Exploring Autism Spectrum Disorders: Parental Experiences of Diagnosis and the Behavioural Heterogeneity within the Spectrum.

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Declaration Page

This work has not been submitted for any other degree or to any other institution.

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Abstract

This thesis contains a systematic literature review, and an exploratory research study.

Studies exploring how parents had experienced the process of seeking an autism spectrum disorder (ASD) diagnosis for their child were reviewed (*N*=28). These indicated that many parents have dissatisfying experiences due to delays, disrespectful interactions with professionals, and a paucity of information. There are issues surrounding clear clinical pathways and communication between services which cause delays in diagnosis and accessing subsequent services.

The research study explored the heterogeneity of behavioural presentations in ASD. Participants were 42 children aged 5 to 17 (25 with ASD and 17 typically developing). Participants contributed demographic, behavioural, cognitive, and neurological data which were explored through cluster and descriptive statistical analyses. The three emergent clusters were strongly influenced by cognitive ability, but also demonstrated a continuum of behavioural presentations and physical and developmental health, with one cluster representing a typically developing group, one representing high-functioning ASD, and one representing low functioning ASD. In contrast to previous research, there were no associations with alpha frontal power recorded with EEG. The social subtypes of ASD identified by Wing and Gould (1979) were strongly correlated with cognitive ability and severity of symptoms.

Overall this research indicates the need to continue improving the diagnosis of ASD. The heterogeneity in symptoms of ASD could be one reason why the diagnostic process is long and complex, and should be explored further. Future research should consider cognitive and behavioural

presentations, developmental trajectories, responses to treatment, and physical and neurological abnormalities.

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Contents

Section 1: Literature Review

Parents' Experiences of Engaging in the Diagnostic Process for Autism Spectrum Disorder for their Child: a Systematic Review of the Literature

Abstract

Objectives

This review aims to explore parental experiences of the diagnostic process for autism spectrum disorders (ASD).

Methods

The search terms employed were: “experience”, “autism”, “diagnosis”, “family”, “parent”, “Asperger”, “service user”. The databases searched were OvidSP (PsychInfo), Web of Science (Medline; Web of Knowledge; BIOSIS Previews and BIOSIS Citation Index), CINAHL, and Scopus. The search produced 28 articles.

Results

A significant proportion of parents report dissatisfaction with the diagnostic process for ASD, which has been attributed to delays in the process, disrespectful interactions with professionals, and a lack of information about the diagnosis and educational and support services. Delays in the process are caused by consultation with multiple professionals, waiting lists, poor communication, and misdiagnosis and dismissal of parents’ early concerns. There is some inconsistent evidence to suggest that characteristics of the child and their family impact on the speed of diagnosis, and features of the diagnostic process. Parents reported a range of emotional experiences throughout the process.

Conclusions

A significant proportion of parents continue to express dissatisfaction with the diagnostic process for ASD. The lengthy process is exacerbated by poor communication and a lack of integration between services. Parents

experience disrespect and dismissal from services and professionals causing more delays and dissatisfaction.

Practitioner Points

Clinical Implications

- Services should have a clear assessment pathway for ASD;
- Training should be provided to professionals regarding early diagnosis of ASD to avoid inappropriate reassurance and misdiagnosis;
- Services should tailor provided information to the needs of the families that they are working with.

Limitations

- Due to the low prevalence of ASD many of the studies included small sample sizes;
- As methodologies employed were qualitative or correlational in design, it was not possible to establish cause and effect between satisfaction and components of the process;
- Self-selecting samples were employed which may not be representative of parents of children with ASD.

Autism is a pervasive developmental disorder (PDD) characterised by a triad of impairments including delays in communication, social behaviours, and a restricted repertoire of interests. Communication impairments may include delayed or absent language and use of gestures; those in social functioning may include a lack of interest in friendship, inappropriate use of eye contact and a lack of reciprocal interaction; a restricted repertoire of interests and behaviour may be demonstrated through inflexible adherence to routines or rituals and fixations (*Diagnostic and Statistical Manual of Mental Disorders Fourth Edition,*

Text Revised; DSM-IV-TR, American Psychiatric Association, 1994; *International classification of diseases: Diagnostic criteria for research* (10th ed.); ICD-10, World Health Organization, 1992). Due to a lack of reliability in the clinical diagnosis of PDDs, the new fifth edition of the DSM *(*DSM-5; American Psychiatric Association, 2013) incorporates the diagnoses of autism, Asperger syndrome, atypical autism, and PDD not otherwise specified into the term autism spectrum disorders (ASD).

The presentation of ASD is idiosyncratic (Lenne & Waldby, 2011) and there is no known biological marker that aids identification (Bristol-Power & Spinella, 1999). The National Institute for Health and Clinical Excellence (NICE; 2011) guidance states that the prevalence of autism is estimated at 1% in young people in the United Kingdom (UK). The NICE guidance for the diagnostic assessment procedure includes a detailed medical, developmental, psychological and social history taking through interviews with parents and carers; an assessment of the child's social and communication abilities through observation of and interaction with the child; physiological assessment; and assessment for comorbidities. Therefore it is necessary for this to be a long and thorough process for a valid diagnosis to be provided.

Despite the complexity of the diagnostic process for ASD there have been no reviews focussed on parents' experiences of this process. Reed and Osborne (2012) synthesised the literature surrounding the impact of diagnosis on parents' health and functioning. They highlighted that parents of children with ASD have high levels of parenting stress, including high depression and anxiety and a poor quality of life, which impact upon their child's behaviour and response to treatment. Specific components of the diagnostic process are associated with stress, and particularly difficult interactions with professionals.

Whilst this review did consider parental experiences of the diagnostic process the focus was on the impact on parental functioning thus much of the literature was not included. However it highlights the need to develop an understanding of parents' experiences to produce recommendations for practice during the diagnostic assessment and to consider the long-term psychosocial implications of this process for families.

Chua (2012) carried out a systematic review of 20 international studies to explore parental experience of having a child with ASD with a view to making recommendations for support systems and education planning. The review focussed on living with a child with ASD from the point of diagnosis onwards, and acceptance and adjustment. This included differences in parental roles and stress levels, stressors, and coping strategies as well as parental experiences of the disclosure of a diagnosis of ASD. There was some consideration of how components of the diagnostic process could be improved, however much of the literature surrounding parents' experience of the diagnostic process was excluded.

It is known that parents have historically been dissatisfied with the way in which diagnoses of developmental disabilities are given, and that this is exacerbated by a lack of certainty in the diagnosis (Piper & Howlin, 1992). Due to the heterogeneity of presentations of ASD, uncertainty in the diagnostic process is likely to be common. The current review aims to explore experiences of the diagnostic process in parents of children with ASDs.

Search Strategy

The Cochrane Library and the Centre for Reviews and Dissemination databases were searched for existing systematic reviews in related fields, but produced no results. The search took place on 23rd and 24th February 2013.

The following search terms were employed in a range of combinations using the Boolean AND function: “experience”, “autism”, “diagnosis”, “family”, “parent”, “Asperger”, and “service user”. The * function was also used to capture variations in terminology, for example “autis*” to capture autistic and autism. The databases employed were OvidSP (PsychInfo), Web of Science (Medline; Web of Knowledge; BIOSIS Previews and BIOSIS Citation Index), CINAHL, and Scopus. Once articles had been selected their reference lists were hand-searched to highlight additional studies. The full search process is shown in Figure 1.

Eligibility Criteria

Only primary research was included which had been published in peer-reviewed scientific journals. Whilst international studies were sought, only those written in English were included.

The focus of the literature review was on the formal process of seeking a diagnosis of ASD, defined as the period between the first time that parents sought professional help regarding their child’s presenting difficulties, and the disclosure of the diagnosis. Therefore this review does not explore pre-diagnostic experiences, such as parents’ first concerns, nor post-diagnostic experiences, such as adjustment, acceptance, and living with ASD. Papers that addressed developmental disorders generally were included only if they included a specific focus on the diagnosis of ASD. Studies involving adoptive parents were not excluded.

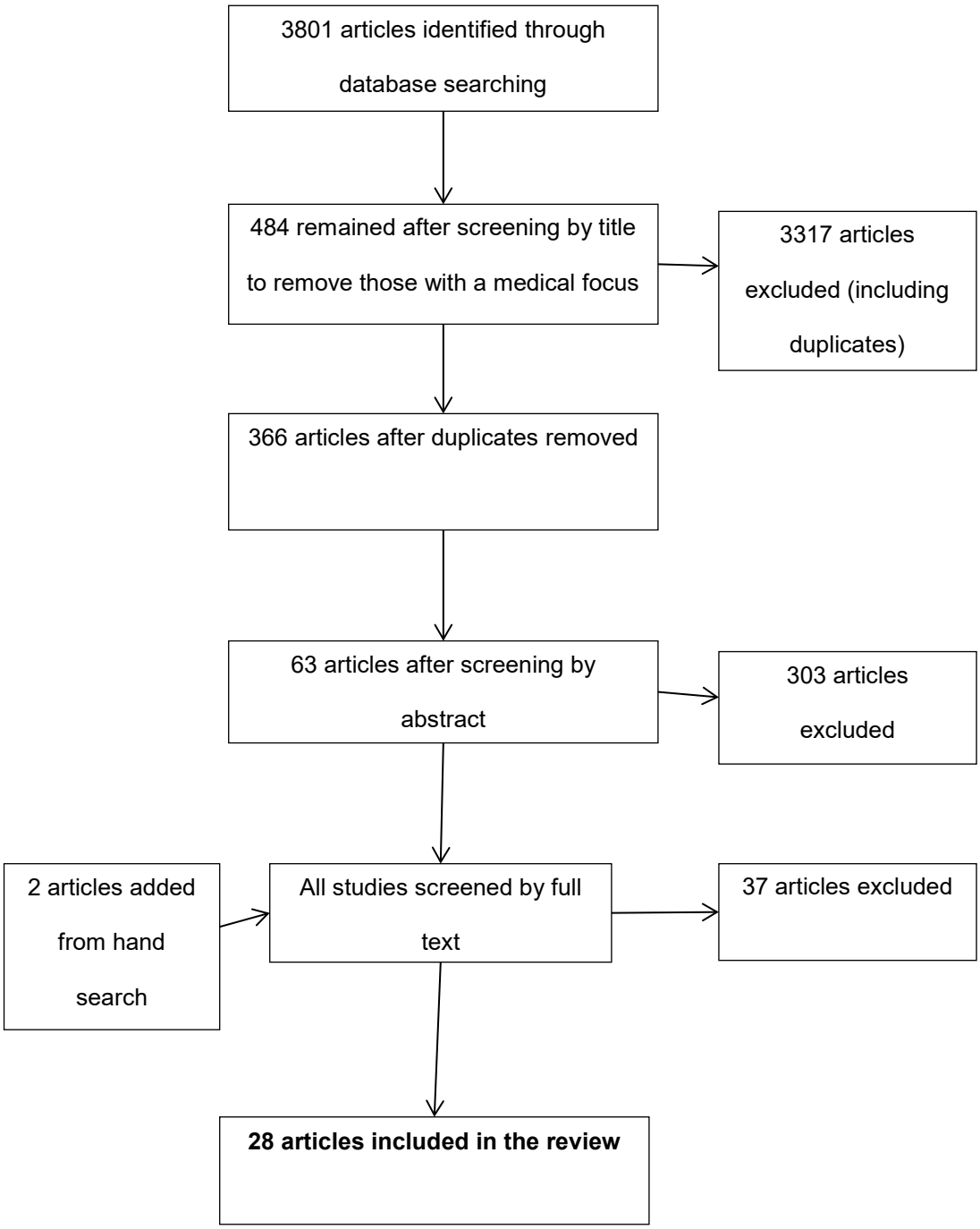


Figure 1. Search strategy

Review

The data extraction table (Table 1) summarises the included articles, organised according to methodology with the six quantitative studies listed first in alphabetical order followed by the seven mixed methods studies and finally the fifteen qualitative studies. Whilst some studies had a broader focus only the components and results related to parents' experience of the ASD diagnostic process are presented here.

Quality Ratings

Qualitative and quantitative methodology was assessed according to separate frameworks. In order to make scores comparable for this review, final scores were calculated by creating a percentage score from the items answered and converting this to a score out of ten with high scores indicating better quality.

Qualitative studies were evaluated in accordance with Spencer, Ritchie, Lewis, and Dillon's (2003) Framework for Assessing Qualitative Evaluations which states that qualitative research should be contributory, defensible in design, rigorous in conduct, and credible (Appendix A). The framework consists of 18 questions designed to facilitate evaluation in relation to these points. Quantitative studies were evaluated using Downs and Black's (1998) checklist (Appendix B). This checklist takes into account reporting, external validity, internal validity, and power. This was modified so that items relating to intervention trials were excluded. Mixed methods papers were subjected to both ratings scales.

