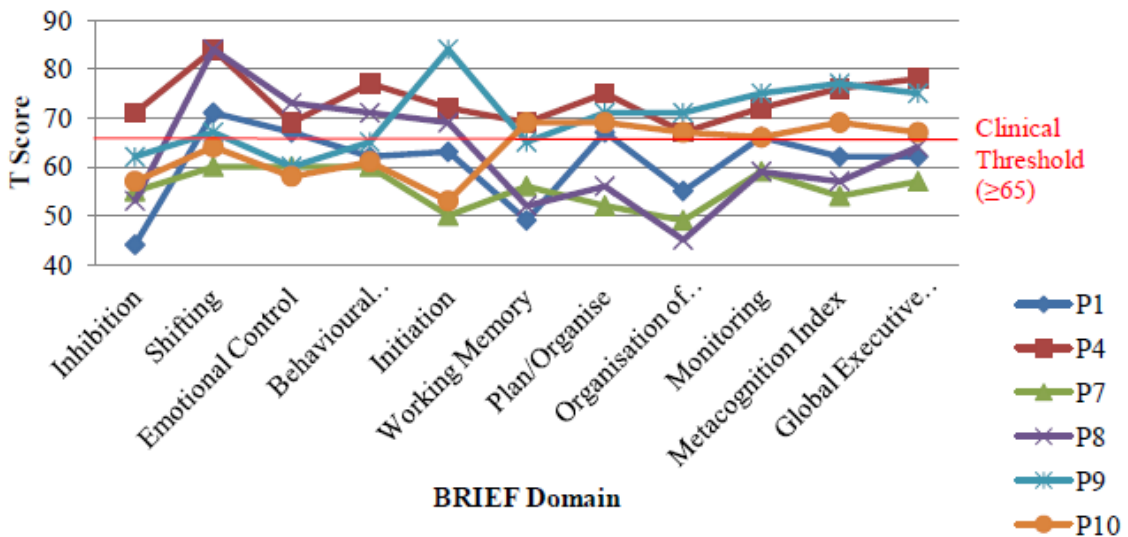


Figure 20 – BRIEF scores across participants with elevated autistic traits

Theory of Mind

On the M&M False Belief task, there was a clear trend in which a greater number of participants with elevated autistic traits failed this task (see Figure 21). The only participant with low autistic

traits that failed this task was P2, whose attentional difficulties may best account for his performance.

On the Reading the Mind in the Eyes task, all participants with elevated autistic traits demonstrated a consistently high error rate of over 30%, suggesting difficulties in inferring and recognizing mental state/affect. Of the participants with low autistic traits, all scored below 25% with the exception of P2, who again appeared as an extreme outlier, producing a 60.71% error rate. This again may be best explained in terms of a difficulty maintaining attention during this task. These findings therefore show that theory or mind impairment seems to be related to autistic traits in this sample, and not SE phenomenon.

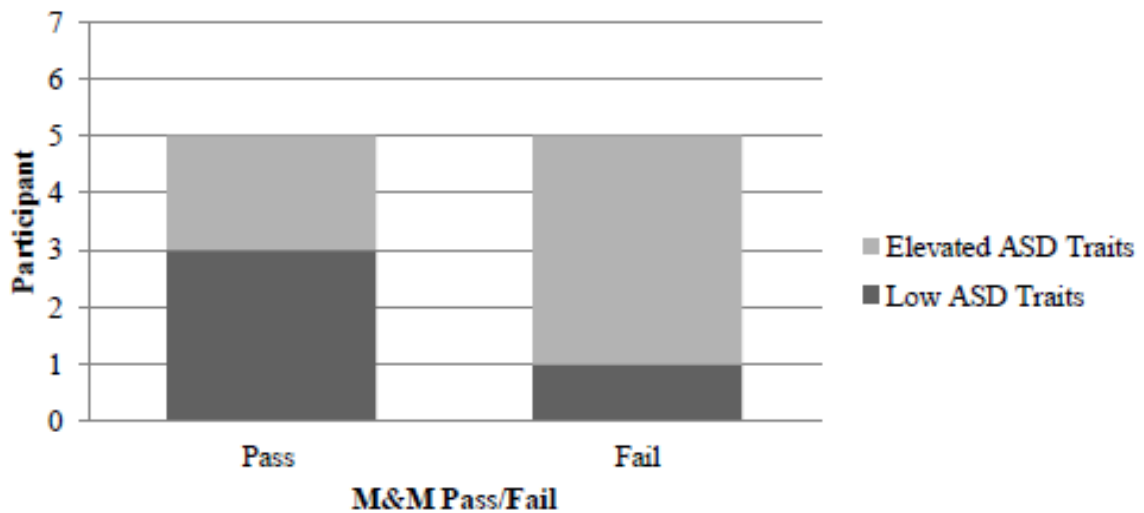


Figure 21 – Performance on the M&M False Belief task across participants with low autistic traits and elevated autistic traits

Sensory Processing

There were no trends evident between participants with low autistic traits or elevated autistic traits in the area of sensory processing, suggesting a universal difficulty in oral sensory processing across all selective eaters in this group.

4.0 DISCUSSION

The aim of the current study was to determine whether there is a distinct neuropsychological profile in children with selective eating (SE) as measured by a standardised neuropsychological assessment battery (the Ravello Profile) and whether aspects of that profile may vary depending on whether a child displays elevated autistic traits (EAT). This chapter will first outline and summarise the findings of the present study in relation to the two hypotheses in the context of previous literature:

- 1) There will be a distinct neuropsychological profile across children and adolescents with SE difficulties across the domains of cognitive flexibility, planning, inhibition, central coherence, visuospatial processing and theory of mind.

- 2) There will be differences in the neuropsychological profiles of children and adolescents with elevated autistic traits in terms of more marked impairments on tasks of cognitive flexibility and stronger performance on visuospatial processing.

The chapter will then discuss the implications, strengths, limitations and possible avenues for future research, before summarising the main conclusions.

4.1 Summary and interpretation of results in relation to Hypothesis 1

The first hypothesis stated that there would be a distinct neuropsychological profile in children with SE in terms of visuospatial processing, central coherence, executive function (EF) (in the domains of cognitive flexibility, inhibition and planning) and theory of mind abilities. The results showed that overall the SE cohort were a broadly heterogeneous group in terms of their performance across various domains and between subtests within domains, with results spanning from the ‘impaired’ to ‘average ranges’. Thus, whilst trends emerged in the data that were suggestive of possible areas of strength and weakness in children with SE, the variability across participants within domains means that a reliably distinct profile did not emerge on a task-by-task analysis in this case series. This echoed the findings of Rose et al., (2012) in their initial application of the Ravello Profile in a case series exploring the profiles of individuals with anorexia nervosa. Nevertheless, the initial indications of areas of possible strength and weakness

in this series is an important first step in exploring possible trends in neuropsychological functioning in children with SE.

4.1.1 Visuospatial processing and central coherence

The findings indicated a consistent weakness in terms of central coherence, where all participants tended to process information in a less global way than might be expected. This is consistent with previous findings in both the anorexia nervosa (Lopez et al., 2008) and in the autism spectrum disorder (ASD) literature (Shah & Frith, 1983; Happe, 1997) and is the first indication that there may be a specific difficulty in this area in children with SE a clear trend whereby all participants performed below 1sd from the T score mean of 50 was evident. When considering SE phenomena it may be hypothesised that a bias toward focusing on, and processing details at the expense of “the big picture” may contribute to explaining aspects of the clinical presentation. For example, the extent to which some children presenting with SE tend to focus on detailed aspects of the food presented, such as inconsistencies in shape, colour or texture (Byrant-Waugh et al., 2010). It may also be that individuals with SE have a heightened focus on oral sensory aspects of food and that they may attend to these when typical children their age may not. This sensory focus may then accentuate anomalies in food such as a small white patch on a piece of chocolate that is then perceived as more prominent and overwhelming, which may then contribute to making feeding an aversive experience (Golding et al., 2009). This also fits with the results to suggesting that there are differences in sensory processing of oral information across participants in this sample, which will be discussed further in section 4.1.6. These findings are consistent with evidence to suggest that both sensory processing and detail-focused cognitive styles are associated with rigidity in children with ASD. Whilst there has been no correlation found between these constructs directly, there is evidently a complex interplay between these factors in some children, particularly those with SE (Chen, Rogers & McConachie, 2009).

Happe and Booth (2008) assert that if information is processed in a detail-focused style, then it is likely to be more difficult to recall. Thus, performance on the visuospatial processing domain may be linked to differences observed in the central coherence index (CCI) scores in this sample. The present results showed a high degree of variability in the visuospatial processing domain across participants ranging from Z scores of 0.93 to -2.97. In the absence of previous neuropsychological research in SE, the two most relevant fields of results are those of eating

disorders, where impaired visuospatial processing has been found in ASD (Key, O'Brien, Gordon, Christie & Lask, 2006; Kingston et al., 1996) and ASD, where superior VSP has been found (Caron et al., 2004; Ozonoff et al., 1991). Although there is evidence to suggest that this strength is primarily in terms of processing visual details, and that in fact there are greater visuospatial impairments in processing a global whole in ASD (Brosnan, Scott, Fox & Pye, 2004). The variability in the present results are consistent with neither of these previous findings however, which may be attributed to the small heterogeneous sample investigated. Without further investigation to clarify and understand this variability, no conclusions can be drawn, except that it is clear that visuospatial abilities are inconsistent and that this and weak central coherence may contribute to differences in the processing of sensory characteristics of food during feeding.

4.1.2 Cognitive flexibility

Secondly there was a trend toward 'average' performance on two of the three cognitive flexibility tasks (Brixton and Verbal Fluency tests). Given the lack of any previous neuropsychological data in SE, findings from the eating disorder literature acted as a guide to where areas of strength and difficulty may lie in this SE sample. These findings are consistent with anorexia nervosa research which has suggested relatively intact verbal fluency in anorexia nervosa (Hatch et al., 2010; Steinglass, Walsh & Stern, 2006; Stedal et al., 2012) but are inconsistent with findings suggesting impaired set-shifting in adults with AN (Tchanturia, 2004; Tchanturia et al., 2005), as well as in childhood anorexia nervosa (Stedel et al., 2012). It may be that in terms of set-shifting, a range of tasks are more or less sensitive depending on their appropriateness to the population, for example the Brixton may be more sensitive in adults, for whom this was developed. Further research is needed to ascertain where impairments or strengths may lie and which tests reliably and sensitively detect these in children.

On the remaining task (the Trail Making test) there was higher variability observed with four participants performing in the "impaired" range. Contrast analyses revealed though that in each of these four cases this was unlikely to reflect a shifting impairment over and above impairments in baseline abilities, for example visual scanning, in which impairments were also found. There are three possible explanations for this finding. First, it may be that a subgroup of selective eaters experience difficulties in baseline skills, which make it particularly difficult to engage their

shifting abilities. Second, that shifting abilities are in fact subtly impaired but that this is not sensitively detected in contrast analyses or third, it may be that there are no impairments in shifting in this group and the impairment seen is only in baseline abilities underpinning this aspect of cognitive flexibility.

The domain composite analysis (which included the Trail Making and Verbal Fluency tests and omitted the Brixton task due to a lack of appropriate age-matched norms) indicated that in relation to published norms, cognitive flexibility abilities were between Z scores of 1 and -1 in nine of 10 participants, suggesting that this is a relatively preserved ability. The remaining participant was P2, whose uneven performance likely resulted from attentional difficulties and thus limited engagement with the tasks, affecting the likelihood of completing these reliably. These findings are also inconsistent with previously found set-shifting impairment in AN (Roberts et al., 2007; Tchanturia et al., 2005; Southgate et al., 2005) and in ASD (Ozonoff, 1997; Hughes et al., 1994). The intact abilities observed in this case series may thus indicate that cognitive flexibility is an area of relative strength that is uniquely distinct to SE, however this conclusion is limited due to the small heterogeneous sample from which these findings emerged, and without further investigation to establish this in a larger representative sample.

High levels of rigidity are commonly observed in SE, anorexia nervosa and ASD (Bryant-Waugh et al., 2010; Roberts et al., 2007; Hill, 2004) and yet this was not reflected in the findings of the current study. An alternative hypothesis may be that the highly rigid behaviour observed clinically in respect of the acceptance of food is not well captured in neuropsychological tests of cognitive flexibility, due to different mechanisms underpinning cognitive flexibility and behavioural rigidity respectively (Geurts, Corbett & Solomon, 2008). Indeed Geurts et al., (2008) assert that much work is needed to understand and assess the different aspects of cognitive inflexibility that these tasks aim to capture, and how they relate to observed behavioural rigidity in a clinical context.

4.1.3 Inhibition

The inhibition domain was a further area of high variability across the group. On the Hayling test there was a split between those performing in the ‘average’ and ‘impaired’ ranges, whereas performance was generally in the ‘average’ range on the Colour-Word Interference test (with the

exception of P2 who achieved an extreme score in the ‘impaired’ range). The overall performance of those in the ‘impaired’ range on the Hayling was likely in part affected by more impaired scores on section A, which indicated difficulties in response initiation. Taken together, these findings suggest relatively intact inhibition skills, and highlight an area of difficulty in response initiation. The domain composite T scores compared performance to population norms on the Colour-Word Interference test (Delis et al., 2001) (the Hayling results were excluded from this analysis due to the lack of an age-matched norm population). This analysis revealed that there was high variability in inhibition skills across the group, but that performance was generally within the ‘average’ range, with the exception of an impairment for P2 ($Z=-3$) and a relative strength for P7 ($Z=1.6$). These findings fit with existing data suggesting that performance on traditional inhibition tasks is unimpaired in ASD (Ozonoff & Jensen, 1999), although they do conflict with evidence to suggest higher levels of impairment in ASD on more innovative and sensitive tests of inhibition such as the “go-/no-go” task (Ozonoff et al., 1994). These findings further provide consistent support for a lack of inhibition impairment in childhood anorexia nervosa (Rose et al., 2012; Stedal et al., 2012) and more recent research that showed no impairment in adult anorexia nervosa samples (Fagundo et al., 2012) although, these contradict earlier adult anorexia nervosa findings (Brewerton et al., 2009).

4.1.4 Planning

On the planning domain, there was a trend toward performance in the ‘average’ to ‘high average’ ranges, with the exception of one participant (P4). However, the planning domain composite score, which assessed performance relative to published norms (Delis et al., 2001), indicated variability across the group with scores ranging from 1.6 to -2, although this included four participants who performed equal to, or above, a Z score of 1. This suggested a trend toward a strength in planning abilities. This evidence was consistent with findings from childhood anorexia nervosa (Rose et al., 2012; Stedal et al., 2012), but largely contradict findings of planning impairments in ASD (Ozonoff et al., 1991; Ozonoff & Jensen, 1999; Ozonoff, 1997). There is however more recent evidence to suggest unimpaired planning in children with ASD (Happé, Booth, Charlton & Hughes, 2006), which the present findings support.

Whilst there was some variability in performance, these findings do suggest average planning abilities in SE. This domain however did rely solely on performance on the overall achievement

score of the Tower test, which recently has been criticised as not being sensitive enough to each aspect of performance on this task (Stedal et al., 2012). For example, points are awarded as long as the trials are completed within a given time frame. The number of moves made are not taken into account in this overall score, thus a participant may employ a disorganized style with many unnecessary moves in completing the task, but this may not be adequately captured. Future applications of the Ravello Profile may aim to incorporate a measure of such task aspects into the profile or include an additional measure of planning abilities. The present findings do suggest though that future applications of the Ravello Profile in SE may not necessarily need to include planning assessments, particularly as the relevance that planning has to the clinical presentation of SE is arguable.

4.1.5 Theory of Mind

On the theory of mind tasks there was great variability across the sample on both tasks. Published control data (Baron-Cohen et al., 2001) was used in a Z transformation for this task, and showed again, large variability across the sample, however only P2 performed in the ‘impaired’ range, and this was likely more representative of his attentional difficulties. There was thus inconsistent evidence to support previous research that might suggest impairments in the related areas of anorexia nervosa and ASD (Russell et al., 2009; Baron-Cohen et al., 1993).

4.1.6 Sensory Processing

A final area of importance to note is that of sensory processing, where differences in the sensory processing of oral information was found across all participants in the present sample. This was consistent with previous evidence to suggest that there are sensory difficulties in children with SE (Bryant-Waugh et al., 2010; Golding et al., 2009; Farrow & Coulthard, 2012). Furthermore, this fits with the DSM-V (APA, 2013) criteria for avoidant restrictive food intake disorder (ARFID) which highlights feeding disturbances in the context of the sensory characteristics of food. Many of the participants in this sample also scored highly on domains indicating extreme behavioural and emotional responses to sensory stimuli. These findings are important to consider alongside the neuropsychological findings and may fit with the observed local processing bias and differences in visuospatial processing to create an aversive feeding experience, resulting in behavioural rigidity as an outcome.

4.1.7 Summary of findings relating to Hypothesis 1

Thus in relation to the first hypothesis, that there would be a distinct neuropsychological profile across children and adolescents with SE difficulties across the domains of cognitive flexibility, planning, inhibition, central coherence, visuospatial processing and theory of mind, the high variability in the data meant that a distinct neuropsychological profile did not emerge. However there were trends in the data that were consistent with the previous literature in anorexia nervosa and ASD, for example, a high proportion of participants showed difficulties in visuospatial processing and all participants showed WCC alongside relatively intact performance across various EF abilities (Rose et al., 2012; Stedel et al., 2012).

4.2 Summary and interpretation of results in relation to Hypothesis 2

The second hypothesis stated that there would be differences in the neuropsychological profiles of those selective eaters with elevated autistic traits in terms of particular impairments on tasks of cognitive flexibility, and stronger performance on visuospatial processing. Overall, there were few distinct areas of difference between those participants with low autistic traits and elevated autistic traits, due to the high variability in the data. There is thus limited evidence to support this hypothesis.

4.2.1 Visuospatial processing

The results showed trends toward differences in those participants with elevated autistic traits in the visuospatial processing domain, Firstly, those participants with low autistic traits tended to score in the more impaired range on the visuospatial processing task, whereas there was a high level of variability in those with elevated autistic traits, including more participants showing better performance. This supported the previous literature that suggested relatively intact abilities in this domain in ASD (Caron et al., 2004; Ozonoff et al., 1991). Moreover, those with elevated autistic traits were more homogenous in terms of the memory profile patterns produced, where all of them produced a 'retrieval memory profile' pattern. Those with low autistic traits produced a variety of memory profile patterns indicating different types of visuospatial memory retrieval styles in these participants. Furthermore there was greater impairment in the initial copying and encoding of information in participants with elevated autistic traits. In summary, there was greater variability in those with low autistic traits relative to elevated autistic traits in terms of visuospatial processing abilities, with those with elevated autistic traits tending towards poorer

copying and encoding of information, but nevertheless showing more uniform patterns of memory retrieval style. The overall variability in performance in this case series though may have masked more definitive effects emerging.

4.2.2 Cognitive flexibility

In terms of cognitive flexibility the participants with low autistic traits and elevated autistic traits performed similarly on the Verbal Fluency and Brixton tasks, however on the Trail Making test, a higher frequency of participants with elevated autistic traits performed in the ‘impaired’ range relative to those with low autistic traits. This is somewhat consistent with previous literature to suggest that individuals with ASD have difficulties switching between stimuli (Hill, 2004; Ozonoff, 1997; Hughes et al., 1994). Contrast analyses revealed however that in these participants, impairments in underlying baseline abilities likely explained the observed flexibility difficulties. This would suggest that selective eaters with elevated autistic traits show a trend toward experiencing more baseline difficulties that are then likely to cause difficulties employing EF. Thus, despite trends emerging that supported the previous literature, in such a small sample conclusions regarding this are limited and the effects of baseline impairments, difficult to delineate from cognitive inflexibility.

4.2.3 Other areas of ability

There were no distinct patterns between those with elevated autistic traits and low autistic traits in terms of the CCI, indicating that this was a consistent weakness across all participants including those with autistic features, which is consistent with previous ASD literature that highlighted a weakness in this area in ASD (Frith, 1989; Happe, 1997; Shah & Frith, 1983).

In terms of inhibition abilities there was variability in performance between subtests, making firm conclusions impossible, although there was no evidence of significant inhibition impairment in those specifically with elevated autistic traits. This is consistent with previous literature suggesting relatively intact abilities on classic inhibition tasks (Ozonoff & Jensen, 1999), but does contradict earlier findings on classic tasks which suggested a weakness in this area (Ozonoff et al., 1994).

A similar pattern was found in planning abilities where those with elevated autistic trait achieved a higher mean score relative to low autistic trait participants, the extreme variability in the latter group ($sd=14.10$) meant that this was not interpretable. Thus there was no evidence to support or contradict previous findings of difficulties on the planning domain (Ozonoff et al., 1991, Ozonoff & Jensen, 1999; Ozonoff, 1997).

Finally, on the theory of mind tasks there was a trend toward those with elevated autistic traits failing the M&M False Belief task and making higher error rates on the Reading the Mind in the Eyes task. This showed a trend toward selective eaters with low autistic traits displaying relatively intact theory of mind skills. This is consistent with evidence to suggest that theory of mind abilities are largely impaired in the ASD population (Baron-Cohen et al., 1993; Gilbert et al., 2008).

4.3 Strengths and limitations

This case series was a novel approach to investigating neuropsychological profiles in children with SE, and one of the core strengths of this research was its novelty. Before conducting this case series, best practice guidelines for utilizing such a design were sought and this research adhered to recommendations to ensure quality in the design of the study (see Schwartz & Dell, 2010; Kooistra et al., 2009; Vandenbroucke, 1999). This research was therefore an important first step in providing an initial exploration of SE to provide suggestions for the next stages of research in this area.

A further strength of this case series were the robust applications of procedures to ensure that the analysis and interpretation was reliable, for example in discussing and achieving consensus on the scoring of the Rey-Osterrieth Complex Figure. Furthermore, where validity and consistency scales were embedded in tests, such as the Behaviour Rating Inventory of Executive Function (BRIEF), these were used to ensure that internal validity was reached. Moreover, all data was presented to the Ravello Profile group to ensure that reliable interpretations were made of the data obtained.

There were several limitations to the present study. First, the issue of comorbidity needs to be considered, as there were comorbidities across the sample in terms of depressive, anxiety and

obsessive compulsive disorder (OCD) symptomology. Each of these phenomenon have been linked independently with neuropsychological deficits (Porter, Gallagher, Thompson & Young, 2003; Wood, Mathews & Dalgleish, 2001; Andres-Perpina, Lazaro-Garcia, Canalda-Salhi & Boget-Llucia, 2002; Purcell, Maruff, Kyrios & Pantelis, 1998) and it is therefore unclear whether the differences found in the present study are reflective of neuropsychological differences in SE, in the comorbidities found or in both. These findings do however have important implications for the monitoring and treatment of comorbidities such as depressive symptomology that may impact on a feeding intervention throughout treatment (Jacobi et al., 2008). It may also be important for clinicians to consider whether such difficulties are a likely outcome of feeding difficulties and assess improvement in these areas using standardised outcome measures, to help evaluate the effectiveness of interventions. Conversely if these difficulties are felt to have preceded feeding difficulties, it will be important to clarify whether a feeding intervention may be successful without comorbid emotional difficulties first being addressed (Micali et al., 2011).

This research applied the well-established Ravello Profile, which was developed for assessment of neuropsychological factors in anorexia nervosa, to a group of selective eaters meeting ARFID diagnostic criteria for the first time. A strength of this research was that the profile was modified with the addition of various tasks based on existing knowledge about the clinical presentations in SE and the high prevalence of ASD in this population. For example, the addition of the Child Autism Spectrum Test allowed for the assessment of autistic traits. To assess for additional cognitive difficulties common in ASD and in the related eating disorder field, two theory of mind tasks were also added. Meanwhile, given the exploratory nature of this research, the parent-rated BRIEF questionnaire, which assessed for EF impairments across a broad range of areas, was added to provide a clearer understanding of whether additional EF impairments may be present and further explored in future research. Indeed, response initiation was identified as a possible area of impairment and may benefit from future assessment in SE.

There were however several limitations identified in the application of this profile in SE. First, the age norms for the majority of tasks started at eight years old, as this is an adequate age to capture the anorexia nervosa patients for whom the profile was originally developed. For the purposes of this research, this restricted the lower bound of the age range of children that were recruited. Given the high prevalence of SE in infancy and early childhood (Micali et al., 2011; Carruth et

al., 2004), it may be that the sample was skewed by this limitation, and a more representative sample of selective eaters may have more appropriately included children from around five to six years old. The older age range of the children in the present study likely meant that the participants recruited had been identified for assessment later in development. This may be due to complex medical and neurodevelopmental difficulties delaying exploration of SE, which may mean the sample is not typically representative of selective eaters. Moreover, the recruitment of older children may also have captured a cohort who had previously received treatment in local services before ultimately being referred for specialist assessment and intervention. Their difficulties may therefore be more complex or severe, again biasing the sample. Furthermore, those children that may present with a more anxiety/phobic SE presentation (Kreipe & Palomaki, 2012; Dovey et al., 2008) did not seem to be detected in this sample, and it may be that these children are more common in earlier age groups before these phobic responses allay with time and developmental maturity. Thus, the present findings may be representative only of a certain subgroup within the SE population, with limited generalisability.

Second, several aspects of the battery were found to be unhelpful or would benefit from replacement or modification. Firstly, the theory of mind tasks lacked any standardised thresholds to indicate clear levels of difficulty as well as any standardised norms. This meant that only raw scores could be calculated and no firm conclusions about levels of impairment could be made. Given the initial findings regarding theory of mind performance in this sample, further applications of the profile may benefit from the use of standardised theory of mind tasks, such as those found in the NEPSY-II (Korkman, Kirk & Kemp, 2007a, 2007b). Secondly, the Child Autism Spectrum Test appeared not to capture all aspects of an autistic presentation, focusing largely on social and communication impairments and not adequately capturing the behavioural rigidities or restricted interests observed in ASD presentations. This is particularly important given that the latter traits have now been given greater weight in the new DSM-V (APA, 2013) criteria and are highly relevant to SE. The established cut-off for the Child Autism Spectrum Test is 15, however a conservative cut-off for elevated autistic traits was utilised in the present study given that one of the participants with a confirmed Asperger's diagnosis (P8) scored 13, and this was thus taken as a more conservative cut-off for the presence of elevated autistic traits. This measure was hence somewhat limited in its sensitivity and application in detecting autistic traits in a way that considered thoroughly all aspects of an ASD presentation, and future applications of

this profile might benefit from more well-rounded autism screening tools such as the Social Communication Questionnaire (Rutter, Bailey & Lord, 2003).

Furthermore, using the overall achievement score on the Hayling test meant that this took into account performance across all three sections of this task, the first of which assessed a basic ability in response initiation. Whilst this is relevant to inhibition, it is arguably a related EF, and there was a trend toward participants performing poorly on this aspect of the task, which skewed their overall score. This raises the question as to how reflective the overall achievement score is of a single EF difficulty on such tasks. Furthermore, Strauss, Sherman and Spreen (2006) assert that the Hayling test utilises the EF of planning, in terms of planning a novel response for each new item. Given that in the current sample, planning abilities were found to be in the average to superior range in nine of 10 participants, it may be that a strength in this skill facilitated improved performance on the inhibition aspects of this task. Furthermore, performance on this task has been suggested to be facilitated by the use of heuristic strategies when generating nonsensical words for sentence completion (Burgess & Shallice, 1997). This was particularly evident in the present study where several participants completed these sentences according to themes of interest, for example completing sentences with names of different aliens or armoury from computer games. This strategy may have masked impairment in inhibition on this task.

Finally, having reflected on the clinical presentations of participants, it was clear that in some cases there were presenting factors that should be taken into account when interpreting results. For example P2, whilst not hyperactive, was very inattentive and found it difficult to concentrate and apply himself to the tasks. This fit with concerns about a possible attention deficit disorder and may account for his scores often appearing as outliers on tasks. Furthermore P1 was particularly tired towards the end of testing, and while he was given the opportunity to take a break, he refused this. His fatigue may have thus influenced his performance on certain tasks. Finally, P6, who had a history of a neurological illness, did not perform in line with participants across some tasks, for example the visuospatial processing tasks and this may reflect a distinct neuropsychological profile for her given the brain lesions that she would have following neurosurgery.