Quality rating scores are shown in Table 1. An independent rater scored four (14%) of the studies and achieved .77 agreement. Areas of disagreement surrounded the representativeness of the sample, where the author was more

conservative due to the high incidence of self-selecting samples employed. This is considered further in the discussion. No studies were excluded due to their quality rating, but limitations are considered throughout the review.

The table is followed by a narrative synthesis of the data extracted from the eligible articles. This addresses the emergent themes from the literature including parental satisfaction with the diagnostic process and the factors that impact on this, which included delays and the speed of the process, professional manner and information-giving, diagnostic classification, and emotional reactions to the diagnosis.

Table 1

Data Extraction table

Author(s) and Year of Publication	Country	Qualitative or Quantitative	Participants	Objective	Method and Outcome Variables	Experience of the Process	Quality Rating
Brogan and Knussen (2003)	Scotland	Quantitative	126 parents children with ASD	To investigate the determinants of parental satisfaction with the ASD diagnostic disclosure interview	Questionnaire: satisfaction; diagnostic process information; demographics	55% were satisfied with their disclosure interview. Increased satisfaction scores were associated with better information at disclosure, the professional's manner, the opportunity to ask questions, acceptance of parent's initial concerns by the professional, and a definite diagnosis.	6.4
Goin-Kochel, Mackintosh, and Myers (2006)	USA	Quantitative	494 parents of children with ASD	To describe parental satisfaction with the ASD diagnostic process, and to investigate the association between these outcomes, demographics, and features of the diagnostic process.	Questionnaire: parent and child demographics; diagnostic information; satisfaction	40% of parents were not satisfied with the process. Parents reported greater satisfaction when their child was diagnosed at a younger age, which was associated with more recent diagnoses, male gender, consultation with fewer professionals, and more specific diagnoses. The number of professionals consulted was the only significant predictor of satisfaction.	5.7
Howlin and Moore (1997)	UK	Quantitative	1295 parents of children and adults with ASD	To examine parents' experiences of the diagnostic process across the UK	Questionnaire: diagnostic information and satisfaction	Most diagnoses involved multiple professionals and many parents were dismissed or reassured. 49% of families reported dissatisfaction. Satisfaction was higher where children were diagnosed younger, when there were shorter delays, and when a clear autism diagnosis was given.	6.4

Author(s) and Year of Publication	Country	Qualitative or Quantitative	Participants	Objective	Method and Outcome Variables	Experience of the Process	Quality Rating
Moh and Magiati (2012)	Singapore	Quantitative	102 parents of children with ASD and 17 professionals	To assess parental experiences of the ASD diagnostic process in the previous ten years and to explore factors associated with parental stress and satisfaction.	Questionnaire: demographics; diagnostic; parental stress and satisfaction; perspectives from professionals	Factors that decreased stress and increased satisfaction included interactions with practitioners and the quality of information provided. Parental characteristics impacted on when concerns were noticed and when the diagnostic process commenced, and parents of children with more severe symptomology were less satisfied.	6.1
Siklos, and Kerns (2007)	Canada	Quantitative	56 parents of children with ASD	To evaluate parents' experiences of diagnosis to determine whether ASD is being diagnosed more quickly and at a younger age due to emphasis on early intervention.	Questionnaires: diagnostic information; satisfaction; family and child demographics; symptomatology	51% of parents were dissatisfied with the process. Those who had to wait longer were less satisfied. Older children and girls took longer to get a diagnosis. Parents of children with more communication difficulties were more satisfied with the process whereas parents of children with more behavioural difficulties were less satisfied.	7.1
Smith, Chung, and Vostanis (1994)	England	Quantitative	127 families of children with ASD	To explore whether advances have been made in diagnosis, support and provision in the last ten years for children with ASD according to parents' experiences.	Questionnaire: experience of the diagnostic process	Experiences of parents of a younger group of children with ASD (age 1-9) were compared with an older group (aged 10-20). The authors concluded that little change had been made in the diagnosis, support and early provision for children with ASD.	4.7

Author(s) and Year of Publication	Country	Qualitative or Quantitative	Participants	Objective	Method and Outcome Variables	Experience of the Process	Quality Rating
Chamak, Bonniau, Oudaya, and Ehrenberg (2011)	France	Mixed methods	248 parents of adults and children with ASD.	To explore parents' reactions to diagnosis and their satisfaction with the diagnostic process, and to compare experiences now with those in the past.	Questionnaire: demographics, diagnostic history, and satisfaction	93% of parents of the adult group were dissatisfied with the diagnostic process due to the professionals' manner, blame, and difficulties in obtaining diagnoses. 63% of parents of the child group were dissatisfied due to a lack of information and help. Parents reported emotions of relief, distress, stress, and sorrow.	5.9
Hutton and Caron (2005)	USA	Mixed methods	21 families with children with autism	To explore the experience of recognition and diagnosis, interventions and coping of families of children with autism in New England	Structured telephone interview	Most diagnoses were given within 3 years. Reassurance and misdiagnosis resulted in delays. Parents described grief, relief, shock, and self-blame. 48% experienced some disrespectful interactions.	6.8
Keenan, Dillenburger, Doherty, Byrne, and Gallagher (2010)	Ireland	Mixed methods	95 parents and carers of children with ASD and 67 professionals	To explore parental experiences of diagnosis and forward planning for children with ASD	Questionnaires: demographics, diagnostic information, and a professional questionnaire; focus group of ten parents	Parents reported dissatisfaction with the timeliness of diagnosis and diagnostic information. Parents and professionals suggested additional support should be in place during the process.	6

Author(s) and Year of Publication	Country	Qualitative or Quantitative	Participants	Objective	Method and Outcome Variables	Experience of the Process	Quality Rating
Mansell and Morris (2004)	England	Mixed methods	55 parents of children with ASD	To assess and get feedback on change in the local diagnostic service; to assess the information services, support and treatment available; to assess the consequences of a diagnosis; to assess how parents' attitudes towards the diagnosis had changed	Questionnaire: demographics; diagnostic information; information and treatment use; attitudes towards diagnosis	Parents reported satisfaction with the sensitivity of the clinicians, but were dissatisfied with the amount of information provided surrounding the diagnosis and prognosis, and sign-posting to other services. There was some evidence for improvements in parental satisfaction with more recent diagnoses.	5.9
Renty and Roeyers (2005)	Belgium	Mixed methods	139 parents of children with ASD	To evaluate parents' satisfaction with the accessibility and quality of education and support for their child	Questionnaire: demographics, diagnostic information, satisfaction; semi-structured interview with 15 parents	Half of the parents were satisfied or very satisfied with the process. Higher satisfaction was correlated with increased information provision and lower age at diagnosis.	8
Sansosti, Lavik, and Sansosti (2012)	USA	Mixed methods	16 primary caregivers of children with ASD	To identify early family experiences during the diagnostic process and explore variables that affected the duration of this process.	Questionnaires and semi-structured interviews	Dissatisfaction was associated with delays due to concerns being dismissed by professionals, and perceived lack of professional knowledge. The length of the process was affected by racial background, but no other parental factors.	7.7
Whitaker (2002)	England	Mixed methods	Unspecified number of parents of children with ASD	To explore parental satisfaction with a service supporting preschool children with ASD, and to explore their experience of diagnosis	Semi-structured interview	75% of parents were satisfied with the diagnostic process and felt that their concerns had been taken seriously. Suggested improvements included providing more information about ASD in non-technical language and helping parents to apply this to their child.	4.0

Author(s) and Year of Publication	Country	Qualitative or Quantitative	Participants	Objective	Method and Outcome Variables	Experience of the Process	Quality Rating
Avdi, Griffin and Brough (2000)	England	Qualitative	3 families with a child with developmental delay or ASD	To examine parents' constructions of their child's problem and how these are constrained by available discourses.	Semi-structured interview	Parents reported feeling unheard by professionals, feeling blamed, a lack of clarity in diagnoses, and fear and relief reactions.	9.2
Braiden, Bothwell, and Duffy (2010)	Northern Ireland	Qualitative	11 mothers with a child with ASD	To explore parents' experiences of the diagnostic process for ASD	Semi-structured interview	Parents were largely satisfied with the process but described many challenges. Recommended improvements included better and more appropriately timed provision of information about ASD, and increased transparency.	6.9
Brookman-Frazee, Baker-Ericzén, Stadnick, and Taylor (2012)	USA	Qualitative	23 parents of children with ASD who had received outpatient therapy	To examine parent experiences of accessing Community Mental Health clinics and the impact of the services on child and parent functioning.	Semi-structured interview	Multiple and conflicting diagnoses were provided before an ASD diagnosis. The diagnostic process was accompanied by emotions of relief, stress, confusion, and guilt.	8.1
Chell (2006)	England	Qualitative	13 parents of children with Asperger syndrome	To understand the experiences of parents of children with Asperger syndrome	Focus groups	Parents reported feeling blamed and dismissed by professionals early in the diagnostic process, then reported feeling validated upon diagnosis.	3.9
Jegatheesan, Fowler, and Miller (2010)	USA	Qualitative	3 families of a child with autism who had immigrated to USA from South Asia	To extend research about families of children with autism to include the experiences of Muslim immigrant families	Unstructured interviews and descriptive statistics	Parents preferred working with professionals with their language. They were dissatisfied with the lack of opportunity for discussion in the disclosure of diagnosis. Families reported shock, disbelief, confusion and stress reactions.	7.5

Author(s) and Year of Publication	Country	Qualitative or Quantitative	Participants	Objective	Method and Outcome Variables	Experience of the Process	Quality Rating
Kerrell (2001)	Wales	Qualitative	11 parents of a child with ASD	To ascertain the views, experiences and expectations of parents whose children had been assessed by the team at a diagnostic clinic	Interviews	The majority of parents were not satisfied with the assessment and diagnosis process. They felt that professionals were unable to meet their needs and that many changes could be made to improve the service.	3.1
Lutz, Patterson, and Klein (2012)	USA	Qualitative	16 mothers of children (N=10) or adults (N=6) with autism	To examine the impact of autism on the family unit from the perspective of the mother	Interviews	Parents reported grief, anger, and blame of themselves and others during the diagnostic process and upon diagnosis.	8.6
Midence and O'Neill (1999)	Wales	Qualitative	5 families of children with autism	To explore the diagnostic experiences of parents of children with autism	Semi-structured interview	Parents reported being given incorrect advice, reassurance, and misdiagnoses. They were often dissatisfied with professionals' knowledge until referred to an autism specialist. Emotional responses to the diagnosis included sadness and relief.	7.8
Minnes and Steiner (2009)	Canada	Qualitative	3 mothers of children with autism	To gather information about the quality of health services for persons with autism and to identify factors affecting the quality of care.	Focus group	Difficulties in obtaining a diagnosis were reported, which prevented access to services.	5.6
Mouzourou, Santos, and Gaffney (2011)	Cyprus	Qualitative	Family of one child with autism	To explore the family's lived experience of having a child with autism	Interviews with family members and observations	The mother's initial concerns were dismissed by family members and the paediatrician, and reassurance was offered when the child was older. Mother reported that the delivery of the diagnosis met functional requirements but offered no hope.	8.6

Author(s) and Year of Publication	Country	Qualitative or Quantitative	Participants	Objective	Method and Outcome Variables	Experience of the Process	Quality Rating
Mulligan, MacCulloch, Good, and Nicholas (2012)	Canada	Qualitative	10 parents of children with ASD	To examine what a diagnosis of ASD for their child meant for parents	Semi-structured interview	Parents described the diagnostic process as disempowering, frustrating, overwhelming, and confusing.	8.1
Nissenbaum, Tollefson, and Reese (2002)	USA	Qualitative	11 professionals and 17 parents of children with ASD	To examine families' and professionals' perceptions of the delivery of the diagnosis of autism	Unstructured interviews and descriptive statistics	Parents had a negative perception of their child's prognosis and reported mixed emotions. Most were satisfied with professionals although some felt that professionals lacked knowledge or were disinterested.	6.7
Osborne and Reed (2008)	England	Qualitative	70 parents of children with ASD	To survey parental perceptions of the diagnostic process	Focus group	Suggested improvements to the process related to the provision of information, integration of services, and reduced delays. Many parents reported that the diagnostic process was not useful, and positive reflections related to a sense of relief and validation.	8.1
Schall (2000)	USA	Qualitative	3 families of children with ASD	To understand family experiences of raising a child with ASD	Transcripts (source not stated)	Parents reported having their concerns disregarded by professionals and experiencing them as indifferent. They described despair and relief upon diagnosis.	2.8
Yazbak (2002)	France/ England	Qualitative	Mother of 2 children with autism	To present a mother's experience of having two sons with autism	Case study	The family experienced reassurance and misdiagnosis and had to pursue many channels before receiving a diagnosis of autism. They felt the condition was poorly investigated in relation to their children's other medical difficulties.	3.1

Satisfaction with the Process

A key outcome variable in many studies was satisfaction with the diagnostic process, most commonly measured on Likert scales ranging from most dissatisfied to most satisfied. Overall the studies indicated low satisfaction rates at around 50% (Brogan and Knussen, 2003; Chamak et al. , 2011; Goin-Kochel et al., 2006; Howlin & Moore, 1997; Siklos & Kerns, 2007), although some small-scale studies reported the majority of parents being dissatisfied (Kerrell, 2001). Further, in the United Kingdom this varied according to region in the UK, ranging from only 16.1% of those in Cumbria, the Isle of Man and Belfast reporting that they were satisfied to 45.5% of those in the Midlands, suggesting variation in the quality of the process nationally (Howlin & Moore, 1997). In contrast to the low rates of satisfaction reported above, in two studies just under 75% of parents reported feeling satisfied with the diagnostic process (Braiden et al., 2010; Whitaker, 2002). However both studies had a very specific focus: Whitaker's study included a sample in which all of the children had definite diagnosis and had received a specific support service, perhaps increasing their satisfaction with the diagnosis. It is also important to note that this study was of poorer quality than those that found higher rates of dissatisfaction; it did not give details about the number or demographics of the participants included, and very little detail was provided surrounding the methodology, making it difficult to assess the reliability and validity of the findings. Braiden and colleagues (2010) used a small sample (N=11), and had a very specific time frame of 18 months, and so their findings may have been relevant to a specific cohort.