4.4 Implications of the results

There are several clinical implications of the findings from this initial case series. First, in terms of assessment, several participants in the current sample scored above clinical cut-off for depressive and anxiety symptomology and a proportion of the participants also endorsed items relating to suicidal ideation on comorbidity questionnaires. This fits with previous literature that suggests a high rate of such difficulties in SE (Micali et al, 2011). These difficulties were detected with self-report measures and this highlights the importance of administering these during assessment of feeding difficulties. Importantly, in several of the participants these difficulties had not been previously raised and these issues were therefore discussed with the participant and their family, before the information was passed on to their treating clinician. Included in those that endorsed depressive symptomology were participants with ASD and it may be that with the use of a concrete self-report questionnaire such as those administered here, they were able to express emotional difficulties. It may be that previously, with the lack of provision of such questionnaires, the relevant prompts were not available to them to express these thoughts and feelings. These results will be fed back to the recruitment service during dissemination of the findings. Given the established literature of comorbidities in SE that has been reviewed and the present results, there is evidence to suggest that clinical services may benefit from updating their assessment protocol to incorporate assessments of comorbidities.

A further implication is raised by the finding that parental behavioural observations detected by the BRIEF may not be well correlated with cognitive or neuropsychological deficits observed on tasks (Anderson, Anderson, Northam, Jacobs & Mikiwicz, 2002). This has significant implications for the assessment of EF impairment in everyday settings, where, if tools are used in isolation, only certain constructs may be assessed and areas of difficulty may not be captured. Using behavioural measures and assessments of cognitive abilities in conjunction may overcome this and provide a thorough picture of EF difficulties.

Furthermore there was some evidence of weak central coherence, which has implications for treatment approaches given that individuals with weak central coherence have been found to respond well to cognitive remediation therapy (Tchanturia, Whitney, & Treasure, 2006; Tchanturia et al., 2008). It may be that selective eaters with primary deficits in central coherence may also benefit from aspects of such interventions, and that other selective eaters who show more behavioural rigidity may instead benefit from more behavioural or cognitive behavioural

approaches to therapy. Thus patterns in neuropsychological profiles have important implications for therapeutic approaches and how these may be better tailored to presenting difficulties and possible neuropsychological differences that may contribute to these.

Moreover, the finding of weak central coherence in this SE sample and its consistency with previous anorexia nervosa research has implications for this possibly being a common feature across a range of feeding and eating disorders. This has further implications for the sharing of successful therapeutic techniques between presentations with similar areas of underlying neuropsychological difficulty.

Finally, a preliminary analysis of data from the Ravello Profile reported in Rose et al., (2010) has suggested that there may be unique clusters in neuropsychological performance in different subgroups of individuals with anorexia nervosa. There may therefore also be distinct clusters within SE populations in terms of neuropsychological functioning which fit with the distinct presentations observed (that is, those with a more sensory based behavioural rigidity versus those with a more avoidant phobia/anxiety response). This should be borne in mind when designing treatments.

The findings and implications of this case series have been disseminated to the Ravello Profile group and will be further disseminated in the form of a research presentation to the recruitment service, where a summary of the findings will also be posted on a research notice board accessible to families in order to allow them to read about the research.

4.5 Future research

This study presents the first neuropsychological findings in SE to date and has proven an important first step in investigating this population. It has also facilitated the application of a relevant existing neuropsychological test battery and allowed for the identification of limitations in the existing profile to be uncovered when applied to SE. Future applications of this battery may benefit from further modifying the existing battery to improve its application to a SE population. This may be done by, for example, eliminating tasks that were less helpful in more definitively identifying difficulties, for example the Hayling test. Further research may also benefit from ensuring adequate questionnaires and tests are used with standardised norms and good reliability,

for example by replacing the theory of mind tasks and including a more well-rounded assessment of autistic symptomology. Given that response initiation appeared an area of particular difficulty identified in the Hayling task and on the BRIEF, future applications of the battery may also benefit from inclusion of a task that assesses this EF.

Furthermore, given the prevalence of SE in younger children and the possible biases identified in including older children (that is, the greater likelihood of complexity in terms of presenting difficulties), future research may endeavour to investigate neuropsychological differences in a younger age range. This may mean a more ‘pure’ sample is recruited in future group-based studies. In order to achieve this, tests applicable to younger ages and with lower age norms would be necessary (for example the NEPSY-II; Korkman et al., 2007a, 2007b), and the trends towards areas of strength, difficulty and greater variability in the present research will prove a vital starting point in identifying the most relevant areas of functioning that might be tested for.

The present study is an important first step in establishing the variability in neuropsychological profiles in SE in children, in a similar way to the study conducted by Rose and colleagues (2012), investigating neuropsychological profiles in anorexia nervosa in children and young adolescents. The next stage will be to apply an adapted profile, including the suggested modifications resulting from this case series. This would best be conducted in a larger sample of selective eaters in order to achieve sufficient power to determine whether distinct patterns emerge in the neuropsychological profiles in relation to published norms, or ideally a control sample of typically developing children. A further step may then be to consider how different patterns in profiles may cluster and fit with different clinical presentations within SE, for example whether those that fit into either of the main clinical presentations (that is sensory aversive versus anxious aversive) have distinct patterns of neuropsychological functioning underlying their SE.

4.6 Conclusions

This novel case series was the first of its kind to investigate neuropsychological differences in children with a SE presentation meeting diagnostic criteria for ARFID (DSM-V, APA 2013). While SE is a developmentally appropriate difficulty in early childhood (Tseng et al., 2009), in a proportion of children these difficulties escalate and persist, with resulting clinical presentations consistent with those described in this case series. This preliminary snapshot of

neuropsychological profiles in this population has shown the high degree of variability across children presenting with clinically significant SE. The results showed high variability particularly in terms of visuospatial processing. A striking finding of relatively impaired central coherence also emerged from this case series, supporting previous literature from the anorexia nervosa and ASD fields (Lopez et al., 2008; Shah & Frith, 1983; Happe, 1997). However, only tentative conclusions can be drawn from this finding, given the small heterogeneous nature of the sample. There were otherwise relatively intact abilities across EF domains including in cognitive flexibility, planning and inhibition. There were no substantive findings in relation to those participants with elevated autistic traits, however trends suggesting underlying visuospatial processing differences did emerge in these participants, although these conclusions are again limited by the nature of this study. In conclusion then, this research modified the profile utilised by Rose et al., (2012) to apply a neuropsychological test battery developed for use in eating disorders, to describe a series of participants with SE difficulties. Whilst the trends in the data were suggestive of areas of strength or weakness, the variability in the sample and the small heterogeneous nature of the sample mean that a distinct neuropsychological profile in SE did not emerge. This echoed the findings of Rose et al., (2012) in their first description of the neuropsychological profiles in children and young adolescents with anorexia nervosa. Nevertheless, the initial indications of areas of strength and weakness provide the pivotal first step in further exploring the neuropsychological functioning of children with SE.

5.0 REFERENCES

Achenbach, T. M. (1991). *Child behaviour checklist/4-18*. Burlington: University of Vermont.

Addison, L. R., Piazza, C. C., Patel, M. R., Bachmeyer, M. H., Rivas, K. M., Milnes, S. M., & Oddo, J. (2012). A comparison of sensory integrative and behavioral therapies as treatment for pediatric feeding disorders. *Journal of applied behaviour analysis, 45*(3), 455-471.

Ahearn, W. H., Castine, T., Nault, K., & Green, G. (2001). An assessment of food acceptance in children with autism or pervasive developmental disorder-not otherwise specified. *Journal of autism and developmental disorders, 31*(5), 505-511.

Ahearn, W. H., Kerwin, M. E., Eicher, P. S., Shantz, J., & Swearingin, W. (1996). An alternating treatments comparison of two intensive interventions for food refusal. *Journal of Applied Behavior Analysis, 29*(3), 321-332.

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Arlington, VA: American Psychiatric Publishing.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Anderson, V. A., Anderson, P., Northam, E., Jacobs, R., & Mikiewicz, O. (2002). Relationships between cognitive and behavioral measures of executive function in children with brain disease. *Child Neuropsychology, 8*(4), 231-240.

Archer, L. A., Rosenbaum, P. L., & Streiner, D. L. (1991). The children's eating behaviour inventory: reliability and validity results. *Journal of Pediatric Psychology, 16*(5), 629-642.

Andres-Perpina, S., Lazaro-Garcia, L., Canalda-Salhi, G., & Boget-Llucia, T. (2002). Neuropsychological aspects of obsessive compulsive disorder. *Revista de Neurologia*, 35, 959–963.

Ayres, A.J. (1979). *Sensory integration and the child*. Los Angeles: Western Psychological Services.

Bandura, A. (1977). *Social Learning Theory*. Englewood Cliffs, NJ: Prentice Hall.

Baranek, G. T. (2002). Efficacy of sensory and motor interventions for children with autism. *Journal of autism and developmental disorders*, 32(5), 397-422.

Baron-Cohen, S., Tager-Flusberg, H. and Cohen, D.J. (1993). *Understanding Other Minds: Perspectives from Autism*. Oxford University Press.

Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001). The “reading the mind in the eyes” test revised version: a study with normal adults and adults with Asperger syndrome or high-functioning autism. *Journal of child psychology and psychiatry*, 42(2), 241-251.

Baron-Cohen, S., Wheelwright, S., Spong, A., Scahill, V., & Lawson, J. (2001). Are intuitive physics and intuitive psychology independent? A test with children with Asperger Syndrome. *Journal of Developmental and Learning Disorders*, 5(1), 47-78.

Beauchamp, G. K., & Moran, M. (1982). Dietary experience and sweet taste preference in human infants. *Appetite*, 3(2), 139-152.

Bentovim, A. (1970). The clinical approach to feeding disorders of childhood. *Journal of psychosomatic research*, 14(3), 267-276.

Billstedt, E., Carina Gillberg, I., & Gillberg, C. (2007). Autism in adults: symptom patterns and early childhood predictors. Use of the DISCO in a community sample followed from childhood. *Journal of Child Psychology and Psychiatry*, 48(11), 1102-1110.

Birch, L. L., & Marlin, D. W. (1982). I don't like it; I never tried it: effects of exposure on two-year-old children's food preferences. *Appetite*, 3(4), 353-360.

Birch, L. L., Gunder, L., Grimm-Thomas, K., & Laing, D. G. (1998). Infants' consumption of a new food enhances acceptance of similar foods. *Appetite*, 30(3), 283-295.

Booth, R. (2006). *Local global processing and cognitive style in autism spectrum disorders and typical development*. (Unpublished doctoral thesis). King's College, University of London.

Bouchard, T. J., & McGue, M. (2003). Genetic and environmental influences on human psychological differences. *Journal of neurobiology*, 54(1), 4-45.

Brewerton, TD, Frampton, I., & Lask, B. (2009). The neurobiology of anorexia nervosa. *US Psychiatry*, 2(1), 57-60.

Brosnan, M. J., Scott, F. J., Fox, S., & Pye, J. (2004). Gestalt processing in autism: Failure to process perceptual relationships and the implications for contextual understanding. *Journal of Child Psychology and Psychiatry*, 45(3), 459-469.

Bryant-Waugh, R. (2000). Overview of the eating disorders. *Anorexia nervosa and related eating disorders in childhood and adolescence*, 27-40.

Bryant-Waugh, R. (2013). Avoidant restrictive food intake disorder: an illustrative case example. *International Journal of Eating Disorders*, 46(5), 420-423.

Bryant-Waugh, R., & Lask, B. (1995). Annotation: Eating disorders in children. *Journal of Child Psychology and Psychiatry*, 36(2), 191-202.

Bryant-Waugh, R., Markham, L., Kreipe, R. E., & Walsh, B. T. (2010). Feeding and eating disorders in childhood. *International journal of eating disorders*, 43(2), 98-111.

Bryant-Waugh, R. J., & Piepenstock, E. H. (2008). Childhood disorders: Feeding and related disorders of infancy or early childhood. *Psychiatry, Third Edition*, 830-846.

Burgess, P., & Shallice, T. (1997). *The Hayling and Brixton Tests. Test manual*. Bury St Edmunds, UK: Thames Valley Test Company.

Butler, N., & Bynner, J. (1997). British Cohort Study: Ten-Year Follow-up. *Colchester, Essex: UK Data Archive*.

Caron, M-J., Mottron, L., Rainville, C., and Chouinard, S. (2004). Do high functioning persons with autism present superior spatial abilities? *Neuropsychologia*, 42, 467-481.

Carruth, B. R., Ziegler, P. J., Gordon, A., & Barr, S. I. (2004). Prevalence of picky eaters among infants and toddlers and their caregivers' decisions about offering a new food. *Journal of the American Dietetic Association*, 104, 57-64.

Case-Smith, J., & Humphry, R. (2005). Feeding intervention. *Occupational therapy for children*, 481-520.

Cashdan, E. (1994). A sensitive period for learning about food. *Human Nature*, 5(3), 279-291.

Cermak, S. A. (2001). *The effects of deprivation on processing, play, and praxis. Understanding the nature of sensory integration with diverse populations*. San Antonio, TX: Therapy Skill Builders.

Chatoor, I. (2002). Feeding disorders in infants and toddlers: diagnosis and treatment. *Child and adolescent psychiatric clinics of North America*, 11(2), 163-183.

Chen, Y. H., Rodgers, J., & McConachie, H. (2009). Restricted and repetitive behaviours, sensory processing and cognitive style in children with autism spectrum disorders. *Journal of autism and developmental disorders*, 39(4), 635-642.

Cooke, L., Carnell, S., & Wardle, J. (2006). Food neophobia and mealtime food consumption in 4–5 year old children. *International Journal of Behavioral Nutrition and Physical Activity*, 3(1), 14.

Cooke, L. J., Haworth, C. M., & Wardle, J. (2007). Genetic and environmental influences on children's food neophobia. *The American journal of clinical nutrition*, 86(2), 428-433.

Cooper, L. J., Wacker, D. P., McComas, J. J., Brown, K., Peck, S. M., Richman, D., Millard, T. (1995). Use of component analyses to identify active variables in treatment packages for children with feeding disorders. *Journal of Applied Behavior Analysis*, 28(2), 139-153.

Coulthard, H., Harris, G., & Emmett, P. (2009). Delayed introduction of lumpy foods to children during the complementary feeding period affects child's food acceptance and feeding at 7 years of age. *Maternal & child nutrition*, 5(1), 75-85.

Coulthard, H., Harris, G., & Fogel, A. (2014). Exposure to vegetable variety in infants weaned at different ages. *Appetite*, 78, 89-94.

Crane, L., Goddard, L., & Pring, L. (2009). Sensory processing in adults with autism spectrum disorders. *Autism*, 13(3), 215-228.

Dagenbach, D., & Carr, T. H. (1994). *Inhibitory processes in perceptual recognition: Evidence for a center-surround attentional mechanism*. Academic Press.

Damasio, A. R., & Maurer, R. G. (1978). A neurological model for childhood autism. *Archives of neurology*, 35(12), 777-786.

Delis, D. C., Kaplan, E., & Kramer, J. H. (2001a). *Delis-Kaplan Executive Function System (D-KEFS)*. San Antonio, TX: The Psychological Corporation.

Desor, J. A., Maller, O., & Andrews, K. (1975). Ingestive responses of human newborns to salty, sour, and bitter stimuli. *Journal of comparative and physiological psychology*, 89(8), 966.

Dovey, T. M., Staples, P. A., Gibson, E. L., & Halford, J. C. (2008). Food neophobia and 'picky/fussy' eating in children: A review. *Appetite*, 50(2), 181-193.

Dubois, L., Farmer, A., Girard, M., Peterson, K., & Tatone-Tokuda, F. (2007). Problem eating behaviors related to social factors and body weight in preschool children: A longitudinal study. *International Journal of Behavioral Nutrition and Physical Activity*, 4(1), 9.

Duncan, J. (1986). Disorganisation of behaviour after frontal lobe damage. *Cognitive Neuropsychology*, 3(3), 271-290.

Dunn, W. (1999). *Sensory Profile*. San Antonio, TX: The Psychological Corporation.
Fagundo, A. B., De la Torre, R., Jiménez-Murcia, S., Agüera, Z., Granero, R., Tárrega, S, ...
Fernández-Aranda, F. (2012). Executive functions profile in extreme eating/weight conditions: from anorexia nervosa to obesity. *PloS one*, 7(8), e43382.

Farrow, C. V., & Coulthard, H. (2012). Relationships between sensory sensitivity, anxiety and selective eating in children. *Appetite*, 58(3), 842-846.

Frith, U. (1989). *Autism: Explaining the enigma*. Oxford: Basil Blackwell.

Galloway, A. T., Fiorito, L., Lee, Y., & Birch, L. L. (2005). Parental pressure, dietary patterns, and weight status among girls who are "picky eaters". *Journal of the American Dietetic Association*, 105(4), 541-548.

Gilbert, S. J., Bird, G., Brindley, R., Frith, C. D., & Burgess, P. W. (2008). Atypical recruitment of medial prefrontal cortex in autism spectrum disorders: An fMRI study of two executive function tasks. *Neuropsychologia*, 46(9), 2281-2291.

Golding, J., Steer, C., Emmett, P., Bartoshuk, L. M., Horwood, J., & Smith, G. D. (2009). Associations between the Ability to Detect a Bitter Taste, Dietary Behavior, and Growth. *Annals of the New York Academy of Sciences*, 1170(1), 553-557.

Gillberg, I. C., Billstedt, E., Wentz, E., Anckarsäter, H., Råstam, M., & Gillberg, C. (2010). Attention, executive functions, and mentalizing in anorexia nervosa eighteen years after onset of eating disorder. *Journal of clinical and experimental neuropsychology*, 32(4), 358-365.

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). Test review behaviour rating inventory of executive function. *Child Neuropsychology*, 6(3), 235-238.

Goh, A.J. (2012). Perception of picking eating among children in Singapore and its impact on caregivers: a questionnaire survey. *Asia Pacific Family Medicine*, 11.

Gregory, J. E., Paxton, S. J., & Brozovic, A. M. (2010). Pressure to eat and restriction are associated with child eating behaviours and maternal concern about child weight, but not child body mass index, in 2-to 4-year-old children. *Appetite*, 54(3), 550-556.

Geurts, H. M., Corbett, B., & Solomon, M. (2009). The paradox of cognitive flexibility in autism. *Trends in cognitive sciences*, 13(2), 74-82.

Happé, F. G. (1997). Central coherence and theory of mind in autism: Reading homographs in context. *British journal of developmental psychology*, 15(1), 1-12.

Happe, F., & Booth, R. (2008). The power of the positive: Revisiting weak coherence in autism spectrum disorders. *The Quarterly Journal of Experimental Psychology*, 61, 50–63.

Happé, F., Booth, R., Charlton, R., & Hughes, C. (2006). Executive function deficits in autism spectrum disorders and attention-deficit/hyperactivity disorder: Examining profiles across domains and ages. *Brain and cognition*, 61(1), 25-39.

Happé, F., & Frith, U. (2006). The weak coherence account: detail-focused cognitive style in autism spectrum disorders. *Journal of autism and developmental disorders*, 36(1), 5-25.

Hatch, A., Madden, S., Kohn, M. R., Clarke, S., Touyz, S., Gordon, E., & Williams, L. M. (2010). In first presentation adolescent anorexia nervosa, do cognitive markers of underweight status change with weight gain following a refeeding intervention?. *International journal of eating disorders*, 43(4), 295-306.

Hill, E. L. (2004). Executive dysfunction in autism. *Trends in cognitive sciences*, 8(1), 26-32.

Hughes, C., Russell, J., & Robbins, T. W. (1994). Evidence for executive dysfunction in autism. *Neuropsychologia*, 32(4), 477-492.

Jacobi, C., Agras, W. S., Bryson, S., & Hammer, L. D. (2003). Behavioral validation, precursors, and concomitants of picky eating in childhood. *Journal of the American Academy of Child & Adolescent Psychiatry*, 42(1), 76-84.

Jacobi, C., Schmitz, G., & Agras, W. S. (2008). Is picky eating an eating disorder?. *International journal of eating disorders*, 41(7), 626-634.

Kenney, L., & Walsh, B. (2013). Avoidant/Restrictive Food Intake Disorder (ARFID)—Defining ARFID. *Eating Disorders Review, Gurze Books*, 24(3).

Key, A., O'Brien, A., Gordon, I., Christie, D., & Lask, B. (2006). Assessment of neurobiology in adults with anorexia nervosa. *European Eating Disorders Review*, 14(5), 308-314.

Kimball, J. (1999). Sensory integration frame of reference: Postulates regarding change and application to practice. *Frames of reference for pediatric occupational therapy*, 2, 119-159.

Kingston, K., Szmukler, G., Andrewes, D., Tress, B., & Desmond, P. (1996). Neuropsychological and structural brain changes in anorexia nervosa before and after refeeding. *Psychological Medicine*, 26(1), 15-28.

Kooistra, B., Dijkman, B., Einhorn, T. A., & Bhandari, M. (2009). How to design a good case series. *The Journal of Bone & Joint Surgery*, 91(Supplement_3), 21-26.

Korkman, M., Kirk, U., & Kemp, S.L. (2007a). *NEPSY II. Administrative manual*. San Antonio, TX: Psychological Corporation.

Korkman, M., Kirk, U., Kemp, S.L. (2007b). *NEPSY II. Clinical and interpretative manual*. San Antonio, TX: Psychological Corporation.

Kreipe, R. E., & Palomaki, A. (2012). Beyond picky eating: Avoidant/restrictive food intake disorder. *Current psychiatry reports*, 14(4), 421-431.

Lask, B., & Bryant-Waugh, R. (2000). *Anorexia nervosa and related eating disorders in childhood and adolescence*. Taylor & Francis.

Leekam, S. R., Nieto, C., Libby, S. J., Wing, L., & Gould, J. (2007). Describing the sensory abnormalities of children and adults with autism. *Journal of autism and developmental disorders*, 37(5), 894-910.

Li, Y., Shi, A., Wan, Y., Hotta, M., & Ushijima, H. (2001). Child behaviour problems: prevalence and correlates in rural minority areas of China. *Pediatrics international*, 43(6), 651-661.

Lillard, A. S. (2008). *Montessori: The science behind the genius*. Oxford University Press.

Lopez, C., Tchanturia, K., Stahl, D., & Treasure, J. (2008). Central coherence in eating disorders: a systematic review. *Psychological Medicine*, 38(10), 1393-1404.

Maier, A., Chabanet, C., Schaal, B., Issanchou, S., & Leathwood, P. (2007). Effects of repeated exposure on acceptance of initially disliked vegetables in 7-month old infants. *Food Quality and Preference*, *18*(8), 1023-1032.

Marchi, M., & Cohen, P. (1990). Early childhood eating behaviors and adolescent eating disorders. *Journal of the American Academy of Child & Adolescent Psychiatry*, *29*(1), 112-117.

Marks, L. E. (1975). On colored-hearing synesthesia: cross-modal translations of sensory dimensions. *Psychological bulletin*, *82*(3), 303.

Martin, N., Boomsma, D., & Machin, G. (1997). A twin-pronged attack on complex traits. *Nat. Genet*, *17*, 387-92.

Mascola, A. J., Bryson, S. W., & Agras, W. S. (2010). Picky eating during childhood: A longitudinal study to age 11 years. *Eating behaviors*, *11*(4), 253-257.

Meyers, J., & Meyers, K. (1995). *Rey complex figure test and recognition trial*. Odessa: Psychological Assessment Resources, Inc.

Micali, N., Simonoff, E., Elberling, H., Rask, C. U., Olsen, E. M., & Skovgaard, A. M. (2011). Eating patterns in a population-based sample of children aged 5 to 7 years: association with psychopathology and parentally perceived impairment. *Journal of Developmental & Behavioral Pediatrics*, *32*(8), 572-580.

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex “frontal lobe” tasks: A latent variable analysis. *Cognitive Psychology*, *41*, 49–100.

Molloy, C. A., & Manning-Courtney, P. (2003). Prevalence of chronic gastrointestinal symptoms in children with autism and autistic spectrum disorders. *Autism*, *7*(2), 165-171.

Morris, S. E. (1989). Development of oral-motor skills in the neurologically impaired child receiving non-oral feedings. *Dysphagia*, 3(3), 135-154.

Neiderman, M., Farley, A., Richardson, J., & Lask, B. (2001). Nasogastric feeding in children and adolescents with eating disorders: toward good practice. *International Journal of Eating Disorders*, 29(4), 441-448.

Neiderman, M., Tattersall, M., Lakatos, M., & Lask, B. (2000). Enteric feeding in severe adolescent anorexia nervosa: A report of four cases. *International Journal of Eating Disorders*, 28, 470-475.

Nicholls, D., Chater, R., & Lask, B. (2000). Children into DSM don't go: A comparison of classification systems for eating disorders in childhood and early adolescence. *International Journal of Eating Disorders*, 28(3), 317-324.

Nicholls, D., Christie, D., Randall, L., & Lask, B. (2001). Selective eating: Symptom, disorder or normal variant. *Clinical Child Psychology and Psychiatry*, 6(2), 257-270.

Nicholls, D. E., Lynn, R., & Viner, R. M. (2011). Childhood eating disorders: British national surveillance study. *The British Journal of Psychiatry*, 198(4), 295-301.

Nicholls, D. E., & Viner, R. M. (2009). Childhood risk factors for lifetime anorexia nervosa by age 30 years in a national birth cohort. *Journal of the American Academy of Child & Adolescent Psychiatry*, 48(8), 791-799.

Osterrieth, P.A. (1944). The test of copying a complex figure: A contribution to the study of perception and memory. *Archives de Psychologie*, 30, 286-356.

Ozonoff, S. (1997). Components of executive function in autism and other disorders. In J. Russell (Ed.), *Autism as an executive disorder*. New York: Oxford University Press.

Ozonoff, S., & Jensen, J. (1999). Brief report: Specific executive function profiles in three neurodevelopmental disorders. *Journal of autism and developmental disorders*, 29(2), 171-177.

Ozonoff, S., Pennington, B. F., & Rogers, S. J. (1991). Executive function deficits in high-functioning autistic individuals: relationship to theory of mind. *Journal of child Psychology and Psychiatry*, 32(7), 1081-1105.

Ozonoff, S., Rogers, S. J., & Pennington, B. F. (1991). Asperger's Syndrome: Evidence of an Empirical Distinction from High-Functioning Autism. *Journal of Child Psychology and Psychiatry*, 32(7), 1107-1122.

Ozonoff, S., Strayer, D. L., McMahon, W. M., & Filloux, F. (1998). Inhibitory deficits in Tourette syndrome: A function of comorbidity and symptom severity. *Journal of Child Psychology and Psychiatry*, 39, 1109-1118.

Perner, J., Frith, U., Leslie, A. M., & Leekam, S. R. (1989). Exploration of the autistic child's theory of mind: Knowledge, belief, and communication. *Child development*, 689-700.

Piazza, C. C., Fisher, W. W., Brown, K. A., Shore, B. A., Patel, M. R., Katz, R. M., ...Blakely-Smith, A. (2003a). Functional analysis of inappropriate mealtime behaviours. *Journal of Applied Behaviour Analysis*, 36(2), 187-204.

Piazza, C. C., Patel, M. R., Gulotta, C. S., Sevin, B. M., & Layer, S. A. (2003b). On the relative contributions of positive reinforcement and escape extinction in the treatment of food refusal. *Journal of Applied Behavior Analysis*, 36(3), 309-324.

Pooni, J., Ninteman, A., Bryant-Waugh, R., Nicholls, D., & Mandy, W. (2012). Investigating autism spectrum disorder and autistic traits in early onset eating disorder. *International Journal of Eating Disorders*, 45(4), 583-591.

Porter, R., Gallagher, P., Thompson, J., & Young, A. (2003). Neurocognitive impairment in drug-free patients with major depressive disorder. *The British Journal of Psychiatry*, 182, 214–220.

Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind?. *Behavioral and brain sciences*, 1(04), 515-526.

Purcell, R., Maruff, P., Kyrios, M., & Pantelis, C. (1998). Neuropsychological deficits in obsessive–compulsive disorder: A comparison with unipolar depression, panic disorder, and normal controls. *Archives of General Psychiatry*, 55, 415–423.