An association has been found between satisfaction ratings and the child's age on diagnosis, with negative scores being related to older age (r=-.15,

p=0.001, Goin-Kochel et al., 2006; *r*=-.81, p=0.024, Howlin & Moore, 1997; *r*=-.30, p<0.01, Renty & Roeyers, 2005). In France, huge variation in satisfaction scores was found according to the age of the child where 93% of parents of children aged 18 to 45 years reported feeling dissatisfied with the diagnostic process as opposed to 63% of the parents of children aged four to seventeen years (Chamak et al., 2011). Research exploring this relationship further has found no relationship between satisfaction and the length of time since a diagnosis had been made, indicating that the relationship with children's age was not representative of changes in diagnostic practice over time (Goin-Kochel et al., 2006; Siklos & Kerns, 2007).

In the UK there was a strong negative correlation between the length of delay in receiving a diagnosis and parents' satisfaction (*r*=-.85, *p*=0.033, Howlin & Moore, 1997). However in Singapore this finding was not replicated in a study of similar quality (Moh & Magiati, 2012). There is some evidence of a relationship between the number of professionals consulted and satisfaction ratings, with a greater number of professionals being associated with poorer satisfaction (*r*=-.31, p<0.001, Goin-Kochel et al, 2006). This suggests that the relationship between satisfaction and the child's age at diagnosis may be an artefact of an effect caused by delays in the process including those caused by multiple referrals (Renty & Roeyers, 2005). Again, these findings were not replicated in Singapore where those who consulted more professionals were not less satisfied; however involvement with more professionals did increase reported stress levels (Moh & Magiati, 2012). Therefore this finding may be an artefact of a lack of a standardised tool to measure satisfaction throughout the studies.

There has been some conflicting evidence that has indicated that although those with a more recent diagnosis were more satisfied, contrary to expectations satisfaction ratings were not related to the age of the child at any stage in the diagnostic process (Brogan & Knussen, 2003).

It is important to note that all of these studies were correlational, and therefore it is not possible to establish cause and effect. However, in summary it would seem that a significant proportion of parents are unsatisfied with the diagnostic process, and that taking longer and involving more people is less satisfactory for parents. However, in contrast to the majority of the results, and contrary to expectations, Brogan and Knussen (2003) found that satisfaction ratings were not related to periods of delay during the diagnostic process.

Waiting Time and Speed of Process.

Parents have frequently reported that the diagnostic process was not completed in a timely manner (Chell, 2006; Keenan et al., 2010; Moh & Magiati, 2012; Osborne & Reed, 2008). A significant consequence of the delays in diagnosis was that this prevented access to supportive and educational services (Minnes & Steiner, 2009; Renty & Roeyers, 2005).

One cause of delays in the diagnostic process was the need to consult multiple professionals (Chamak et al., 2010; Howlin & Moore, 1997). A large questionnaire study found that 7.8% of 1295 parents reported that their children received a diagnosis from the first professional approached, 40% at the second referral, and 63% at the third referral (Howlin & Moore, 1997). Parents may have lacked understanding of multi-disciplinary assessment due to a lack of information at the start of the process (Braiden et al, 2010).

Long waiting lists once an assessment had been arranged caused delays (Mulligan et al., 2012). During this time parents experienced great

concern due to the uncertainty surrounding how to support their child. A lack of standardisation on a national and international level means that there is often no clear clinical pathway, which causes more delays (Osborne & Reed, 2008). This is exacerbated by poor communication between different services involved in the process (Braiden et al, 2010; Osborne & Reed, 2008).

A third major cause of delays reported by parents was having their concerns dismissed through reassurance from professionals and through misdiagnosis (Avdi et al., 2000; Brookman-Frazee et al., 2012; Chamak et al., 2010; Howlin & Moore, 1997; Hutton & Caron, 2005; Jegatheesan et al., 2010; Keenan et al, 2010; Midence & O'Neill, 1999; Moh & Magiati, 2012; Mouzourou et al., 2011; Mulligan et al, 2012; Sansosti et al., 2012; Schall, 2000; Smith et al., 1994; Yazbak, 2002). This included normalisation of their children's developmental difficulties (Avdi et al., 2000); misattribution to poor parenting and adjustment problems (Brookman-Frazee et al., 2012; Chamak et al., 2010, Chell, 2006); misdiagnoses of psychosis, speech and language problems and learning disability (Chamak et al., 2010); and misattribution to the use of multiple languages in the home (Jegatheesan et al., 2010). The experience of misdiagnosis and reassurance led to frustration and self-doubt regarding their competency as parents (Avdi et al., 2000).

Some studies reported characteristics of the child that impacted on the length of the diagnostic process. Sansosti and colleagues (2012) found that on average children of African American and mixed racial backgrounds received a diagnosis of ASD six months later than Caucasian children despite concerns being raised at the same age. However this study included a very small sample of only 16 participants, 62.5% of whom were Caucasian, therefore these results may not be reliable. In contrast to these findings, Goin-Kochel et al. (2006)

found that there were no differences between racial groups, however again the sample were predominantly Caucasian (88%). Older children had to be seen by more professionals and had to wait longer to receive a diagnosis (Siklos & Kerns, 2007), and girls were diagnosed with an ASD later than boys (Goin-Kochel et al., 2006; Siklos & Kerns, 2007). However Siklos and Kerns (2007) found that there were no differences in the reported levels of satisfaction between the families of males and females, although with 70% of the sample being male and a small sample size (*N*=54) this lack of effect may be due to low statistical power. Parents of younger children gave more positive reports of feeling respected, being given time by professionals, and doctors being more open minded, sympathetic and understanding (Chamak et al., 2010).

There was conflicting evidence regarding associations between the families' demographics and the length of the diagnostic process. On one hand research indicates that greater levels of parental education and family income were related to a younger age at diagnosis and greater satisfaction with the diagnostic process (Goin-Kochel et al., 2006). However other research indicates that whilst parents with higher educational qualifications and higher income noticed developmental difficulties sooner and consulted professionals earlier, the diagnostic period was no shorter, and the same number of professionals were consulted as during the process with parents with lower educational qualifications and income (Moh & Magiati, 2012). In contrast to both of these findings, other research has not found significant relationships between parental characteristics and satisfaction with the diagnostic process (Brogan & Knussen, 2003; Sansosti et al., 2012).

Diagnostic Classification

There were some interesting relationships between the diagnosis (e.g. autism, autistic tendencies, ASD, Asperger syndrome) and both the diagnostic process and parental satisfaction. Parents of children who received a definite diagnosis reported greater satisfaction than those who received a diagnosis that was tentative (Brogan & Knussen, 2003; Howlin & Moore, 1997). The severity of symptoms was not predictive of the duration of the diagnostic period (Moh & Magiati, 2012; Sansosti et al., 2012). However fewer professionals were consulted before a diagnosis was made where symptoms were severe (Moh & Magiati, 2012). Despite this the parents of those with more severe symptomology reported lower satisfaction with the diagnostic process. Siklos and Kerns (2007) found that parents of children with greater communication impairments reported greater satisfaction with the process whereas parents of children with more behavioural difficulties reported lower satisfaction. The authors proposed that communication difficulties may be more obvious to parents, thus they are better prepared to receive a diagnosis, although further research would be needed to substantiate this claim.

Satisfaction with Professionals

Parents' satisfaction with professionals they interacted with varied. Some studies reported that most parents were satisfied with the sensitivity of the team during the diagnostic process (Braiden et al., 2010; Mansell & Morris, 2004) whereas other studies indicated that around 50% of parents had experienced disrespect or were dissatisfied with the professionals' manner (Hutton & Caron, 2005; Keenan et al, 2010).

Parents reported a poor level of professional knowledge causing delayed diagnosis (Kerrell, 2001; Midence & O'Neill, 1999; Sansosti et al., 2012); a

dismissive attitude leaving them feeling unsupported (Braiden et al., 2010; Midence & O'Neill, 1999; Nissenbaum et al., 2002; Sansosti et al., 2012; Schall, 2000; Yazbak, 2002); a lack of thoroughness in the assessment process where the child was only seen in one context and over a short time period (Kerrell, 2001); blunt or hopeless announcement of the diagnoses (Chamak et al., 2010; Mouzourou et al., 2011); and a lack of empathy regarding parents' stress (Kerrell, 2001). Some parents felt that professionals lacked knowledge surrounding the variation in presentations within autism and the relationship with comorbid conditions (Sansosti et al., 2012), and lacked willing to explore this (Yazbak, 2002).

Parents reported a lack of information about the diagnostic process (Braiden et al., 2010; Mulligan et al., 2012), and a paucity of or poor delivery of information about the diagnosis and prognosis (Jegatheesan et al., 2010; Mansell & Morris, 2004; Mouzourou et al., 2011; Nissenbaum et al., 2002; Osborne & Reed, 2008; Renty & Roeyers, 2005; Sansosti et al., 2012; Whitaker, 2002). Parents expressed that diagnoses were not explained well to them (Keenan et al., 2010; Smith et al., 1994), leaving some parents uncertain about whether the diagnosis was definite (Smith et al., 1994), and some parents had to read their child's diagnosis in a report or medical notes rather than being told (Chamak et al., 2010). Upon diagnosis parents reported a lack of advice and information on diagnoses and services (Braiden et al., 2010; Keenan et al., 2010; Mansell & Morris, 2004; Mouzourou et al., 2011; Sansosti et al., 2012). Alternatively, some parents felt overloaded with information following the diagnostic disclosure and unsure how to apply the information to their child (Braiden el al., 2010; Mulligan et al., 2012; Whitaker, 2002). They desired more time for questions and discussion (Kerrell, 2001; Jegatheesan et al., 2010).

Greater satisfaction with professionals was reported when children were referred to professionals that specialised in autism (Midence & O'Neill, 1999; Nissenbaum et al., 2002); when parents felt that their concerns were heard (Braiden et al., 2010; Moh & Magiati, 2012; Nissenbaum et al., 2002; Whitaker, 2002); when the diagnostic disclosure was honest yet hopeful (Mulligan et al., 2012); and when warmth, empathy and compassion were shown (Kerrell, 2001; Nissenbaum et al., 2002). In Jegatheesan and colleagues' (2010) study of Muslim immigrant families in the USA parents reported a preference for working with professionals with their native language as they provided more informal interaction and were able to gather culturally appropriate information about their adaptation to living in the USA, their support systems, and their child's difficulties. They felt that the doctor's familiarity with their culture provided a comfort zone whereas European-American doctors were straightforward and time conscious.

Specific information on a child's ASD and the reasons for diagnosis in clear language were associated with higher satisfaction (Moh & Magiati, 2012; Nissenbaum et al., 2002; Renty & Roeyers, 2005; Whitaker, 2002); when realistic prognostic information was provided (Nissenbaum et al., 2002; Osborne & Reed, 2008; Whitaker, 2002); and when parents received information on available interventions (Moh & Magiati, 2012; Nissenbaum et al., 2002; Osborne & Reed, 2008). The more helpful the information provided, the lower the levels of stress and the higher the levels of satisfaction reported (Moh & Magiati, 2012). Parents who received a diagnosis a long time ago indicated that post-diagnostic information should be provided in phases to support continued learning and transitions, but parents with more recent diagnoses wanted this information immediately so that they could refer back to it at the

appropriate time even if they were unable to take all of information on board from the beginning (Braiden et al., 2010; Osborne & Reed, 2008). Those parents that had the opportunity for discussion with the professionals valued this (Whitaker, 2002).

Emotional Reactions

Many parents identified feelings of stress throughout the diagnostic process (Brookman-Frazee et al., 2012; Jegatheesan et al., 2010; Siklos & Kerns, 2007). It was common for parents to feel relief upon diagnosis (Avdi et al., 2000; Brookman-Frazee et al., 2012; Chamak et al., 2010; Chell, 2006; Hutton & Caron, 2005; Nissenbaum et al, 2002; Mansell & Morris, 2004; Midence & O'Neill, 1999; Mulligan et al, 2012; Osborne & Reed, 2008) which was attributed to the end of uncertainty and a sense of having their concerns validated. However, parents also reported experiences of fear or worry (Avdi et al., 2000; Mansell & Morris, 2004; Whitaker, 2002), sadness and grief (Chamak et al., 2010; Hutton & Caron, 2005; Lutz, Patterson, & Klein, 2012; Midence & O'Neill, 1999; Mulligan et al., 2012; Nissenbaum et al., 2002; Schall, 2000), anger and frustration (Chamak et al., 2010; Lutz et al., 2012; Mouzourou et al., 2011), powerlessness (Chamak et al., 2010), shock (Chamak et al., 2010; Hutton & Caron, 2005; Jegatheesan et al., 2010; Mansell & Morris, 2004; Mouzourou et al., 2011; Mulligan et al., 2012; Nissenbaum et al., 2002; Whitaker, 2002), hopelessness (Mouzourou et al., 2011), disappointment (Mouzourou et al., 2011), and self-blame (Hutton & Caron, 2005; Lutz et al., 2012).

Parents and professionals felt that increased support should be in place during the diagnostic process (Keenan et al., 2010). Parents of younger children reported greater levels of support than parents of older children with the former

receiving greater financial support (41% versus 15% of parents of older children) and a greater opportunity for discussion (30% versus 15%) throughout the diagnostic process; 18% of parents of younger children and only 3% of parents of older children had contact with other parents of children with ASD during the process (Smith et al., 1994). Parents who accessed support groups felt that these should be more available (Osborne & Reed, 2008). Jegatheesan and colleagues (2010) found that Muslim families generally reported feeling unsupported when receiving the diagnosis as they withheld their worries from their families to protect them, and did not identify with local support groups.

Discussion

The process of obtaining a diagnosis of ASD is long and complex due to multiple factors including the variability in presentation and the need to consider comorbidities. Parents are required to consult multiple professionals and to be rigorously interviewed about their child. The literature indicates that significant numbers of parents continue to be dissatisfied with the diagnostic process (Brogan & Knussen, 2003; Chamak et al., 2011; Goin-Kochel et al., 2006; Howlin & Moore, 1997; Siklos & Kerns, 2007). There is an association between dissatisfaction and older age at diagnosis (Goin-Kochel et al., 2006; Howlin & Moore, 1997; Renty & Roeyers, 2005; Siklos & Kerns, 2007), which is not due to changes in diagnostic practice over time. Although there is some inconsistency, evidence suggests that the relationship with age may be an artefact of the relationship between delays in the diagnostic process and dissatisfaction (Chell, 2006; Keenan et al., 2010; Moh & Magiati, 2012; Osborne & Reed, 2008).

Delays are caused by the need to consult multiple professionals (Chamak et al., 2010; Howlin & Moore, 1997); waiting lists and poor

communication between services (Mulligan et al., 2012; Osborne & Reed, 2008); and misdiagnosis and dismissal of parental concerns (Avdi et al., 2000; Brookman-Frazee et al., 2012; Chamak et al., 2010; Howlin & Moore, 1997; Hutton & Caron, 2005; Jegatheesan et al., 2010; Keenan et al., 2010; Midence & O'Neill, 1999; Moh & Magiati, 2012; Mouzourou et al., 2011; Mulligan et al., 2012; Sansosti et al., 2012; Schall, 2000; Smith et al., 1994; Yazbak, 2002). Worryingly, there is some evidence to suggest that child and family characteristics such as race (Sansosti et al., 2012), gender and age of the child (Goin-Kochel et al., 2006; Siklos & Kerns, 2007), and parental education and income (Goin-Kochel et al., 2006) are associated with delays in the diagnostic process. However these delays are not consistently associated with parental satisfaction with the diagnostic process (Brogan & Knussen, 2003; Sansosti et al., 2012; Siklos & Kerns, 2007).

The presentation of a child's symptoms can impact on the experience of the diagnostic process. Whilst severity of symptoms is not predictive of early diagnosis, it can impact on the number of professionals consulted along the way (Moh & Magiati, 2012). Further, parents of children with greater communication impairments were more satisfied than parents of children with behavioural difficulties (Siklos & Kerns, 2007). In line with literature from other developmental disorders (Watson, Hayes, & Radford-Paz, 2011), parents of children that received a definite diagnosis of ASD rather than a tentative or possible diagnosis were more satisfied (Brogan & Knussen, 2003; Howlin & Moore, 1997).

The interactions between parents and professionals are key yet parents frequently report that they have experienced some disrespect during the diagnostic process (Hutton & Caron, 2005; Keenan et al., 2010) due to a lack of

professional assessment, knowledge and guidance (e.g. Kerrell, 2001; Midence & O'Neill, 1999); and dismissive and blunt interactions that indicated a lack of empathy (e.g. Chamak et al., 2010; Mouzourou et al., 2011). Unsurprisingly, greater satisfaction with professionals was associated with referrals to specialists, and warmth, hope, empathy, and acknowledgement of parental concerns (e.g. Nissenbaum et al., 2002, Whitaker, 2002). There was also evidence to suggest that acknowledgement and understanding of cultural factors and their impact on the experience of autism and the diagnostic process were important (Jegatheesan et al., 2010).

The diagnostic process provokes many emotions for parents including stress, relief, fear, sadness, self-blame and anger, and disappointment (e.g. Lutz et al., 2012; Mouzourou et al., 2011; Nissenbaum et al., 2002). Parents and professionals felt that increased support should be available throughout the process (Keenan et al., 2010).

Clinical Implications and Future Research

The evidence described here demonstrates the need for a clear diagnostic pathway for ASD. This research suggests that training needs to be provided for healthcare professionals that are likely to be the first approached by concerned parents, such as health visitors and family doctors, so that they are able to refer to appropriate specialists and do not provide misguided reassurance causing delays. Further, it is a common issue in autism that treatable health conditions are overlooked and left untreated (Bristol-Power & Spinella, 1999), and further assessment of potential co-morbidities such as digestive and immune difficulties should be integrated into the diagnostic pathway.

Whilst a long process may be somewhat inevitable due to the complexities of diagnosing ASD, there is a large body of evidence that indicates that interventions for ASD have greater success when administered early in the child's life (Reed & Osborne, 2012). Similarly, whilst some distress in the process may be unavoidable for parents, professionals are able to lessen this through empathic interactions and the provision of clear, individualised information. This is particularly important as the evidence indicates that when parents are dissatisfied with their interactions with professionals during the diagnostic process, this can impact negatively on the efficacy of treatments for the child (Reed & Osborne, 2012). These implications are consistent with the NICE (2011) guidance for good practice in the diagnosis of ASD in children and young people. These guidelines recommend local pathways for the recognition, referral and diagnosis of possible autism as well as person-centred care, and exploration of differential diagnosis and potential comorbidities.

This review highlights the need for empirical research into the relationships between the components of the diagnostic process and their impact on parental satisfaction identified in the correlational and qualitative studies. There is also scope to explore the relationships between family and child characteristics and the length of the process to identify whether delays relate to the increased complexity of certain cases or whether there may be prejudices and ethnocentricities within the current diagnostic criteria and services.

One challenge for current models of diagnosis is that many support and education services require a definite diagnosis before accepting a child into their service. This can not only cause delays for families in receiving the appropriate services, but can also pressurise clinicians to make a decision

quickly. The diagnosis of autism is not being used with precision by professionals due to the heterogeneity in clinical presentations (Sabatino, Vance, & Fuller, 2001). Partly, this is due to difficulty differentiating autism from other PDDs, and the lack of specificity in the existing diagnostic criteria (Beglinger & Smith, 2001), but this could be indicative of a bias in the symptoms that clinicians are aware of. Diagnoses based on behavioural symptoms alone are fraught with subjectivity and difficulty, thus a biomarker that could supplement the current diagnostic process is highly desirable. This highlights the need for further understanding of ASD in order to be able to refine the diagnostic criteria and to inform training for clinicians. It is widely known that early intervention has a positive impact on the prognosis for children with ASD (White, Weitlauf, & Warren, 2012). Thus delays in diagnosis have long-term implications for the child and their family. Further, there is still little knowledge about the developmental courses of the different presentations of ASD, making it difficult for clinicians to provide helpful prognostic information to families (White et al., 2012).

Limitations of the Review

Only articles published in English were included therefore this review is not representative of international experiences of the ASD diagnostic process. The studies relied on parents to provide their child's diagnosis. These were not validated either through a screening questionnaire or through checking medical records, thus some children without a formal diagnosis of ASD may have inadvertently been included.

Many studies included small samples. This is unsurprising due to the low prevalence of ASD which makes it difficult to employ random sampling techniques, and opportunity and self-selecting samples were common. Some

studies provided little information about how they selected their sample or where they recruited from, which means that it is not possible to determine how representative these samples are of the population of parents of children with ASD. Further, small samples meant that many statistical tests were underpowered, and should be interpreted with caution. Many of the quantitative studies used correlational methodology, therefore it is not possible to establish cause and effect relationships between the variables. In addition to the limitations of the quantitative research, the qualitative research predominantly included small sample sizes recruited from specific cohorts and regions. This further affects the generalizability of the findings. However it is important to note that there was good coherence between the findings of the qualitative, quantitative and mixed methodology studies. To improve validity an area for future research may be the use of experimental methods to explore more effective diagnostic pathways, although this may be difficult to establish due to the low prevalence of ASD.

The studies included employed self-report methodology, which is susceptible to social desirability effects. These were retrospective and relied on parents recalling their experiences that may have been months or years ago. Self-selecting samples may be particularly problematic as parents that were keen to respond may have been those who had experienced the extremes, i.e. a very good or very poor service, during the diagnostic process, and those who are involved in research groups and autism-focussed interest or support groups and so were exposed to the adverts. Therefore it is possible that these are not representative of typical parent of a child with ASD. Further, the questionnaires included were often developed or modified by the authors, therefore their psychometric properties were unknown. This means that it is not possible to

ascertain whether the questionnaires were reliable or valid. However, some authors replicated previous studies by using their questionnaires making their results comparable with previous findings (e.g. Moh & Magiati, 2012; Siklos & Kerns, 2007).

Conclusion

A significant proportion of parents report dissatisfaction with the diagnostic process for ASD. Factors that influence this include the length of delay in receiving a diagnosis, interactions with professionals, a lack of information, the nature of the child's symptoms, and the certainty of the final diagnosis. Delays were caused by the number of professionals consulted during the process, waiting lists, and a lack of clear clinical pathways and communication between services. Many parents reported having their early concerns dismissed through reassurance and misdiagnosis. Delays in the diagnostic process prevent access to education and supportive services, and may impact on the child's responsiveness to interventions. There was some conflicting evidence that the child's ethnic background and gender may impact on the length of the diagnostic process, as well as family education and income, and this should be further explored in relation to prejudices within assessments and services. Parents experienced a range of emotions during the diagnostic process including relief, shock, grief, and hopelessness.

The diagnostic process is necessarily long and thorough, which is challenging for parents, who should be well supported by professionals and services. Services should ensure that healthcare professionals that are first approached with concerns regarding ASD are well trained to minimise misdiagnosis and inappropriate reassurance. Upon entering the diagnostic pathway services should provide parents with clear information about what to

expect during the process, e.g. a leaflet, a video, or an information evening with other parents at the same stage. Throughout the process services should provide person-centred care to minimise any unnecessary distress and dissatisfaction for families.

References

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC: Author.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: Author.