Raiten, D. J., & Massaro, T. (1986). Perspectives on the nutritional ecology of autistic children. *Journal of autism and developmental disorders*, 16(2), 133-143.

Reed, G. K., Piazza, C. C., Patel, M. R., Layer, S. A., Bachmeyer, M. H., Bethke, S. D., & Gutshall, K. A. (2004). On the relative contributions of noncontingent reinforcement and escape extinction in the treatment of food refusal. *Journal of Applied Behavior Analysis*, 37(1), 27-42.

Rey, A. (1941). L'examen psychologique dans les cas d'encephalopathie traumatique (Psychological examination of traumatic encephalopathy). *Archives de Psychologie*, 28, 286–340.

Roberge, C., Tran, M., Massoud, C., Poirée, B., Duval, N., Damecour, E., ...Henry-Amar, M. (2000). Quality of life and home enteral tube feeding: a French prospective study in patients with head and neck or oesophageal cancer. *British Journal of Cancer*, 82(2), 263.

Roberts, M. E., Tchanturia, K., Stahl, D., Southgate, L., & Treasure, J. (2007). A systematic review and meta-analysis of set-shifting ability in eating disorders. *Psychological Medicine*. 37(8), 1075.

Rose, M. (2009). The Ravello Profile. *Child and Adolescent Mental Health*, 14(3), 156-157.

Rose, M., Davis, J., Frampton, I., & Lask, B. (2011). The Ravello Profile: Development of a global standard neuropsychological assessment for young people with anorexia nervosa. *Clinical child psychology and psychiatry*, *16*(2), 195-202.

Rose, M., Frampton, I., & Lask, B. (2012). A case series investigating distinct neuropsychological profiles in children and adolescents with anorexia nervosa. *European Eating Disorders Review*, *20*(1), 32-38.

Rose, M., Frampton, I., Watkins, B., Davis, J., Overas, M., Stedal, K., & Lask, B. (2010, October). *Proceedings of 2010 Eating Disorder Research Society meeting*. Cambridge, Massachusetts.

Royeen, C. B., & Lane, S. J. (1991). Tactile processing and sensory defensiveness. *Sensory integration: Theory and practice*, 108-136.

Russell, T. A., Schmidt, U., Doherty, L., Young, V., & Tchanturia, K. (2009). Aspects of social cognition in anorexia nervosa: Affective and cognitive theory of mind. *Psychiatry Research*, *168*(3), 181-185.

Rutter, M., Bailey, A., & Lord, C. (2003). *The social communication questionnaire: Manual*. Western Psychological Services.

Rydell, A. M., Dahl, M., & Sundelin, C. (1995). Characteristics of school children who are choosy eaters. *The Journal of genetic psychology*, *156*(2), 217-229.

Saylor, C.F., Finch, A.J., Spirito, A., & Bennett, B. (1984). The Children's Depression Inventory: A systematic evaluation of psychometric properties. *Journal of consulting and clinical psychology*, *52*, 955-967.

Schaaf, R. C., & Davies, P. L. (2010). Evolution of the sensory integration frame of reference. *The American Journal of Occupational Therapy*, *64*(3), 363-367.

Schreck, K. A., Williams, K., & Smith, A. F. (2004). A comparison of eating behaviors between children with and without autism. *Journal of autism and developmental disorders*, 34(4), 433-438.

Schwartz, M. F., & Dell, G. S. (2010). Case series investigations in cognitive neuropsychology. *Cognitive neuropsychology*, 27(6), 477-494.

Scott, F., Baron-Cohen, S., Bolton, P., & Brayne, C. (2002) The CAST (Childhood Asperger Syndrome Test): Preliminary development of UK screen for maintream primary school children. *Autism*, 6(1), 9-31.

Shafran, R., Frampton, I., Heyman, I., Reynolds, M., Teachman, B., & Rachman, S. (2003). The preliminary development of a new self-report measure for OCD in young people. *Journal of Adolescence*, 26(1), 137-142.

Shah, A., & Frith, U. (1993). Why do autistic individuals show superior performance on the block design task?. *Journal of Child Psychology and Psychiatry*, 34(8), 1351-1364.

Shim, J.E. & Kim, J.A.M. (2011). Associations of infant feeding practices and picky eating behaviours of preschool children. *Journal of American Dietetic Association*, 111, 1363-1368.

Skinner, B. F. (1938). *The Behaviour of Organisms: An Experimental Analysis*. New York: Appleton-Century.

Skovgaard, A. M., Olsen, E. M., Houmann, T., Christiansen, E., Samberg, V., Lichtenberg, A., & Jorgensen, T. (2005). The Copenhagen County child cohort: design of a longitudinal study of child mental health. *Scandinavian journal of public health*, 33(3), 197-202.

Southgate, L., Tchanturia, K., & Treasure, J. (2005). Building a model of the aetiology of eating disorders by translating experimental neuroscience into clinical practice. *Journal of Mental Health*, 14(6), 553-566.

Spalding, K., & McKeever, P. (1998). Mothers' experiences caring for children with disabilities who require a gastrostomy tube. *Journal of Pediatric Nursing, 13*(4), 234-243.

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the state-trait anxiety inventory*. Palo Alto, CA: Consulting Psychologists Press.

Stedal, K., Rose, M., Frampton, I., Landrø, N. I., & Lask, B. (2012). The neuropsychological profile of children, adolescents, and young adults with anorexia nervosa. *Archives of clinical neuropsychology, 27*(3), 329-337.

Steinglass, J. E., Walsh, T., & Stern, Y. (2006). Set shifting deficit in anorexia nervosa. *Journal of the International Neuropsychological Society, 12*, 431-435.

Strauss, E. Sherman. EMS, Spreen, O.(2006). *A compendium of neuropsychological tests: Administration, norms, and commentary*.

Stuss, D. T., & Levine, B. (2002). Adult clinical neuropsychology: lessons from studies of the frontal lobes. *Annual review of psychology, 53*(1), 401-433.

Sullivan, S. A., & Birch, L. L. (1994). Infant dietary experience and acceptance of solid foods. *Pediatrics, 93*(2), 271-277.

Tan, C. C., & Holub, S. C. (2012). Maternal feeding practices associated with food neophobia. *Appetite, 59*(2), 483-487.

Tarbell, M. C., & Allaire, J. H. (2002). Children with feeding tube dependency: Treating the whole child. *Infants & Young Children, 15*(1), 29-41.

Tchanturia, K. (2004). Set shifting in anorexia nervosa: An examination before and after weight gain, in full recovery and relationship to childhood and adult OCPD traits. *Journal of Psychiatric Research, 38*, 545-552.

Tchanturia, K., Anderluh, M. B., Morris, R. G., Rabe-Hesketh, S., Collier, D. A., Sanchez, P., & Treasure, J. L. (2004). Cognitive flexibility in anorexia nervosa and bulimia nervosa. *Journal of the International Neuropsychological Society*, *10*(04), 513-520.

Tchanturia, K., Davies, H., Lopez, C., Schmidt, U., Treasure, J., & Wykes, T. (2008). Letter to the editor: neuropsychological task performance before and after cognitive remediation in anorexia nervosa: a pilot case-series. *Psychological medicine*, *38*(09), 1371-1373.

Tchanturia, K., Campbell, I. C., Morris, R., & Treasure, J. (2005). Neuropsychological studies in anorexia nervosa. *International Journal of Eating Disorders*, *37*(S1), S72-S76.

Tchanturia, K., Happé, F., Godley, J., Treasure, J., Bara-Carril, N., & Schmidt, U. (2004). 'Theory of mind' in anorexia nervosa. *European Eating Disorders Review*, *12*(6), 361-366.

Tchanturia, K., Whitney, J., & Treasure, J. (2006). Can cognitive exercises help treat anorexia nervosa?. *Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity*, *11*(4), e112-e116.

Tenconi, E., Santonastaso, P., Degortes, D., Bosello, R., Titton, F., Mapelli, D., & Favaro, A. (2010). Set-shifting abilities, central coherence, and handedness in anorexia nervosa patients, their unaffected siblings and healthy controls: Exploring putative endophenotypes. *World Journal of Biological Psychiatry*, *11*(6), 813-823.

Thomas, J. J., Hartmann, A. S., & Killgore, W. D. (2013). Non-fat-phobic eating disorders: Why we need to investigate implicit associations and neural correlates. *International Journal of Eating Disorders*, *46*(5), 416-419.

Thompson, S. B. (1993). Implications of neuropsychological test results of women in a new phase of anorexia nervosa. *European Eating Disorders Review*, *1*(3), 152-165.

Timimi, S., Douglas, J., & Tsiftopoulou, K. (1997). Selective eaters: A retrospective case note study. *Child: Care, Health and Development*, *23* (3), 265-278.

Towgood, K. J., Meuwese, J. D., Gilbert, S. J., Turner, M. S., & Burgess, P. W. (2009). Advantages of the multiple case series approach to the study of cognitive deficits in autism spectrum disorder. *Neuropsychologia*, *47*(13), 2981-2988.

Tseng, A. G., & Biagioli, F. E. (2009). Counseling on early childhood concerns: sleep issues, thumb sucking, picky eating, and school readiness. *American family physician*, *80*(2).

Uher, R., & Rutter, M. (2012). Classification of feeding and eating disorders: review of evidence and proposals for ICD-11. *World Psychiatry*, *11*(2), 80-92.

Vandenbroucke, J. P. (1999). Case reports in an evidence-based world. *Journal of the Royal Society of Medicine*, *92*(4), 159.

Vivanti, G., Hudry, K., Trembath, D., Barbaro, J., Richdale, A., & Dissanayake, C. (2013). Towards the DSM-5 Criteria for Autism: Clinical, Cultural, and Research Implications. *Australian Psychologist*, *48*(4), 258-261.

Volkert, V. M., & Piazza, C. C. (2012). *Pediatric feeding disorders. Handbook of Evidence-Based Practice in Clinical Psychology*.

Wardle, J., Guthrie, C.A., Sanderson, S., & Rapoport, L. (2001). Development of the children's eating behaviour Questionnaire. *Journal of child psychology and psychiatry*, *42*(7), 963-970.

Waters, W. F., McDonald, D. G., & Koresko, R. L. (1972). Psychophysiological responses during analogue systematic desensitization and non-relaxation control procedures. *Behaviour research and therapy*, *10*(4), 381-393.

Wechsler, D. (1999). *Wechsler Abbreviated Scale of Intelligence (WASI)*. London: Harcourt Assessment.

Wilbarger, P. (1984). Planning an adequate sensory diet—Application of sensory processing theory during the first year of life. *Zero to Three*, *1*, 7-12.

Willcutt, E., Sonuga-Barke, E., Nigg, J., & Sergeant, J. (2008). Recent developments in neuropsychological models of childhood psychiatric disorders. *Biological child psychology*, *24*, 195-226.

Wolfe, C. D., & Bell, M. A. (2004). Working memory and inhibitory control in early childhood: Contributions from physiology, temperament, and language. *Developmental psychobiology*, *44*(1), 68-83.

Wood, J., Mathews, A., & Dalgleish, T. (2001). Anxiety and cognitive inhibition. *Emotion*, *1*, 166-181.

Wright, C. M., Parkinson, K. N., Shipton, D., & Drewett, R. F. (2007). How do toddler eating problems relate to their eating behaviour, food preferences, and growth?. *Pediatrics*, *120*(4), 1069-1075.

Zero to Three (2005). *Diagnostic classification of mental health and developmental disorders of infancy and early childhood: Revised edition (DC: 0-3R)*. Zero To Three Press. Washington: DC.

Appendix 1 – Summary of examples of neuropsychological research

	Anorexia Nervosa	Autism Spectrum Disorder
Visuospatial processing	Impaired abilities (e.g. Kingston et al., 1996).	Normal or superior abilities (Caron et al., 2004).
Central coherence	Difficulties with global processing (Lopez et al., 2008).	Bias toward local processing (Happé & Frith, 2006).
Cognitive flexibility	Set shifting impaired in adults (Tchanturia, 2002). Verbal Fluency is a strength in childhood AN with set-shifting found as a weakness (Stedal et al., 2012).	Switching impaired in children (Hill, 2004; Ozonoff, 1997; Hughes et al., 1994).
Inhibition	Inhibition impaired in adults (Brewerton et al., 2009). No impairment detected in children (Rose et al., 2012; Stedal et al., 2012).	Inhibition impaired in adults with ASD (Burgess & Shallice, 1997). Mixed findings in child research with some showing intact abilities (Ozonoff & Jensen, 1999) and some showing impaired abilities (Ozonoff, et al., 1994).
Planning	No planning impairments found in childhood AN (Rose et al., 2012; Stedal et al., 2012).	Impairments in children with ASD (Ozonoff, et al., 1991; Ozonoff & Jensen, 1999; Ozonoff, 1997).
Theory of mind	Impaired (Russell et al., 2009)	Impaired (Baron-Cohen, et al., 1993)

Notes: AN: Anorexia Nervosa; ASD: Autism Spectrum Disorder



NRES Committee North West - Liverpool Central

HRA NRES Centre - Manchester
3rd Floor
Barlow House
4 Minshull Street
Manchester
M1 3DZ

Telephone: 0161 625 7818
Facsimile: 0161 625 7299

23 September 2013

Miss Charlotte Mawbey
Trainee Clinical Psychologist
Camden and Islington NHS Trust
Doctorate in Clinical Psychology, Department of Psychology
Royal Holloway University of London
Egham, Surrey
TW20 0EX

Dear Miss Mawbey

Study title: Neuropsychological profiles of children with selective eating difficulties – do these vary in those children with elevated autistic traits?
REC reference: 13/NW/0689
IRAS project ID: 121213

The Proportionate Review Sub-committee of the NRES Committee North West - Liverpool Central reviewed the above application on 23 September 2013.

We plan to publish your research summary wording for the above study on the NRES website, together with your contact details, unless you expressly withhold permission to do so. Publication will be no earlier than three months from the date of this favourable opinion letter. Should you wish to provide a substitute contact point, require further information, or wish to withhold permission to publish, please contact the REC Manager Mrs Carol Ebenezer, nrescommittee.northwest-liverpoolcentral@nhs.net.

Ethical opinion

The Committee requested some clarifications from you and their queries and responses are below.