Avdi, E., Griffin, C., & Brough, S. (2000). Parents' constructions of the 'problem' during assessment and diagnosis of their child for an autistic spectrum disorder. *Journal of Health Psychology, 5*, 241-254. doi:10.1177/135910530000500214

Beglinger, L. J., & Smith, T. H. (2001). A review of subtyping in autism and proposed dimensional classification model. *Journal of autism and developmental disorders*, *31*, 411-22. doi:10.1023/A:1010616719877

Braiden, H.J., Bothwell, J., & Duffy, J. (2010). Parents' experience of the diagnostic process for autistic spectrum disorder. *Child Care in Practice, 16*, 377-389. doi:10.1080/13575279.2010.498415

Bristol-Power, M.M., & Spinella, G. (1999). Research on screening and diagnosis in autism: a work in progress. *Journal of Autism and Developmental Disorder*, *29*, 435-438. doi:10.1023/A:1021991718423

Brogan, C.A., & Knussen, C. (2003). The disclosure of an autistic spectrum disorder: determinants of satisfaction in a sample of Scottish parents. *Autism*, *7*, 31-46. doi:10.1177/1362361303007001004

Brookman-Frazee, L., Baker-Ericzén, M., Stadnick, N., & Taylor, R. (2012). Parent perspectives on community mental health services for children with autism spectrum disorders. *Journal of Child and Family Studies, 21*, 533-544. doi:10.1007/s10826-011-9506-8

Chamak, B., Bonniau, B., Oudaya, L., & Ehrenberg, A. (2011). The autism diagnostic experiences of French parents. *Autism*, *15*, 83-97. doi:10.1177/1362361309354756

Chell, N. (2006). Experiences of parenting young people with a diagnosis of Asperger syndrome: a focus group study. *The International Journal of Psychiatric Nursing Research, 11*, 1348-1358.

Chua, A.K. (2012). Parental experience of having a child diagnosed with autistic spectrum disorder: and integrative literature review. *Singapore Nursing Journal, 39*, 8-18.

Downs, S.H., & Black, N. (1998). The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. Journal of Epidemiology and Community Health, *52*, 377-384. doi:10.1136/jech.52.6.377

Goin-Kochel, R.P., Mackintosh, V.H., & Myers, B.J., (2006). How many doctors does it take to make an autism spectrum diagnosis? *Autism*, *10*, 439-451. doi:10.1177/1362361306066601

Howlin, P., & Moore, A. (1997). Diagnosis in autism: a survery of over 1200 patients in the UK. *Autism*, *1*, 135-162. doi: 10.1177/1362361397012003

Hutton, A.M., & Caron, S.L. (2005). Experiences of families with children with autism in rural New England. *Focus on Autism and Other Developmental Disabilities, 20*, 180-189. doi:10.1177/10883576050200030601

Jegatheesan, B., Fowler, S., & Miller, P.J. (2010). From symptom recognition to services: how South Asian Muslim immigrant families navigate autism. *Disability and Society, 25*, 797-811. doi:10.1080/09687599.2010.520894

Keenan, M., Dillenburger, K., Doherty, A., Byrne, T., & Gallagher, S. (2010). The experiences of parents during diagnosis and forward planning for children with autism spectrum disorder. *Journal of Applied Research in Intellectual Disabilities, 23*, 390-397. doi:10.1111/j.1468-3148.2010.00555.x

Kerrell, H. (2001). Service evaluation of an autism diagnostic clinic for children. *Nursing Standard, 15*, 33-37.

Lenne and Waldby (2011). Sorting out autism spectrum disorders: evidence-based medicine and the complexities of the clinical encounter. *Health Sociology Review, 20*, 70-83. doi:10.5172/hesr.2011.20.1.70

Lutz, H.R., Patterson, B.J., & Klein, J. (2012). Coping with autism: a journey towards adaptation. *Journal of Pediatric Nursing, 27*, 206-213. doi:10.1016/j.pedn.2011.03.013

Mansell, W., & Morris, K. (2004). A survey of parents' reactions to the diagnosis of an autistic spectrum disorder by a local service: access to information and use of services. *Autism*, *8*, 387-407. doi:10.1177/1362361304045213

Midence, K., & O'Neill, M. (1999). The experience of parents in the diagnosis of autism: a pilot study. *Autism, 3*, 273-285. doi:10.1177/1362361399003003005

Minnes, P., & Steiner, K. (2009). Parent views on enhancing the quality of health care for their children with fragile X syndrome, autism or Down syndrome. *Child: Care, Health and Development, 35*, 250-256. doi:10.1111/j.1365-2214.2008.00931

Moh, T.A., & Magiati, I. (2012). Factors associated with parental stress and satisfaction during the process of diagnosis of children with autism spectrum disorders. *Research in Autism Spectrum Disorders, 6*, 293-303. doi:10.1016/j.rasd.2011.05.011

Mouzourou, C., Santos, R.M., & Gaffney J.S. (2011). At home with disability: one family's three generations narrate autism. *International Journal of Qualitative Studies in Education, 24*, 693-715. doi:10.1080/9518398.2010.529841

Mulligan, J., MacCulloch, R., Good, B., & Nicholas, D.B. (2012). Transparency, hope and empowerment: a model for partnering with parents of a child with autism spectrum disorder at diagnosis and beyond. *Social Work in Mental Health, 10*, 311-330. doi:10.1080/15332985.2012.664487.

National Institute for Health and Clinical Excellence (2011). *Autism Diagnosis in Children and Young People: Recognition, Referral and Diagnosis of Children and Young People on the Autism Spectrum.* (NICE Clinical Guideline 128). Retrieved from http://publications.nice.org.uk/autism-diagnosis-in-children-and-young-people-cg128

Nissenbaum, M.S., Tollefson, N., & Reese, R.M. (2002). The interpretative conference: sharing a diagnosis of autism with families. *Focus on Autism and Other Developmental Disabilities, 17*, 30-43. doi:10.1177/108835760201700103

Osborne, L.A., & Reed, P. (2008). Parents' perceptions of communication with professionals during the diagnosis of autism. *Autism, 12*, 309-324. doi:10.1177/1362361307089517

Piper, E. and Howlin, P. (1992). Assessing and diagnosing developmental disorders that are not evident at birth: parental evaluations of intake procedures. *Child: Care, Health and Development, 18*, 35-55. doi:10.1111/j.1365-2214.1992.tb00339.x

Reed, P., & Osborne, L.A. (2012). Diagnostic practice and its impacts on parental health and child behaviour problems in autism spectrum disorders. *Archives of Disease in Childhood, 97*, 927-931. doi:10.1136/archdischild-2012-301761

Renty, J., & Roeyers, H. (2005). Satisfaction with formal support and education for children with autism spectrum disorder: the voices of the parents. *Child: Care, Health & Development, 32*, 371-385. doi: 10.1111/j.1365-2214.2006.00584.x

Sabatino, D. A., Vance, H. B., & Fuller, G. (2001). Pervasive Developmental Disorders. In H. B. Vance & A. Pumariega (Eds.), *Clinical Assessment of Child & Adolescent Behavior* (pp. 188-230). New York: John Wiley and Sons.

Sansosti, F.J., Lavik, K.B., & Sansosti, J.M. (2012). Family experiences through the autism diagnostic process. *Focus on Autism and Other Developmental Disabilities*, *27*, 81-92. doi:10.1177/1088357612446860

Schall, C. (2000). Family perspectives on raising a child with autism. *Journal of Child and Family Studies, 9*, 409-423. doi:10.1023/A:1009456825063

Siklos, S., & Kerns, K.A. (2007). Assessing the diagnostic experiences of a small sample of parents of children with autism spectrum disorders. *Research in Developmental Disabilities, 28*, 9-22. doi:10.1016/j.ridd.2005.09.003

Smith, B., Chung, M. C., & Vostanis, P. (1994). The path to care in autism: is it better now? *Journal of Autism and Developmental Disorders, 24*, 551-563. doi:10.1007/BF02172137

Spencer, L., Ritchie, J., Lewis, J., and Dillon, L. (2003). *A Framework for Assessing Research Evidence.* London: Crown.

Watson, S.L., Hayes, S.A., & Radford-Paz, E. (2011). “Diagnose me please!” A review of research about the journey and initial impact of parents seeking a diagnosis of developmental disability for their child. In R. Hodapp (Ed.), *International Review of Research in Developmental Disabilities* (Vol. 41, pp. 31-72). London: Academic Press.

Whitaker, P. (2002). Supporting families of preschool children with autism: what parents want and what helps. *Autism*, *6*, 411-426. doi:10.1177/1362361302006004007

White,S.P., Weitlauf, A.S., and Warren (2012). Early diagnosis of autism spectrum disorder: progress, challenges, and remaining questions for families and professionals. *International Review of Research in Developmental Disabilities, 43*, 47-84. doi:10.1016/B978-0-12-398261-2.00002-7

World Health Organization. (1992). *International classification of diseases: Diagnostic criteria for research* (10th edition). Geneva, Switzerland: Author.

Yazbak, K. (2002). The new autism: one family’s perspective. *Clinical Child Psychology and Psychiatry, 7*, 505-517. doi:10.1177/1359104502007004003

Section 2: Research Report

Investigating the Behavioural Heterogeneity in Autism Spectrum Disorder

Abstract

Objectives

This study aimed to explore how social and communicative behaviours cluster with intellectual functioning in autism spectrum disorders (ASD), and the emergent clusters' properties in terms of presentations, symptom severity, alpha frontal power, and health. The relationship between the clusters and the social subtypes proposed by Wing & Gould (1979) was also explored.

Design

This exploratory study employed descriptive statistical analysis and cluster analysis. The sample included a total of 42 participants (25 ASD, 17 typically developing).

Methods

Participants completed the Autism Diagnostic Observation Schedule (ADOS), Wing Subgrouping Questionnaire, Social Communication Questionnaire, British Ability Scales, an Electroencephalograph (EEG) and developmental and health questionnaires.

Results

Three clusters emerged; one with average intelligence and good communication and social interaction skills, a higher-functioning ASD group with low-average intelligence and impaired social but intact communication skills, and a low-functioning ASD group with global impairment. As the level of impairment increased co-morbid developmental and physical health difficulties increased.

The Wing subgroups strongly correlated with the severity of autism symptoms but had little association with the ADOS once cognitive ability was controlled for.

There were no relationships with alpha frontal power, thus this would not be a suitable biomarker for ASD.

Conclusions

There is evidence of subgroups within ASD which are strongly influenced by cognitive ability, which also lie on a continuum of behavioural presentations. These clusters are not related to alpha frontal power, but have some association with the Wing subtypes which in turn are strongly correlated with severity of autism.

Practitioner Points

Clinical implications

- This lends support to the conceptualisation and diagnosis of ASD as a unitary concept as in the new DSM-V with interactions between behavioural presentations and cognitive ability;
- Future research exploring the underpinnings of and treatment for ASD should consider the interaction between cognitive ability and the behavioural symptoms;

Limitations

- The small sample size and incompleteness of data due to non-return from parents means that results should be interpreted with caution;
- The study included a self-selecting sample further limiting the generalisability to the population of people with ASD.

Prior to the recent publication of the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013), autism was categorised under the term pervasive neurodevelopmental disorders along with atypical autism, Asperger's disorder,

childhood disintegrative disorder, pervasive developmental disorder-not otherwise specified (PDD-NOS) and Rett's disorder (*Diagnostic and Statistical Manual of Mental Disorders, Fourth Ed. Text Rev.;* American Psychiatric Association, 1994). There has been long-standing debate around whether the separate diagnoses were valid, or whether it is more appropriate to consider a continuum of symptoms within a single condition. Further, there was evidence to suggest that these diagnostic labels were not being used with consistency across clinical settings (e.g. Lord et al, 2012). With the exception of Rett's disorder, following the introduction of the fifth edition of the DSM, these labels are now captured under the term autism spectrum disorders (ASD) which are considered to range in severity across a continuum. In order to be diagnosed with an ASD, a person must demonstrate impairments in social communication and interaction in a range of contexts, and restricted and repetitive patterns of behaviour, interests or activities. Additionally, these difficulties must manifest themselves in early childhood, although diagnoses may be made later, and must limit everyday functioning.

It is widely acknowledged that there is great heterogeneity in the clinical presentations of ASD (Beglinger & Smith, 2001; Castelloe & Dawson, 1993; Geschwind & Levitt, 2007; Lenne and Waldby, 2011). This is over and above variation accounted for by intellectual functioning, language ability or behavioural, communication and social disabilities (Jones & Klin, 2009). The heterogeneity in all aspects of ASD from the genetic basis (e.g. Betancur, 2011), through to the neurological (e.g. Toal et al, 2009), cognitive, and behavioural factors makes research into a cause or any aetiological basis very challenging, and thus limits available interventions (e.g. Jones & Klin, 2009; Sherer & Schreibman, 2005). At this time there is no cure for ASD. Existing

treatments are not equally effective for all children with ASD, and further exploration of the variables that impact on treatment success need to be explored, including the child's behavioural profile (Stahmer, Schreibman, & Cunningham, 2011). Further, there are no known biological markers or physiological tests to confirm the presence of ASD (Lenne and Waldby, 2011).

The diagnosis of ASD is not being used with precision by professionals due to the heterogeneity in clinical presentations (Sabatino, Vance, & Fuller, 2001). Partly, this is due to significant difficulty differentiating ASD from other developmental disorders, and the lack of specificity in the existing diagnostic criteria (Beglinger & Smith, 2001). The impact of this is that parents may have their concerns dismissed, they may be offered reassurance about their child's development, or their child may be misdiagnosed (Avdi, Griffin, & Brough, 2000; Brookman-Frazee, Baker-Ericzén, Stadnick, and Taylor, 2012; Chamak, Bonniau, Oudaya, & Ehrenberg, 2010; Howlin & Moore, 1997; Hutton & Caron, 2005; Jegatheesan, Fowler, & Miller, 2010; Keenan, Dillenburger, Doherty, Byrne, & Gallagher, 2010; Midence & O'Neill, 1999; Moh & Magiati, 2012; Mouzourou, Santos, & Gaffney, 2011; Mulligan, MacCulloch, Good, & Nicholas, 2012; Sansosti, Lavik, & Sansosti, 2012; Schall, 2000; Smith, Chung, & Vostanis, 1994; Yazbak, 2002). This leads to parents' dissatisfaction with the diagnostic process for ASD (e.g. Howlin & Moore, 1997; Midence & O'Neill, 1999), and can also cause delays in accessing interventions and support and educational services (Minnes & Steiner, 2009; Renty & Roeyers, 2005). This is particularly concerning as the early timing of intervention for ASD has been shown to have an impact on the effectiveness of the intervention and the long-term prognosis (Reed & Osborne, 2012).

Wing and Gould (1979) explored the heterogeneity in the behavioural presentations of 132 children with either impaired social interaction, impaired language skills, or highly repetitive behaviour and low intellectual functioning. The inclusion criteria did not specify the presence of ASD. They proposed that children can be divided into four behavioural groups: socially appropriate, passive, active but odd, and aloof. Children in the 'social aloofness' category demonstrated severe impairments in social interaction and were indifferent in social situations. Children that demonstrated 'passive interaction' accepted social approaches and did not resist the demands of other children but did not initiate any social contact. Those classified as 'active, but odd' did initiate social interaction but often did this in inappropriate, idiosyncratic ways, and did not adapt their behaviour to others once in a social context. Finally, those that demonstrated 'appropriate interaction' enjoyed social contact, paid attention to others, and appropriately anticipated others' behaviour. This method of classification showed greater associations with behavioural, psychological and medical variables than a straightforward diagnostic cut-off for the presence or absence of autism. However, there was also an association between lower intellectual functioning and increased social impairment.

Many studies have expanded on the Wing and Gould (1979) proposal, applying it more specifically to people with ASD, and using cluster analysis to identify subgroups. These have suggested that there are subgroups based on social and communicative behaviour in people with ASD with both high and low intellectual functioning, but that intellectual functioning does plays a key role in identifying clusters (Eaves, Ho, & Eaves, 1994; Prior et al., 1998; Stevens et al., 2000; Beglinger & Smith, 2001). For example, aloofness appears to be more common in the presence of low intellectual functioning, whereas active-but-odd

presentations may be found in people with higher-functioning autism or Asperger's syndrome (Beglinger & Smith, 2001).

However, the findings of these studies have been inconsistent. Some results have suggested close proximity to the diagnostic categories of autism, Asperger's syndrome, and PDD-NOS (Prior et al., 1998). Others have found an interaction between the social and communicative behaviours associated with ASD and intellectual functioning, identifying groups with major impairments in one area and relatively preserved abilities in the other (Eaves et al., 1994; Stevens et al., 2000). This is consistent with the idea that people with ASD can have 'islets of ability' where their ability on specific tasks exceeds their performance in most areas (Smith, Cowie, & Blades, 2003). Certainly, there is evidence that there is a huge variability in the severity of both the symptoms in the triad of impairments and levels of intellectual functioning within the diagnosis of ASD (Filipek et al, 1999). There is a need to continue the exploration of how the different features of ASD cluster together, and why (Rutter, 2005).

One limitation of existing studies has been the inconsistency in the measures used, both between and within studies. In some studies, this has been due to the retrospective use of clinical data in which various diagnostic measures and measures of intellectual functioning and specific cognitive abilities have been used. The measurement of intellectual functioning has been particularly challenging due to the inclusion of non-verbal participants, and some studies have included up to four different measures of intelligence to try to overcome this (e.g. Eaves et al., 1994; Lam, Bodfish, & Piven, 2008). Furthermore, since many of the studies were published a clear set of 'gold standard' clinical measures have been developed that should be employed for

research purposes to explore ASD symptomology and to validate existing clinical diagnoses.

On a neurological level, researchers have explored brain activity in people with ASD using electroencephalography (EEG). In the past, these studies have indicated a number of differences in brain activity including abnormal frontal activity (Coben, Clarke, Hudspeth, & Barry, 2008).There is some evidence that people with ASD demonstrate reduced alpha power in the frontal area of the brain in comparison with age-matched typically-developing controls and age-matched participants with learning disabilities (Cantor, Thatcher, Hrybyk, & Kaye, 1986; Dawson, Klinger, Panagiotides, Lewy, & Castelloe, 1995) . Dawson et al (1995) also explored the relationship between EEG alpha power and behavioural subgroups using subgroups developed by Wing and Gould (1979). They found that different patterns of brain activity were associated with the different behavioural groups, in that children who fell into the passive category had the lowest alpha power in the frontal region, which was significantly different from the active-but-odd group. Alpha power is associated with arousal levels during information processing. The authors hypothesised that their finding that the lowest alpha power was associated with the greatest social impairments supported a link between the social difficulties present in autism and frontal lobe dysfunction, and specifically impaired social processing. There is a clear need for further neuroscientific research to understand the neurological basis of ASD to aid earlier diagnosis and to guide intervention (Bristol-Power and Spinella, 1999).

Behavioural interventions are currently the predominant treatment approach for people with ASD (Hetherington, Parke, Gauvain, & Locke, 2006; Sabatino et. al, 2001). Therefore, it seems imperative to understand behavioural

subtypes within ASD by integrating the existing literature, and considering the relationship between behavioural presentation and neurological factors whilst simultaneously accounting for the effects of age and intellectual functioning.

The current literature is inconsistent, and there is a clear need to integrate the knowledge surrounding the heterogeneity of ASD on a cognitive, behavioural and physiological level. This project will be an exploratory first-step towards a more coherent model. The study will further develop the theoretical base surrounding the heterogeneity of ASD, contributing towards improved assessment, further understanding and exploration of its causes, and the development of more appropriate interventions.

This is an exploratory study that aims to further develop the evidence surrounding the heterogeneity within ASD, and to consider whether subtypes exist within the spectrum. This will build on existing literature by integrating intellectual ability, behavioural presentations and brain activity. Specifically, this will integrate EEG alpha-band power in the frontal region of the brain, social behaviour, communicative behaviour, and intellectual functioning.

This project is linked to two additional research projects exploring the cognitive heterogeneity within ASD, and exploring the neurophysiological heterogeneity in ASD (Appendix C).

The aims of the project are:

1. Explore how social and communicative behavioural presentations cluster with intellectual functioning to form subgroups of autism.
2. Explore the properties of the emergent subgroups.
3. Explore whether the emergent subgroups relate to the existing model proposed by Wing & Gould (1979) including the subgroups of social aloofness, active-but-odd interaction, passive interaction, and appropriate

interaction, and explore the relationships with alpha power in the frontal region and symptom severity.

Method

Participants

Recruitment. Opportunity sampling was employed to recruit as many participants with ASD as possible due to the low base-rate of autism spectrum disorders in the general population. The aim was to recruit a sample in which one quarter were typically developing (TD) children, and one quarter were children with an ASD. This was due to the theory that ASD falls along a continuum (e.g. Constantino & Todd, 2003) with some of the symptoms present in a non-clinical population, and varying degrees of severity within each of the diagnostic categories (e.g. Baron-Cohen, Wheelwright, Skinner, Martin & Clubley, 2001; Beglinger & Smith, 2001), therefore it would be useful to enter TD children into a cluster analysis to see how their characteristics related to children with ASD. However, due to the difficulty in recruiting the clinical sample, TD children represented 40% of the final sample.

A small pilot including ten children carried out prior to the development of this project indicated that it was not feasible for children with the most severe intellectual difficulties to reliably complete the cognitive test employed, partly due to their difficulties in understanding and attending to the tasks. Therefore, sites with a specialist learning disability focus were not contacted for recruitment. The recruitment sites included:

1. Child and Adolescent Mental Health Service A; 40 letters were sent to parents of children with ASD, and seven children participated (17.5%);
2. Mainstream secondary school; 21 letters were sent out (seven to parents of children with ASD), and 14 young people participated (66.7%);

3. After school club (attached to mainstream primary school); 40 letters were sent out, and seven children participated (17.5%);
4. Specialist primary and secondary school for children with autism; 40 letters sent to parents, and eight young people participated (20%);
5. Child and Adolescent Mental Health Service B; 40 letters sent to parents and one participated (2.5%);
6. Personal and professional contacts; five young people recruited.

Two groups of participants were recruited: children with ASD and TD children. Letters and information sheets (Appendices D to F) were sent out by the schools and services to parents of children known to have a diagnosis of ASD, with adapted versions sent to reflect which kind of service they were being sent from (i.e. school or CAMHS). This included diagnoses of autism, ASD, Asperger's Syndrome, atypical autism, and pervasive developmental disorder-not otherwise specified (PDD-NOS). For the children contacted through CAMHS, parents were asked to return a reply slip to the research team registering their child's interest in taking part. They were then contacted to book a testing session at the University of Sheffield, or at their local CAMHS service according to their preference and availability of space within the service. The young people recruited through schools were given the option of attending testing sessions at school during school hours. Therefore their parents were posted consent forms (Appendix G) to return to the research team as they would not be present at these sessions.

Young people over 16 years were required to give their own consent. Adapted information sheets (Appendix H) were sent directly from the schools and CAMHS to these young people, who were asked to return a reply slip and to sign a consent form (Appendix I) on attendance to a testing session. These

young people were asked to provide consent for the team to contact their parents to complete the questionnaires outlined below. In addition, during school testing sessions any young people aged 16 that expressed interest in the project while the research team were present were given the opportunity to participate.

TD children were recruited from schools and through personal contacts to match age and gender more appropriately. This followed the same procedure as for the children with ASD recruited through schools, with modification to the documentation sent out.

The following inclusion criteria were applied:

1. Participants were required to be between five years and seventeen years and eleven months of age. It was felt that children under five years old would not be able to concentrate and sit still for the required length of time, and alpha power in adults is not comparable to that in children due to maturational effects (e.g. Daoust, Limoges, Bolduc, Mottron, & Godbout, 2004). Further, the British Ability Scales cannot be used over the age of 17years 11 months;
2. All participants required some expressive language;
3. Participants in the ASD group required an existing clinical diagnosis.

Additionally, parents were encouraged to consider their child's ability to remain in test conditions for a prolonged period of time. They were asked to consider whether their child would be comfortable with having the electroencephalograph (EEG) equipment on their head, and being touched on the head and face by the researchers during set-up, and whether they would be able to remain still enough to provide a complete set of data during the EEG test. However, those who were unable to complete the EEG component for this

reason were still able to contribute behavioural and cognitive data if they had attended for a testing session. People with a history of seizures were excluded from the EEG component of the study due to the minor risk presented through the use of flickering stimuli.

Sample size and power. At the time of writing there was no method or rule of thumb that related specifically to sample sizes in cluster analysis. However, it was important to include sufficient participants so that the clusters would include groups rather than individuals. There is a rule of thumb for a similar analysis, exploratory factor analysis, which proposes 10 to15 participants per variable (Field, 2009). Previous studies in the field of ASD research that have employed cluster analysis have used ratios from 3.86 subjects per variable (Eaves et al., 1994) to 6.63 subjects per variable (Bitsika, Sharpley, & Orapeleng, 2008).

Sample. The sample included 25 children with an ASD, and 17 TD children. Within the ASD group nine participants had a diagnosis of autism, six had a diagnosis of Asperger's syndrome, and seven had a diagnosis of ASD. Of these, 15 reported that they had their diagnoses made at a Child and Adolescent Mental Health Service, and one at a Child Development Centre; two reported paediatric involvement, and two reported that their diagnosis had been made by a doctor but did not specify the setting. Seven did not disclose who made their diagnosis. The mean age at diagnosis for the participants with ASD was 6.59 (*SD*=2.88), however this information was only provided for 17 of the 25 participants with ASD. Three parents did not return details of their child's diagnosis. The gender and average age of the TD group were matched to the ASD group in order to reduce the bias introduced by the association between gender or chronological age and emergent traits associated with ASD (DSM-IV,

1994; Prior et al., 1998). The demographics of the two groups are shown in Table 1 below.