Can you explain why the parents cannot be there during their child's test? Is this optional? If not this needs to be made clear why.

Parents are not provided with the option of being present for two main reasons:

1. Children are required to concentrate fully on their performance without distraction or approval seeking. Parents can often be distracting during these times and children can focus on

asking parents questions, asking if they are doing well, which detracts from their performance.

2. Understandably parents want their children to do as well as possible and during such tasks parents often provide feedback to children both verbally and in terms of eye contact, smiles and gestures. There is also the possibility that if a child directly asks them a question that they may answer, providing the child with an unreliable score.

This being said, if a parent insists that they are present during testing or a child becomes distressed at being separated, this would be facilitated.

You say the tests will take no more than 2.5 hours but the university review said that they thought these might take considerably longer - what will they do if they take over 2.5 hours?

The initial estimated test administration time for this study was based on the time taken to administer the bulk of the tests in a previous piece of research (Rose et al., 2011). We initially estimated that the testing time would take 1-2 hours, which the university committee based their comment on. Based on this feedback we calculated the time that the additional tests we added into the battery would take and raised the maximum administration time to 2.5 hours to account for any additional time taken. This is an upper estimate which the university review accepted and it is not anticipated that this will be exceeded.

There will be regular breaks in which families will be updated on progress and timings, in the unlikely event that testing time does run over, families will be provided with the option of taking more frequent breaks, or a longer break, or the opportunity to complete their participation at another more convenient time.

During the breaks in the 2.5 hour session for the children, will they be offered appropriate food/drink, bearing in mind the children will have different likes/dislikes?

The testing will take place in the [REDACTED] where there is a well-stocked kitchen and food cupboard with facilities to cater to the preferences or specific dietary requirements of the children participating.

The Committee did not accept the young people cannot be involved in this study and in fact the children's PIS would be greatly improved if some children had looked at this, but highlighted specific PIS issues in a separate point

our response to this is included in your comments regarding the PIS.

A50 if the study is registered on the [REDACTED] trust database then this is a public database

The study will be registered on the [REDACTED] trust database.

Why such a small sample size (n=10) for quantitative research, using questionnaires? You say you are using a case series design, but why use this method? Will 10 patients generate sufficient data to actually answer your research question?

This is a pilot study that aims to provide a description of the neuropsychological profiles that selective eaters have. Whilst quantitative methods are being adopted, this is not a group comparison but a pilot exploratory design to better describe this population. We are extending the methods and using the precedent set by a previous study which piloted using a case series design of the same number of participants in an anorexia nervosa population (Rose et al., 2011). Since the aim is not to compare groups or carry out any analyses that require power statistics to be calculated and we are instead looking at within participant profiles across the group there will be sufficient data to achieve this.

There does not appear to be an option for the child's GP not to be informed. If a parent/guardian requests that this should not happen, can they still be included in the study?

It is a matter of course that GP's are contacted to notify them of participation in research. This is

part of the consent procedures and if families do not tick this box on the consent form, they will not be providing full consent and thus not be included in the study.

Comments:

The parent Consent form:

- No. 8 should say I 'consent' for my child to participate not 'assent'. A child under 16 years can assent but their parent/s must 'consent' for them to participate.

This has been updated on version 2.0 of the parents consent form.

- the standard regulatory authorities clause is missing, please see the example on the HRA website

We will pursue any examples available and update this in our consent form.

- the bottom of the form says name of researcher taking 'assent' please change to consent
Thank you for your feedback.

This has been updated on version 2.0 of the parents consent form.

The child Assent form:

- is far too complex with too many things they have to sign for (especially for an 8 year old)
please reduce considerably the number of things on the assent form.

We have now amended and combined these points more concisely and reduced this from 7 to 4 points on version 2.0 of the child assent form.

- the bottom of the form says name of researcher taking 'consent' please correct to assent.

This has been updated on version 2.0 of the child assent form.

The parent PIS:

- there is only a brief mention in the PIS about the parental questionnaires and it does not really tell them why they are needed - the study described briefly in the PIS does not mention anything about parents and how they relate to the study

This has now been updated on version 2.0 of the Parent Information Sheet.

- one of your research questions relates to children with autism/ASD but you have not mentioned this in the PIS and the parents have a right to know the intentions of the study

This has now been updated on version 2.0 of the Parent Information Sheet.

- the benefits described in the PIS need to be toned down, essentially there are no benefits for these children or their parents

This has now been updated on version 2.0 of the Parent Information Sheet.

- there is no section on risks/disadvantages and there is a considerable time burden on both the child and parents for this study

This has now been updated on version 2.0 of the Parent Information Sheet.

- you should describe in more detail about the questionnaires and puzzles that are going to be done to the parents in the PIS in 2.5 hours

This has now been updated on version 2.0 of the Parent Information Sheet.

-We would like to see contact details for parents who wish to make a complaint or have concerns about the conduct of the study. These details e.g. PALS or similar or someone outside the research team usually appear on the PIS.

This has now been updated on version 2.0 of the Parent Information Sheet.

Is the colourful PIS for the children? It is not labelled as such. I assume it is thus my comments below:

- this PIS is far too technical for younger children eg under 12 years, I would suggest have a much more simple (with bigger text size etc and pictures) PIS for 8-12 year olds - a picture of a child doing the puzzles might be helpful.
- again you need to be clearer and tell the children what they will be doing in 2.5 hours
- I would remove the section on benefits because there really are none for the child
- again even for the 12-16 year olds the PIS could be made simpler.

The child is the main participant and is labelled as such for the purposes of the information sheet. The font size has now been increased from 11 to 14 and a picture has been added. We have made clearer what children will be doing when they are with us and during their breaks. We have also made each section more child-friendly in terms of taking out technical language and information. These updates have now been made on version 2.0 of the Child (participant) Information Sheet.

Following your response the Committee requested further changes

- Please add the 'regulatory authorities' clause to the parental consent form – it is still not there – check the HRA guidance on the website. This was subsequently provided by the REC Manager
- The children's assent form is still too complex – and needs to be reduced – children do not need to 'assent' for their GP being notified etc – this is just too much – it should just be one thing they tick to say they agree - 'I agree to be a part in this study and do these puzzles with the researcher'

You added the clause, please find this in version 3 attached.

You consulted with [REDACTED] about participant assent requirements and they have advised me to use the template used in the guidance documents on the REC website which is specific to child assent forms. You attached this as the updated version 3 of the child assent form.

On behalf of the Committee, the sub-committee gave a favourable ethical opinion of the above research on the basis described in the application form, protocol and supporting documentation, subject to the conditions specified below.

Ethical review of research sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

Management permission ("R&D approval") should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements.

Guidance on applying for NHS permission for research is available in the Integrated Research Application System or at <http://www.rdforum.nhs.uk>.

Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.

For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of approvals from host organisations.

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

You should notify the REC in writing once all conditions have been met (except for site approvals from host organisations) and provide copies of any revised documentation with updated version numbers. The REC will acknowledge receipt and provide a final list of the approved documentation for the study, which can be made available to host organisations to facilitate their permission for the study. Failure to provide the final versions to the REC may cause delay in obtaining permissions.

Approved documents

The documents reviewed and approved were:

Document	Version	Date
Covering Letter		18 September 2013
Evidence of insurance or indemnity		
GP/Consultant Information Sheets	1	03 September 2013
Investigator CV	Mawbey	
Investigator CV	Theodore	
Investigator CV	Watkins	
Investigator CV	Murphy	
Other: Neuropsychological tests		
Other: the Verbal Fluency Test		
Other: the colour word interference		
Other: the tower of London task		
Other: Sensory sensitivity		
Other: WASI		
Other: STAIC C1		
Other: STAIC C2		
Other: CHOC1 & 2		
Other: CDI		
Other: Reading the mind in the eyes		
Participant Consent Form: parent	3	20 September 2013
Participant Consent Form: Assent	3	20 September 2013
Participant Information Sheet: for family members	2	19 September 2013
Participant Information Sheet: child	2	19 September 2013

Protocol	1	03 September 2013
Questionnaire: CEBQ patient		
Questionnaire: CEBQ father		
Questionnaire: CEBQ mother		
Questionnaire: Social and Communication Development Questionnaire		
Questionnaire: CAST		
REC application	3.5	09 September 2013
Referees or other scientific critique report	CRAC provisional	30 May 2013
Referees or other scientific critique report	CRAC approval	19 August 2013
Referees or other scientific critique report	Academic provisional	13 December 2012
Referees or other scientific critique report	Academic approval	21 January 2013

Membership of the Proportionate Review Sub-Committee

The members of the Sub-Committee who took part in the review are listed on the attached sheet.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Reporting requirements

The attached document "After ethical review – guidance for researchers" gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The NRES website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

Feedback

You are invited to give your view of the service that you have received from the National Research Ethics Service and the application procedure. If you wish to make your views known please use the feedback form available on the website. Information is available at National Research Ethics Service website > After Review

13/NW/0689	Please quote this number on all correspondence
------------	--

We are pleased to welcome researchers and R & D staff at our NRES committee members' training days – see details at <http://www.hra.nhs.uk/hra-training/>

With the Committee's best wishes for the success of this project.

Yours sincerely



JJ.
Mrs Julie Brake
Chair

Email: nrescommittee.northwest-liverpoolcentral@nhs.net

Enclosures: *List of names and professions of members who took part in the review*
"After ethical review – guidance for researchers"

Copy to: *Andy Macleod, Royal Holloway University of London*
Dr Thomas Lewis, Great Ormond Street Hospital for Children NHS
Foundation Trust

NRES Committee North West - Liverpool Central

Attendance at PRS Sub-Committee of the REC meeting on 23 September 2013

Committee Members:

Name	Profession	Present	Notes
Mrs Julie Brake	Specialist Diabetes Nurse / Chair	Yes	
Dr Brenda Leese	Lecturer	Yes	
Dr Lyvonne Tume	Senior Nursing Research Fellow Paediatric ICU	Yes	
Dr Duane Mellor	Dietitian	Yes	

Also in attendance:

Name	Position (or reason for attending)
Mrs Carol Ebenezer	REC Manager

Appendix 3 – Royal Holloway University of London ethical approval

Department of Psychology
Royal Holloway, University of London
Egham, Surrey TW20 0EX
www.royalholloway.ac.uk/psychology/home

Professor Patrick Leman
+44 (0) 2784 434406
patrick.leman@rhul.ac.uk



2 June 2014

To whom it may concern

Researchers: Dr Kate Theodore - RHUL
Charlotte Mawbey- RHUL
Beth Watkins
Fay Murphy

Research Study: Neuropsychological profiles of children with selective eating - do these vary in children with elevated autistic traits?

Ethics Reference: 2013/086

This is to confirm that the above study has been approved by the RHUL Psychology Department Ethics Committee for a period of 11 months from the 1st October 2013.

Yours sincerely,

A handwritten signature in black ink, appearing to be 'PL'.

Professor Patrick Leman
Chair, Psychology Department Ethics Committee

Appendix 4 – The Childhood Autism Spectrum Test (CAST) (Scott et al., 2002)

The Childhood Autism Spectrum Test (CAST)

Child's Name: Age: Sex: Male / Female

Birth Order: Twin or Single Birth:

Parent/Guardian:

Parent(s) occupation:

Age parent(s) left full-time education:

Address:

.....

Tel.No: School:

Please read the following questions carefully, and circle the appropriate answer. All responses are confidential.

- | | | |
|--|-----|----|
| 1. Does s/he join in playing games with other children easily? | Yes | No |
| 2. Does s/he come up to you spontaneously for a chat? | Yes | No |
| 3. Was s/he speaking by 2 years old? | Yes | No |
| 4. Does s/he enjoy sports? | Yes | No |
| 5. Is it important to him/her to fit in with the peer group? | Yes | No |
| 6. Does s/he appear to notice unusual details that others miss? | Yes | No |
| 7. Does s/he tend to take things literally? | Yes | No |
| 8. When s/he was 3 years old, did s/he spend a lot of time pretending (e.g., play-acting being a superhero, or holding teddy's tea parties)? | Yes | No |
| 9. Does s/he like to do things over and over again, in the same way all the time? | Yes | No |
| 10. Does s/he find it easy to interact with other children? | Yes | No |
| 11. Can s/he keep a two-way conversation going? | Yes | No |

12. Can s/he read appropriately for his/her age?	Yes	No
13. Does s/he mostly have the same interests as his/her peers?	Yes	No
14. Does s/he have an interest which takes up so much time that s/he does little else?	Yes	No
15. Does s/he have friends, rather than just acquaintances?	Yes	No
16. Does s/he often bring you things s/he is interested in to show you?	Yes	No
17. Does s/he enjoy joking around?	Yes	No
18. Does s/he have difficulty understanding the rules for polite behaviour?	Yes	No
19. Does s/he appear to have an unusual memory for details?	Yes	No
20. Is his/her voice unusual (e.g., overly adult, flat, or very monotonous)?	Yes	No
21. Are people important to him/her?	Yes	No
22. Can s/he dress him/herself?	Yes	No
23. Is s/he good at turn-taking in conversation?	Yes	No
24. Does s/he play imaginatively with other children, and engage in role-play?	Yes	No
25. Does s/he often do or say things that are tactless or socially inappropriate?	Yes	No
26. Can s/he count to 50 without leaving out any numbers?	Yes	No
27. Does s/he make normal eye-contact?	Yes	No
28. Does s/he have any unusual and repetitive movements?	Yes	No
29. Is his/her social behaviour very one-sided and always on his/her own terms?	Yes	No
30. Does s/he sometimes say "you" or "s/he" when		

s/he means "I"?	Yes	No
31. Does s/he prefer imaginative activities such as play-acting or story-telling, rather than numbers or lists of facts?	Yes	No
32. Does s/he sometimes lose the listener because of not explaining what s/he is talking about?	Yes	No
33. Can s/he ride a bicycle (even if with stabilisers)?	Yes	No
34. Does s/he try to impose routines on him/herself, or on others, in such a way that it causes problems?	Yes	No
35. Does s/he care how s/he is perceived by the rest of the group?	Yes	No
36. Does s/he often turn conversations to his/her favourite subject rather than following what the other person wants to talk about?	Yes	No
37. Does s/he have odd or unusual phrases?	Yes	No

SPECIAL NEEDS SECTION

Please complete as appropriate

38. Have teachers/health visitors ever expressed any concerns about his/her development?	Yes	No
--	-----	----

If Yes, please specify.....

39. Has s/he ever been diagnosed with any of the following?:

Language delay	Yes	No
Hyperactivity/Attention Deficit Disorder (ADHD)	Yes	No
Hearing or visual difficulties	Yes	No
Autism Spectrum Condition, incl. Asperger's Syndrome	Yes	No
A physical disability	Yes	No
Other (please specify)	Yes	No

Appendix 5 – Children’s Eating Behaviour Questionnaire (CEBQ) (Wardle, et al., 2001)

Child Eating Behaviour Questionnaire (CEBQ)

Please read the following statements and tick the boxes most appropriate to your child’s eating behaviour.

	Never	Rarely	Some - times	Often	Always	
My child loves food	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	EF
My child eats more when worried	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	EOE
My child has a big appetite	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	SR*
My child finishes his/her meal quickly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	SE*
My child is interested in food	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	EF
My child is always asking for a drink	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	DD
My child refuses new foods at first	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	FF
My child eats slowly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	SE
My child eats less when angry	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	EUE
My child enjoys tasting new foods	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	FF*
My child eats less when s/he is tired	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	EUE
My child is always asking for food	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	FR
My child eats more when annoyed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	EOE
If allowed to, my child would eat too much	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	FR
My child eats more when anxious	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	EOE
My child enjoys a wide variety of foods	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	FF*
My child leaves food on his/her plate at the end of a meal	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	SR
My child takes more than 30 minutes to	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	SE

finish a meal

	Never	Rarely	Some - times	Often	Always	
Given the choice, my child would eat most of the time	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	FR
My child looks forward to mealtimes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	EF
My child gets full before his/her meal is finished	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	SR
My child enjoys eating	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	EF
My child eats more when she is happy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	EUE
My child is difficult to please with meals	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	FF
My child eats less when upset	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	EUE
My child gets full up easily	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	SR
My child eats more when s/he has nothing else to do	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	EOE
Even if my child is full up s/he finds room to eat his/her favourite food	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	FR

If given the chance, my child would drink continuously throughout the day	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	DD
My child cannot eat a meal if s/he has had a snack just before	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	SR
If given the chance, my child would always be having a drink	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	DD
My child is interested in tasting food s/he hasn't tasted before	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	FF*
My child decides that s/he doesn't like a food, even without tasting it	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	FF
If given the chance, my child would always have food in his/her mouth	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	FR
My child eats more and more slowly during the course of a meal	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	SE

Appendix 6 – Stait-Trait Anxiety Inventory for Children (STAIC) (Spielberger & Edwards, 1973)

Not included due to copyright restrictions

Appendix 7 – The Children’s Obsessive Compulsive Inventory (CHOCI) (Shafran et al., 2003)

Not included due to copyright restrictions

Appendix 8 – Children’s Depression Inventory (Saylor et al., 1984).

Not included due to copyright restrictions

Appendix 9 – Ranges of clinical interpretation across measures

Test	Levels for clinical interpretation
CAST	<p>≤ 13 = Low autistic traits</p> <p>≥ 13 = Elevated autistic traits</p>
STAIC	T scores ≥ 65 = Clinical significance
CHOCI	<p>0 to 11 = Subclinical OCD Symptomology</p> <p>12 to 23 = Mild OCD Symptomology</p> <p>24 to 37 = Moderate OCD Symptomology</p> <p>38 and upwards = Severe OCD Symptomology</p>
CDI	<p>Above 75 = Very much above average</p> <p>66 to 70 = Much above average</p> <p>61 to 65 = Above average</p> <p>56 to 60 = Slightly above average</p> <p>45 to 55 = Average</p> <p>40 to 44 = Slightly below average</p> <p>35 to 39 = Below Average</p> <p>30 to 34 = Much below average</p> <p>Below 30 = Very much below average</p>
ROCF	<p>>55 = Above average</p> <p>45 to 54 Average</p> <p>40 to 44 Below average</p> <p>35 to 39 Mildly impaired</p> <p>30 to 34 Mildly to moderately impaired</p> <p>25 to 29 Moderately impaired</p> <p>20 to 24 Moderately to severely impaired</p> <p><19 Severely impaired</p>

Notes: CAST: Child Autism Spectrum Test; STAIC: Stait-Trait Anxiety Inventory for Children; CHOCI: Children's Obsessive Compulsive Inventory; CDI: Children's Depression Inventory; ROCF: Rey Osterrieth Complex Figure

Appendix 10 – Wechsler Abbreviated Scales of Intelligence (WASI) (Wechsler, 1999)

Not included due to copyright restrictions

Appendix 11 – The Rey-Osterrieth Complex Figure (ROCF) (Osterrieth, 1944; Rey, 1941)

Not included due to copyright restrictions

Appendix 12 – Rey-Osterrieth Complex Figure memory profile patterns

Memory Profile Pattern	Description
Normal Pattern	<ul style="list-style-type: none"> • Immediate and delayed recall T scores are above 40. • Immediate and delayed recall T scores display little or no slope. • Delayed recall T score may be marginally higher than immediate recall T score.
Attention Pattern	<ul style="list-style-type: none"> • Immediate, delayed and recognition T scores are below 25 with little or no slope between them. • Should reflect very impaired performance across all memory measures.
Encoding Pattern	<ul style="list-style-type: none"> • Immediate and delayed T scores are below a T score of 25. • Recognition T score is no more than 10 points higher than immediate and delayed T scores.
Storage Pattern	<ul style="list-style-type: none"> • Profile slopes downward to the right. • Immediate recall T score is higher than delayed T score and recognition T score is lower still.
Retrieval Pattern	<p>Variation 1:</p> <ul style="list-style-type: none"> • Immediate and recognition recall T scores are roughly equivalent and delayed recall T score is lower than both, creating a “V” shape. <p>Variation 2:</p> <ul style="list-style-type: none"> • Immediate and delayed recall T scores are roughly equivalent and the recognition T score is higher than both. • The pattern does not qualify for an encoding pattern.

Appendix 13 – Trail Making Test (Delis et al., 2001)

Not included due to copyright restrictions

Appendix 14 – Brixton Test (Burgess & Shallice, 1997)

Not included due to copyright restrictions

Appendix 15 – Verbal Fluency test (Delis et al., 2001)

Not included due to copyright restrictions

Appendix 16 – The Hayling Sentence Completion test (Burgess & Shallice, 1997)

Not included due to copyright restrictions

Appendix 17 – Colour Word Interference test (Delis et al., 2001)

Not included due to copyright restrictions

Appendix 18 – The Tower of London test (Delis et al., 2001)

Not included due to copyright restrictions

Appendix 19 – The Behaviour Rating Inventory of Executive Function (Gioia et al., 2000)

Not included due to copyright restrictions

Appendix 20 – Reading the mind in the eyes task (Baron-Cohen et al., 2001)

jealous

scared



relaxed

hate

Appendix 21 – The Sensory Profile (Dunn, 1999)

Not included due to copyright restrictions

Appendix 22 – Parent information sheet and consent form



Distinct neuropsychological profiles of children and adolescents with selective eating in the presence or absence of an Autism Spectrum Disorder

Information for family members about the study

We are looking for young people to take part in a research study to learn more about some of the strengths and difficulties that young people with eating difficulties experience, and would like to invite your child to take part in the study. Before you decide whether you are happy for your child to participate it's important that you understand why the study is being carried out and what it will mean for you and your family and what it would involve. Please consider this leaflet carefully. Please feel free to contact the research, [REDACTED] (details below) or a member of the team involved with your family at [REDACTED], to answer any questions that you have.

Why are we doing this research?

Selective eating difficulties are quite common but can have a big impact on young people's lives. There isn't very much research about selective eating or what might cause these difficulties in young people though. One way of thinking about selective eating is called the neuropsychological approach. This approach tries to link different parts of the brain and different abilities (such as problem-solving, planning, flexibility in thinking and memory). This approach would focus on how a person's strengths and weakness across tasks that measure these abilities might help explain what drives their selective eating difficulties. Another approach is to think about sensory sensitivity to different foods because of their taste, smell or texture. Another idea has been that young people with eating or feeding difficulties might have ways of thinking or feeling that are similar to those seen in children with an Autism Spectrum Disorder (ASD) and that these traits might make them more likely to have difficulties with their feeding.

This research aims to find out more about these ways of understanding selective eating so that we can know which factors are most important in young people with selective eating difficulties.

The researcher is a Trainee Clinical Psychologist carrying out this research as part of doctoral training. The research is supervised by [REDACTED] Clinical Tutor at Royal Holloway University of London and Clinical Psychologist [REDACTED].

Why has my child been invited to take part?

We are looking for young people between the ages of 8 and 16 years old who are experiencing difficulties with selective eating to take part in an individual meeting. We would like them to complete a range of puzzles and games and answer some questionnaires about their eating and how their difficulties feel for them. There is a separate information sheet enclosed in this pack for your child to read about the study.

Does my child have to take part?

No, your child can choose not to participate. If you agree and give consent for your child to take part, they can withdraw at any point without giving a reason and without any disadvantage to them or your family. Enclosed are the consent forms for you and your child with more information about this.

Distinct neuropsychological profiles of children and adolescents with selective eating in the presence or absence of an Autism Spectrum Disorder

What does taking part involve?

If you and your child agree to take part further information about where and when the meeting will take place will be given. For convenience, we will aim to make your appointment on the same day as one of your usual appointments at [REDACTED]. The meeting will be in a quiet room and will last for no more than two and a half hours including breaks. Only the researcher and your child will be present and together they will complete the games, puzzles and questionnaires described.

As well as set breaks, your child can stop the meeting for a break at any time. If your child feels that they want to end the meeting early then they may do so without having to provide explanation. They are also not expected to answer any questions or do anything that they do not wish to do.

Anything your child says or does in the meeting will be treated as confidential unless it is felt that they, or someone else, may be at risk of harm. Brief notes may be made during certain tasks, however these will be completely anonymised and kept confidential.

We would also be grateful if, whilst waiting for your child, you could complete some questionnaires about some of the difficulties that they are having. These will be about your impression of how they think and feel about things and how they behave in certain situations. This will help us better understand some of the difficulties your child is having, that they might not be able or want to tell us about for themselves, for example because they are too young.

What are the benefits of taking part?

There are no direct benefits to you or your child in participating in this research, however it is hoped that the results of research such as this will help us understand more about selective eating and thus how we can better assess and treat it.

Who will know that my child is taking part?

Members of the team at [REDACTED] that are involved in your families' care may know about your child's participation. We will also inform your GP that your child is participating in the study and that you and your child have consented to take part.

What are the risks? And has this study been approved?

There are no foreseeable risks to you or your child in taking part in this research. However there is a considerable time burden. We aim to make participation as fun as possible for your child and we will have regular breaks in which they can play, eat or spend time with you. This will ensure that they are happy and do not feel over-worked or too burdened by their participation.

Before any research study can go ahead it has to be checked by two Research Ethics Committees. They make sure that the research is fair and safe. The study has been checked by a Royal Holloway University of London committee and the [REDACTED]. It has also received ethical approval from the NHS ethics committee.

Distinct neuropsychological profiles of children and adolescents with selective eating in the presence or absence of an Autism Spectrum Disorder

What do I do now if I want my child to be involved?

Enclosed is an information form about the study for your child to read and consent forms for both you and your child to sign and bring with you on the day of the interview. For further information about taking part or if you have any other questions, please do not hesitate to contact [REDACTED] on:

- > E-mail: [REDACTED]
- > Phone: [REDACTED] (Please note: this is the Royal Holloway University of London's dedicated participant recruitment line. When leaving a message please state that you are interested in participating in [REDACTED] research.

What do I do if [REDACTED] about how this study is being carried out?

You can contact [REDACTED] Patient and Advice Liaison Service in one of the following ways:

- Telephone: [REDACTED]
- E-mail: [REDACTED]
- In person

Thank you for taking the time to read this information sheet, and we look forward to hearing from you in due course!

Centre Number:

Study Number:

Participant Identification Number for this study:

PARENTAL CONSENT FORM

Title of Project: Neuropsychological profiles of children with selective eating (SE) difficulties, do these vary in children with elevated autistic traits?

Name of Researcher: Charlotte Mawbey

Please initial all
boxes

1. I confirm that I have been consulted about 's participation in this research. I have read and understood the information sheet for the above study, dated 03.09.2013. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. I agree to their taking part in this research.

2. I understand that I am not obliged to give assent for my child to participate in the study. I understand that I am free to withdraw assent at any time without giving any reason, and without their, or my family's care or legal rights being affected.

3. I understand that the study will be conducted through a meeting with my child, and will last no more than two and a half hours including breaks. I understand that during this interview my child will be asked to do a series of puzzles, pen and paper tasks and answer questionnaires about the difficulties that they are experiencing.

4. I understand that brief notes may be made during some aspects of the meeting with my child and that these will be anonymised.

5. I understand that relevant sections of my child's contributions may be used in the write-up of this study (e.g. academic assessment, possible publication in a professional journal) but that my child and family will not be personally identifiable and that all information will be anonymised.

6. I am aware that my child's GP or other care professional will be informed of their participation in the study.

7. I am happy to answer some short questionnaires about some of the difficulties my child has been experiencing.

8. I understand that my medical notes and data collected from the study may be looked at by regulatory authorities and by persons from the Trust where it is relevant to my taking part in this research. I give permission for these individuals to have access to this information.

9. I hereby freely and fully consent to allow my child..... to participate in this study.

Name of Parent/guardian

Date

Signature

Name of Person
taking consent

Date

Signature

Appendix 23 – Child information sheet and consent form



Neuropsychological profiles of children with selective eating (SE) difficulties, do these vary in children with elevated autistic traits?

CHILD/PARTICIPANT INVITATION TO TAKE PART IN A RESEARCH STUDY

We would like to know if you would like to take part in a study to find out more about young people who find it difficult to eat lots of different foods. Before you decide, you should know why the study is happening and what you would need to do. Please read this leaflet and talk to your family, friend or doctor about being involved if you want to. Please ask us any questions you have.

Why are we doing this research?

We want to know more about young people who find it difficult to eat lots of different foods. This will help us understand if how we think and feel can link to what we want to eat.

Why have I been asked to take part?