Table 1

Demographics of the TD and ASD groups

Group	*n*	Age in Years			Male Gender		Non-ASD Developmental Disorder	Any Medical Diagnosis
		M	*SD*	Range	*n*	%		
TD	17	12.42	2.23	9.75-17.08	16	94.1	0 (1 missing)	1 (1 missing)
ASD	25	13.02	3.52	5.25-17.83	23	92.0	13 (7 missing)	10 (4 missing)
Total	42	12.78	3.03	5.25-17.83	39	92.9	13 (8 missing)	11 (5 missing)

Parents completed the Social Communication Questionnaire Lifetime Version (SCQ; Appendix J; Rutter, Bailey, & Lord, 2003) to validate existing ASD diagnoses. The SCQ was developed from the short screening form, originally known as the Autism Screening Questionnaire (ASQ; Berument, Rutter, Lord, Pickles, & Bailey, 1999) which was a shorter version of the Autism Diagnostic Interview-Revised (Lord, Rutter, & Le Couteur, 1994). The ADI-R is an interview carried out with parents or caregivers of people with autism. It was designed to differentiate autism and pervasive developmental disorders from learning disabilities and other disorders (Sabatino et al., 2001). The ADI-R has good inter-rater reliability (Sabatino et al., 2001), and the SCQ is strongly correlated with the ADI-R (Charman et al., 2007). Further, research indicates that the SCQ discriminates well between groups with and without ASD (Chandler et al., 2007). The results of this questionnaire indicated that 100% of those whose parents returned the SCQ in the ASD group scored over the threshold of 15 on the SCQ, indicating a presence of ASD (nine parents did not

return the SCQ). In the TD group, 100% of those whose parents returned the questionnaire scored below the threshold, indicating that they did not have an ASD (four parents did not return the SCQ).

Procedure

This was an exploratory study employing cluster analysis and descriptive analyses to explore the heterogeneity of ASD with a focus on the behavioural presentation. The data collected were used for this and the two related projects outlined in Appendix C.

Measures. Exemplar copies of all measures are included in Appendix J. Table 2 below summarises the relationship between the aims, the variables of interest, and the tests used.

Table 2

Use of Measures to Extract the Variables

Aim	Variable(s)	Test(s) used
Aim 1. Explore how social and communicative behavioural presentations cluster with intellectual functioning to form subgroups of autism.	Social behaviour	ADOS Social Interaction subscale total
	Communication behaviour	ADOS Communication subscale averaged-total
	Intellectual functioning	The GCA from the BAS-II
Aim 2. Explore the properties of the emergent subgroups.	Various demographic variables, e.g. language development, linguistic and non-linguistic regression, diagnoses and co-morbid diagnoses.	Brief Medical History Questionnaire Developmental History Questionnaire
	Frontal brain activity	Alpha band frontal power from the EEG recording
	Intellectual functioning	As above
	Communication behaviour	As above
	Social behaviour	As above
	Repetitive behaviour	ADOS repetitive behaviour average score
	Autism severity	SCQ total score
	Wing subgroup	Categorical variable from Wing Subgrouping Questionnaire
Aim 3. Explore whether the emergent subgroups relate to the existing model proposed by Wing and Gould (1979) including the subgroups of social aloofness, active-but-odd interaction, passive interaction, and appropriate interaction, and explore the relationships with alpha power in the frontal region and symptom severity.	Clusters extracted from Aim 1.	As above
	Wing Subgroups	Wing Subgrouping Questionnaire
	Frontal brain activity	As above
	Intellectual functioning	As above
	Communication behaviour	As above
	Social behaviour	As above
	Autism severity	As above

Medical and history questionnaires. Demographics were collected using two questionnaires developed by the research team. These included the Brief Medical History Questionnaire and the Developmental History Questionnaire. The Brief Medical History Questionnaire gathers information surrounding birth, ASD diagnosis, co-morbid psychiatric diagnoses, medical conditions, and family history of mental health conditions. The Developmental History Questionnaire gathers information surrounding social and communicative indicators of autism, age of onset and current language delay. All of these factors have been included in previous studies exploring the behavioural subgroups within ASD (e.g. Prior et al., 1998).

The Autism Diagnostic Observation Schedule. The Autism Diagnostic Observation Schedule (ADOS; Lord, Rutter, DiLavore, & Risi, 1999) is a standardised assessment of the diagnostic components of autism: social interaction, communication, and repetitive behaviours and imaginative play. It comprises four modules tailored to participants with varying language ability ranging from pre-verbal or single word use (module one), to phrase speech (module two), to fluent speech at a child or adolescent level (module three) and up to fluent speech at an adolescent or adult level (module four). It is not suitable for totally nonverbal participants. Participants are required to complete only the module that is best suited to their expressive language level and level of maturity. Module four relies primarily on interview questions and conversation to gather data whereas the previous modules rely more on observation. Each module is comprised of eight tasks, and takes 30 to 45 minutes to administer. The modules are made up of ‘presses’ which are situations set up to mimic social occasions designed to elicit an expected social behaviour. These provide

a standard context in which a rater can observe the participant's behaviour. Scoring algorithms for the social and communicative components enable autism and autism spectrum cut off scores. Each module has seven social interaction items with a maximum score of two on each item, and an overall maximum score of 14. The modules have either four or five communication items. Therefore in order to make scores comparable for this research a mean communication score was calculated, providing a maximum score of two. In addition, each module has a repetitive behaviour or interest component which is not included in the diagnostic scoring algorithm. Again, the number of items contributing to this score varied between modules, with either three or four items, therefore an average score was calculated with a maximum score of two. On all three subscales high scores were indicative of a greater impairment.

The inter-rater reliability of the ADOS is adequate (Sabatino et al., 2001), and for each module the statistic ranges from 80% to 91.5% agreement between raters (Lord et al., 1999). The test-retest reliability statistics for the two subscales included in this analysis are .78 and .73. Item-total correlations between the individual items and their total domain scores range from .62 to .88 in the communication domain and .52 to .90 in the social interaction domain (Lord et al., 1999).

British Ability Scales-II. The British Ability Scales Second Edition (BAS-II; Elliott, P. Smith, & McCulloch, 1996) are designed to allow assessment of cognitive abilities in children with a wide range of intellectual ability, including children who have developmental delays. It is made up of an Early Years Battery for use with pre-school children under six years old, and a School Age Battery for use with children aged seven to seventeen years. Only the School Age battery was employed as the youngest participant that was able to

complete the BAS-II was seven years old. There are six core cognitive subtests that provide the General Conceptual Ability score (GCA), used in the analysis for this study. These include word definitions, verbal similarities, matrices, quantitative reasoning, recall of designs, and pattern construction. The GCA is a standardised score (*M*=100, *SD*=15).

The BAS-II has very good psychometric properties. The test-retest reliability in the school-age battery ranges from .77 to .96. The internal consistency of the GCA is .96 for the school-age battery. High correlations (.76-.79) between the BAS-II and other measures of intellectual ability in children indicate good concurrent validity.

Wing Subgrouping Questionnaire. The Wing Subgrouping Questionnaire (WSQ; Castelloe & Dawson, 1993) is a parent-rated assessment designed to classify children with autism into the four subgroups proposed by Wing and Gould (1979). Parents rate the series of descriptions with regards to how frequently their child displays the behaviour, and indicate which description best describes their child. It consists of thirteen groups of four descriptions of behaviour including three groups related to self- and other-initiated social approaches; three groups related to communication skills; three groups related to imitation and play; and four groups related to idiosyncratic or challenging behaviours and co-ordination. The four descriptions relate to the four subgroups proposed by Wing and Gould: aloof, passive, active-but-odd, and socially appropriate/normal. A score is produced for each of the four subscales (range 0-78), and the child is assigned to the subgroup on which they score the highest total score. Therefore the variables produced for each participant by this questionnaire included a total score for each subgroup (continuous variables) and allocation to one subgroup (categorical variable). A validation study carried

out by Castelloe and Dawson (1993) demonstrated good concordance between the parents' ratings on the WSQ and clinicians' assignments of children to the subgroups based on observations. Chronbach's alpha for the individual subscales ranged from .63 to .85. In terms of inter-rater reliability, O'Brien (1996) reported 63% concurrence between raters' subgroup classification, ranging from .60 to .81 in terms of individual subscale ratings.

The WSQ has a Flesch reading ease score of 49.2 (on a scale of 0-100). This requires an adult level of reading, although it is well below a score that would be suitable for a graduate level (60-70). Whilst it was predicted that most parents would find this manageable, the researchers made it clear that the parents could ask for clarification of the wording or could complete the questionnaire over the telephone with the support of a researcher if they preferred. This was preferable to making changes to the wording, which would affect the validity of the questionnaire, and would make comparisons with previous research less reliable. Parent feedback from the pilot study indicated that parents found the wording manageable. The only complaint raised was that the questionnaire was repetitive.

Electroencephalogram (EEG). The EEG variable of interest for the purpose of this study was the absolute alpha-band power (7.5 to 12.5 Hz) in the frontal region of the brain. EEG was recorded continuously at a sampling rate of 2048Hz using the Biosemi Active II system (Honsbeek, Kuiper, & van Rijn, n.d.). In order to elicit alpha-band frequency activity, participants were required to watch a computer screen on which a series of flickering stimuli appeared and disappeared. One hundred x four trials (total 400 trials) were presented while participants maintained fixation on the screen. A short cartoon was presented in between blocks of trials in order to maintain participants' attention, and to offer a

visual reward. This paradigm ran for five minutes plus breaks. The set-up of the EEG equipment took approximately 20 minutes. Participants were required to sit in a chair while the researchers measured their head circumference, placed a suitably-sized cap on their head, and fitted the 128 individual scalp electrodes. Six electrodes were placed above and below both of the participants' eyes and at the temples in order to record eye movements.

Data collection. Data collection included four components: the administration of the ADOS; the administration of the BAS-II; the EEG recording; and the completion of the WSQ, SCQ, Developmental History Questionnaire, and Brief Medical History Questionnaire by parents.

The four components of data collection could be carried out in multiple sessions according to the needs of the child. Where parents attended with their child, they were asked to complete the questionnaires during the session. If the parent was not present the questionnaires were sent by post and parents were required to return them by post.

Planned Analysis

Aim 1: Explore how social and communicative behavioural presentations cluster with intellectual functioning to form subgroups of autism. A cluster analysis was performed using Ward's method (Everitt, Landau, & Leese, 2001) including the following variables:

1. Social behaviour: the ADOS Social Interaction subscale total;
2. Communication behaviour: the ADOS Communication subscale averaged-total;
3. Intellectual functioning: the GCA taken from the BAS-II;

For this analysis the social behaviour and communication behaviours scores from the ADOS were converted into z-scores.

The specific method of cluster analysis used was Ward's method of hierarchical clustering. This method is robust to outliers in the data, and does not lead to an unhelpful number of clusters whilst preserving a sufficient degree of similarity within clusters so as to make them clinically interesting (Everitt et al., 2001).

Aim 2: Explore the properties of the emergent subgroups. This was a descriptive component of the study and included exploration of the spread of the demographics, alpha frontal power, and stereotyped behaviours across the emergent subgroups. Descriptive statistics such as means, standard deviations and frequencies were employed as well as graphical representations of the data.

In order to extract the frontal brain activity value, the EEG data were analysed using EEGLab (Delorme & Makeig, 2004) and Matlab. After recording, EEG data were high-pass filtered (>1Hz) to remove drift, and divided into 2056 ms epochs. Any epoch containing visibly noisy signal, i.e. generated by participant movement or blinking was removed. The remaining epochs were transformed into the frequency domain using fast Fourier transform. Alpha power was calculated as the mean power across all epochs within the alpha frequency band, i.e. 8 – 13 Hz. Alpha power was computed from electrodes F3 and F4 which are positioned over the left and right frontal cortices respectively.