We would really like to meet with you to find out a bit more about some of the difficulties you have been having with your eating and how you feel about food.



What will I have to do if I decide to take part?

If you take part we will meet at [redacted] a quiet room for no longer than two and a half hours and this will include some breaks where you can play, eat or talk to your family.

In this meeting you will draw some pictures, do some puzzles with a pencil and paper, play with some games and answer some questions about how you have been feeling. You do not have to do anything that you do not want to and you do not have to give a reason why. You can ask any questions at any time.

Will anyone else know that I'm taking part?

The people that you meet at [redacted] who meet with your family will know that you are taking part in this study. We will also let your GP (doctor) know.

What will happen to the things I say and the things that I do?

I will write down some of the things you say and do when we meet but I will never use your name and anything we say or do together will be kept private. I will only tell someone else if you say something that made me think that you or another person might be in danger.

Neuropsychological profiles of children with selective eating (SE) difficulties, do these vary in children with elevated autistic traits?

Is there anything to be worried about if I take part?

No! You will not have to do anything that you do not feel comfortable doing. If you are worried you can ask us questions and we can talk to you about this.

Can I change my mind about coming?

Yes! It's fine to decide that you don't want to come to the meeting. You or your parent or guardian can phone and let us know that you have changed your mind.

Who knows about this study?

Before we could do this study we had to talk to lots of different people. They have all decided that it is fair and safe for us to ask you to be involved.

What do I do now if I want to be involved?

If you would like to be involved there is a form enclosed for you (and one for your parent or guardian) to sign and bring with you to the meeting. You can contact us using the contact details in this pack for more information or any more questions you may have about the study.

For more information about taking part or if you have any other questions please contact Charlotte Mawbey on:

- > E-mail: [REDACTED]
- > Phone: [REDACTED] (Please note: this is the Royal Holloway University of London's dedicated participant recruitment line. When leaving a message please state that you are interested in participating [REDACTED] research).

Thank you for taking the time to read through this leaflet! We look forward to hearing from you!



Centre Number:

Study Number:

Participant Identification Number for this study:

ASSENT FORM FOR YOUNG PERSON TAKING PART IN THE STUDY

Title of Project: Neuropsychological profiles of children with selective eating (SE) difficulties, do these vary in children with elevated autistic traits?

Name of Researcher: Charlotte Mawbey

This consent form is a way of you agreeing that you are happy to be involved in this study. Please read the form and if you are happy to, put your initials in the boxes and then sign at the bottom of the page.

Please tick yes/no

Child (or if unable, parent on their behalf)/young person to circle all they agree with:

- Has somebody else explained this project to you? Yes/No
- Do you understand what this project is about? Yes/No
- Have you asked all the questions you want? Yes/No
- Have you had your questions answered in a way you understand? Yes/No
- Do you understand it's OK to stop taking part at any time? Yes/No
- Are you happy to take part? Yes/No

If any answers are 'no' or you don't want to take part, don't sign your name!

If you do want to take part, you can write your name below

_____	_____	_____
Name of young person	Date	Signature
_____	_____	_____
Name of person taking assent	Date	Signature

Appendix 24 – Visuospatial processing raw data from the Rey-Osterrieth complex figure

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Copy trial:										
Raw Score	22	17.5	32.5	21.5	17	26	26	26.5	9.5	17
Percentile	≤1	≤1	>16	2-5	>16	>16	>16	>16	≤1	≤1
Immediate recall trial:										
Raw Score	22	2.5	16	14	6.5	17.5	19	19.5	8	9
T Score*	55	21	37	44	30	53	53	54	27	35
Percentile	69	<1	10	27	2	62	62	66	1	4
Interpretation	Above average	Moderate to severe	Mild	Below Average	Mild to moderate	Average	Above average	Above average	Moderate	Mild to moderate
Delayed recall trial:										
Raw Score	17	2	12.5	11.5	6	22.5	16.5	16	7	7
T Score*	46	20	30	40	29	63	49	48	25	29
Percentile	34	<1	2	16	3	90	46	42	1	2
Interpretation	Average	Moderately to severely	Mild to moderate	Below average	Moderate	Above average	Average	Below average	Moderate	Moderate
Recognition trial:										
Raw Score	24	15	19	21	17	22	21	21	18	21
T Score*	70	20	40	55	33	62	55	55	35	54
Percentile	98	<1	16	69	4	88	69	69	7	66
Interpretation	Above	Moderately	Below	Above	Mild to	Above	Above	Above	Mild	Above

	average	to severely	average	average	moderate	average	average	average	average
Memory Pattern	Retrieval	Attention	Retrieval	Retrieval	Retrieval	Normal	Retrieval	Retrieval	Retrieval

* *Condition for which T Scores were utilised as performance indicators in the Ravello Profile*

Appendix 25 – Central Coherence Index (CCI) raw data

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Order of Construction Index	2.3	1.8	2.3	1.6	2.2	2.3	2.3	1.7	1.3	2.3
Style Index	0.5	1.2	0.8	1.2	0.7	1	0.5	1	1	0.6
Central Coherence Index*	0.95	1.1	1.1	1.08	0.98	1.2	0.95	1	0.9	1

* *Condition for which T Scores were utilised as performance indicators in the Ravello Profile*

Appendix 26 – Raw data from tests of cognitive flexibility abilities

Trail Making

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Number-Letter sequencing completion time raw score (seconds)	113	240	63	240	202	180	158	96	197	216
Number-Letter sequencing completion time T score*	57	23	53	27	40	43	47	20	27	33
Number-Letter sequencing total errors T score	47	27	50	30	43	47	53	50	53	57
Contrast analyses (T Score):										
Number-Letter sequencing vs Visual Scanning	53	53	60	50	47	43	37	43	43	37
Number-Letter sequencing vs Number Sequencing	80	33	40	57	30	53	43	27	30	37
Number-Letter sequencing vs Letter Sequencing	80	30	57	57	27	63	43	20	57	57
Number-Letter sequencing vs Motor Speed	50	20	50	30	50	43	37	20	50	37

* Condition for which T Score was utilised as a performance indicator in the Ravello Profile

Brixton task

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Overall performance T Score*	50	70	43	50	57	57	50	63	50	43
Overall performance interpretation	Average	Superior	Moderate average	Average	High average	High average	Average	Good	Average	Moderate average

* Condition for which T Scores were utilised as performance indicators in the Ravello Profile

Verbal Fluency Test

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Category switching total correct responses T score	47	37	47	47	50	53	53	57	53	43
Category switching total switching accuracy T score*	43	47	47	47	53	43	57	67	53	37
Contrast analysis:										
Letter Fluency versus Category Fluency	80	50	43	47	50	77	37	43	40	30
Category Switching versus Category Fluency	33	47	50	43	57	37	47	33	43	43
Accuracy analysis:										
Category switching: percentage switching accuracy	46.2	100	90.9	75	72.7	41.7	69.2	1.1	100	57.1
Category switching percentage switching accuracy T score	27	57	50	43	43	23	40	50	57	33

* Condition for which T Score was utilised as a performance indicator in the Ravello Profile

Appendix 27 – Raw data from tests of inhibition tests

Hayling test

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Section A scaled score	4	3	3	2	1	1	1	4	3	1
Section B scaled score	6	6	4	4	4	4	4	6	5	4
Section C scaled score	7	6	8	7	7	6	4	8	6	2
Overall performance T score*	50	43	43	37	30	30	17	50	37	17

** Condition for which T Scores were utilised as performance indicators in the Ravello Profile*

Colour Word Interference task

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Inhibition condition T score*	50	20	47	43	60	57	67	43	47	53
Inhibition/Switching condition T score	53	33	43	43	60	57	67	40	53	47
Error Analysis:										
Inhibition condition (Total errors T score)	47	30	57	47	53	57	60	50	63	57
Inhibition/switching condition (Total errors T score)	53	23	57	27	60	60	53	33	60	40
Contrast Analysis:										
Inhibition versus colour naming	57	23	73	53	53	53	60	47	53	60
Inhibition/switching versus Inhibition	53	63	47	50	57	50	50	40	57	43
Inhibition/Switching versus Colour Naming	60	37	70	53	53	53	60	43	60	53
Inhibition/Switching versus Word Reading	63	40	43	40	60	50	57	40	43	53

** Condition for which T Score was utilised as a performance indicator in the Ravello Profile*

Appendix 28 – Raw data for planning abilities

Tower test

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Total achievement T score⁺	67	47	60	30	60	57	63	47	50	40
Mean First Time Move T score	60	63	57	50	60	60	57	60	60	67
Time Per Move Ratio T score	67	70	40	60	57	47	57	60	53	53
Move Accuracy Ratio T score	47	47	63	53	53	53	60	30	77	27
Rule Violations Per Item Ratio T score	50	20	50	20	53	50	57	50	50	53

** Condition for which T Score was utilised as a performance indicator in the Ravello Profile*

Appendix 29 – Theory of Mind raw data

Raw data for the Reading the Mind in the Eyes and M&M False Belief tasks

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
M&M pass/fail	Pass	Fail	Pass	Fail	Pass	Pass	Pass	Fail	Fail	Fail
Reading in the Mind in the Eyes percentage error	39.9%	60.71%	89.3%	39.3%	17.86%	32.14%	32.14%	39.3%	57.1%	21.4%

Appendix 30 – Raw data from the Behaviour Rating Inventory of Executive Function (BRIEF)

BRIEF raw data

Index T Score	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Inhibit	44	80	58	71	42	64	55	53	62	57
Shift	71	50	56	84	53	53	60	84	67	64
Emotional Control	67	65	64	69	56	62	60	73	60	58
Behavioural Regulation Index (BRI)	62	69	61	77	51	62	60	71	65	61
Initiate	63	69	59	72	52	65	50	69	84	53
Working Memory	49	76	51	69	46	61	56	52	65	69
Plan/Organize	67	56	56	75	45	61	52	56	71	69
Organization of Materials	55	61	43	67	51	60	49	45	71	67
Monitor	66	69	51	72	49	52	59	59	75	66
Metacognition Index (MI)	62	69	53	76	48	61	54	57	77	69
Global Executive Composite (BRI+MI)	62	70	60	78	49	62	57	64	75	67

Appendix 31 – Sensory Profile raw data

Raw data from the Sensory Profile

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Oral Sensory processing	40	36	-	30	34	36	27	30	34	35
Oral Sensory processing interpretation	Probable	Definite	-	Definite	Definite	Definite	Definite	Definite	Definite	Definite
Emotional/Social Responses	44	51	-	49	71	61	39	42	45	71
Emotional/Social Responses interpretation	Definite	Definite	-	Definite	Typical	Probable	Definite	Definite	Definite	Typical
Behavioural Outcomes of Sensory Processing	16	15	-	14	29	24	12	21	17	23
Behavioural Outcomes of Sensory Processing interpretation	Definite	Definite	-	Definite	Typical	Typical	Definite	Probable	Definite	Typical
Factor clusters:										
Oral Sensory Sensitivity	29	29	-	26	23	22	24	16	24	21
Oral Sensory Sensitivity interpretation	Probable	Probable	-	Definite	Definite	Definite	Definite	Definite	Definite	Definite

Appendix 32– Summary of statistical information used in the Z transformation

Test	Source of statistics used in Z transformation	Statistics
D-KEFS	D-KEFS manual (Delis et al., 2001).	Scaled score of: Mean = 10 SD = 3
ROCF	ROCF manual (Osterrieth, 1944; Rey, 1941)	T score: Mean = 50 SD = 10
CCI	Taken from a sample of 79 control participants in Rose et al., (2013)	Mean = 1.6 SD = 0.3
Hayling	Omitted due to lack of appropriate age-matched norms or control sample	-
Brixton	Omitted due to lack of appropriate age-matched norms or control sample	-

Notes: D-KEFS: Delis-Kaplan Executive Function System; ROCF: Rey Osterrieth Complex Figure; CCI: Central Coherence Index; SD: Standard deviation

Appendix 33 – Task Z scores contributing to composite domain scores

	Visuospatial Processing Domain			Cognitive Flexibility Domain		Inhibition Domain	Planning Domain
	ROCF Immediate Recall	ROCF Delayed Recall	ROCF Recognition	Trail Making Test	Verbal Fluency Accuracy Test	Colour-Word Interference Test	Tower Test
P1	0.5	-0.4	2	0.7	-0.7	0	1.7
P2	-2.9	-3	-3	-2.7	-0.3	-3	-0.3
P3	-1.3	-2	-1	0.3	-0.3	-0.3	1
P4	-0.6	-1	0.5	-2.3	-0.3	-0.7	-2
P5	-2	-2.1	-1.7	-1	0.3	1	1
P6	0.3	1.3	1.2	-0.7	-0.7	0.7	0.7
P7	0.3	-0.1	0.5	-0.3	0.7	1.7	1.3
P8	0.4	-0.2	0.5	-3	1.7	-0.7	-0.3
P9	-2.3	-2.5	-1.5	-2.3	0.3	-0.3	0
P10	-1.5	-2.1	0.4	-1.7	-1.3	0.3	-1

Notes: ROCF: Rey Osterrieth Complex Figure

Appendix 34 – ROCF copy raw scores in low and elevated autistic traits

ASD Traits				N	Minimum	Maximum	Mean	Standard Deviation
Elevated	ROCF	Copy	Raw	6	9.50	26.50	20.41	6.37
		Score						
Low	ROCF	Copy	Raw	4	17	32.50	23.25	7.42
		Score						

Notes: ROCF: Rey Osterrieth Complex Figure

Appendix 35 – Executive function statistics across low and elevated autistic traits

		N	Minimum	Maximum	Mean	Standard Deviation
Elevated autistic traits	Trail Making	6	20	57	39.33	15.19
	Brixton	6	43	70	53.33	10.29
	Verbal Fluency	6	43	67	50	9.10
	Hayling	6	30	50	41	9.07
	Colour-Word	6	20	60	46.17	14.27
	Interference					
	Tower	6	47	67	56.33	7.94
Low autistic traits	Trail Making	4	27	47	33.50	9.43
	Brixton	4	43	50	48.25	3.50
	Verbal Fluency	4	37	57	48.50	8.70
	Hayling	4	17	37	26	9.20
	Colour-Word	4	43	67	52.50	10.50
	Interference					
	Tower	4	30	63	45.75	14.10