Aim 3: Explore whether the emergent subgroups relate to the existing model proposed by Wing and Gould (1979) including the subgroups of social aloofness, active-but-odd interaction, passive interaction, and appropriate interaction, and explore the relationships with alpha power in the frontal region and symptom severity. The clusters produced in Aim 1 were compared with the Wing and Gould (1979) subgroups of autism. Prior to obtaining the clusters, it was impossible to predict how even the group sizes would be in terms of both the newly-developed subgroups and the WSQ subgroups. Therefore it was planned that one of two methods would be used to explore this aim: for fairly even numbers of participants in each of the WSQ subgroups and in each of the newly-developed clusters, a chi-squared analysis would be used to explore the relationships between the two sets of groups. This would only be feasible if the assumptions of a chi-squared analysis were met; if the groups were uneven or the assumptions of chi-squared were not met, then descriptive methods would be used, e.g. exploring the mean subscale scores on the WSQ in each of the newly-developed subgroups, or exploring the frequency of each WSQ subtype in each of the new subgroups.

Associations with alpha power in the frontal brain regions, repetitive behaviour, and symptom severity were explored using correlational analyses.

Quality Control, Reliability and Validity

There were a minimum of two researchers present at each session to increase the efficiency of data collection so that participants were less fatigued.

The behavioural components and intellectual functioning were measured using manualised and standardised assessments. The British Ability Scales (BAS-II) were administered by one of two Trainee Clinical Psychologists (JG or HJ) or a supervisor (MF), all of whom were trained by the academic supervisor

(EM) in the administration of the BAS-II, and had previous experience of administering psychometric tests. The investigator (JG) and collaborator (HJ) were trained by the academic supervisor (EM) in the administration of the ADOS. Administration of the ADOS requires training from a person who has completed the full course of training and validation for clinical and research purposes, and the academic supervisor met these requirements. The administration of the ADOS was video recorded and a proportion of these (*n*=4, 11%) were marked alongside a supervisor (MF) and another proportion (*n*=3, 7%) were second-marked by the academic supervisor (EM) in order to enhance the validity of the ratings.

To support the findings of the ADOS, the SCQ was administered to parents. This questionnaire is designed to be administered alongside the ADOS and adds weight to any diagnostic conclusions.

All EEGs were conducted by one researcher (LM) along with an additional member of the team that could offer support in setting up the equipment in a timely fashion. This was to ensure good quality recordings as this researcher had the appropriate training. Interference was minimized through procedures outlined above including controlling for eye movements and absence of water or products in the hair.

Ethical Implications

Approval from National Autistic Society was sought via one of their schools in order to be able to recruit from their site, and in line with good research practice when exploring ASD. National Health Service (NHS) ethical approval was sought for all trusts and sites included in the project (Appendix K), which included North Lincolnshire Child and Adolescent Mental Health Service (in the Rotherham, Doncaster and South Humber NHS Foundation Trust), and

Sheffield Child and Adolescent Mental Health Service (in Sheffield Children's NHS Foundation Trust).

For the protection of the participants, all researchers had CRB checks for the purpose of working with children. The research team had no access to the personal details of anyone until they registered their interest in the project directly. Parents were required to give consent for all children under 16 years, and were asked to attend the testing sessions with them if this was to be conducted outside of school. This included consent for their child to be video recorded whilst completing the ADOS.

Parents were asked to consider the areas that may cause their child distress in the information sheets, such as the length of the testing sessions, and the touch involved in setting up the EEG and in wearing the EEG cap. Participants were reminded that they were free to withdraw at any point, and some young people chose to exercise this right during the EEG component. Further, if a child appeared distressed during testing, the researchers or parent were able to make the decision to discontinue testing on their behalf.

It was made clear in the parent information sheet that the researchers were not able to provide a diagnosis of ASD in order to discourage parents that may have been concerned that their child had an undiagnosed ASD from volunteering for this purpose. Parents were encouraged to consult with their General Practitioner if they had concerns of this nature.

No adverse events took place during testing.

Results

Aim 1: Explore how Social and Communicative Behavioural Presentations Cluster with Intellectual Functioning to Form Subgroups of Autism

Thirty-six participants had complete data for the three variables entered into the cluster analysis. Twenty-two of these were children with ASD (60%), and 16 (73%) of these had a completed SCQ indicating that they met the threshold for ASD. Of the 14 TD participants included, 12 (86%) had completed SCQs indicating that they did not meet the threshold for ASD. In both groups the parents of the remaining participants had not returned their SCQ, therefore the presence or absence of ASD was based on self-reported diagnoses and could not be confirmed. This meant 12 participants to each variable, which is within the recommended number to provide a good level of power (Field, 2009), and is excellent in comparison with the existing literature in the field of ASD outlined above. Of the six excluded participants (three ASD and three TD), one did not complete the ADOS (TD) and all six did not complete the BAS-II. For a comparison of those included in the cluster analysis with those excluded due to a lack of data see Appendix L.

Ward's method of hierarchical clustering produced three main clusters, as highlighted on the dendrogram in Figure 1. Cluster A included 17 participants (six ASD); Cluster B included nine participants (seven ASD); and Cluster C included 10 participants (nine ASD). Due to the non-normal distribution of the variables in the cluster analysis, the nonparametric Kruskal-Wallis test was used to explore differences between the clusters. These tests indicated that there were significant differences in cognitive ability ($H(2)=30.08$, $p<.001$), communication difficulties ($H(2)=12.35$, $p=.002$), and social interaction difficulties ($H(2)=8.43$, $p=.015$).

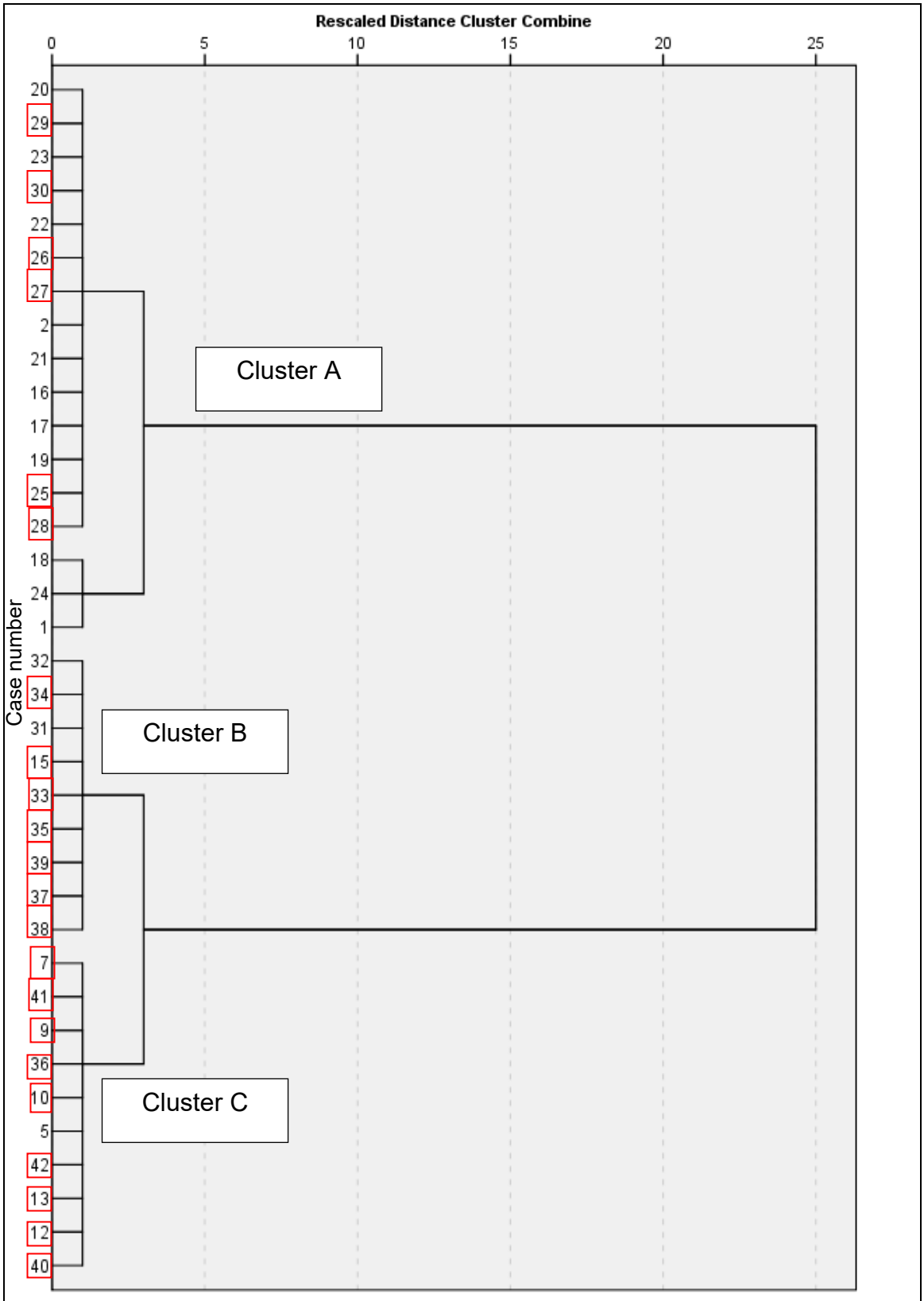


Figure 1. Dendrogram produced by Ward's cluster analysis. Children with ASD highlighted in red.

Due to the small sample size, further statistical tests were not carried out; however Table 3 shows the mean scores on the variables for each cluster, and their scores on the SCQ. Figures 2 and 3 indicate the proportion of participants in each group that met the autism and ASD cut-off points on the ADOS communication and social interaction subscales.

Cluster A were the least impaired group: their mean cognitive ability score fell in the range of high-average intelligence, and most participants within the cluster did not meet diagnostic thresholds on the social interaction or communication subscales. Their average score on the SCQ was well below the diagnostic threshold, although the range was very broad. Cluster C were the most impaired, with extremely low average cognitive ability, and highly impaired social interaction and communication skills. This cluster had the greatest proportion of participants that scored in the autism diagnostic category on both the social interaction and communication subscales. This was supported by their high scores on the SCQ. Cluster B fell between the two groups, with low average intelligence, and impaired social interaction skills, but intact communication skills. This group also scored above the diagnostic threshold on the SCQ on average.

Interestingly, a proportion of Cluster A still scored above the diagnostic thresholds on both the communication (29.4%) and social interaction (23.6%) subscales, and within the communication subscale only those in Cluster A fell into the ASD category.

Table 3

Properties of the clusters. Means and Standard Deviations for GCA scores, ADOS Communication and Social Interaction Scores

Cluster	*n*	GCA		ADOS Average Communication Score[a]		ADOS Social Interaction Score[b]		SCQ Score[c]		
		M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	Range
A	17	118.65	11.55	0.24	0.39	2.06	2.33	6.85	11.04	0-30
B	10	87.33	4.90	0.53	0.43	5.44	4.45	22.38	12.91	3-37
C	9	69.60	8.30	0.93	0.44	5.90	3.60	28.83	6.65	0-38

[a] Maximum score 2;
[b] Maximum score 14.
[c] Scores over 15 meet diagnostic threshold.

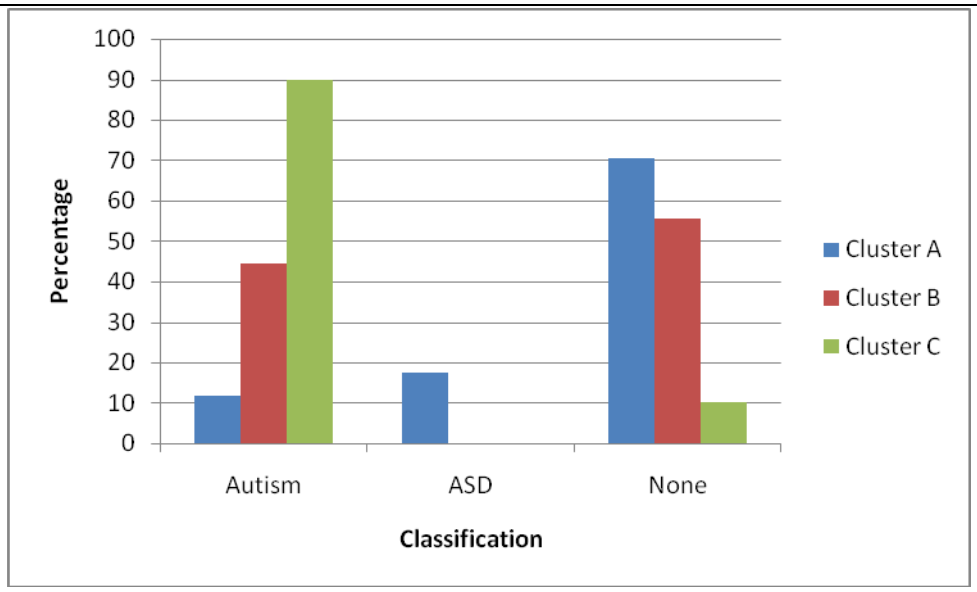


Figure 2. Percentage of diagnostic thresholds met on the ADOS communication subscale within each cluster.

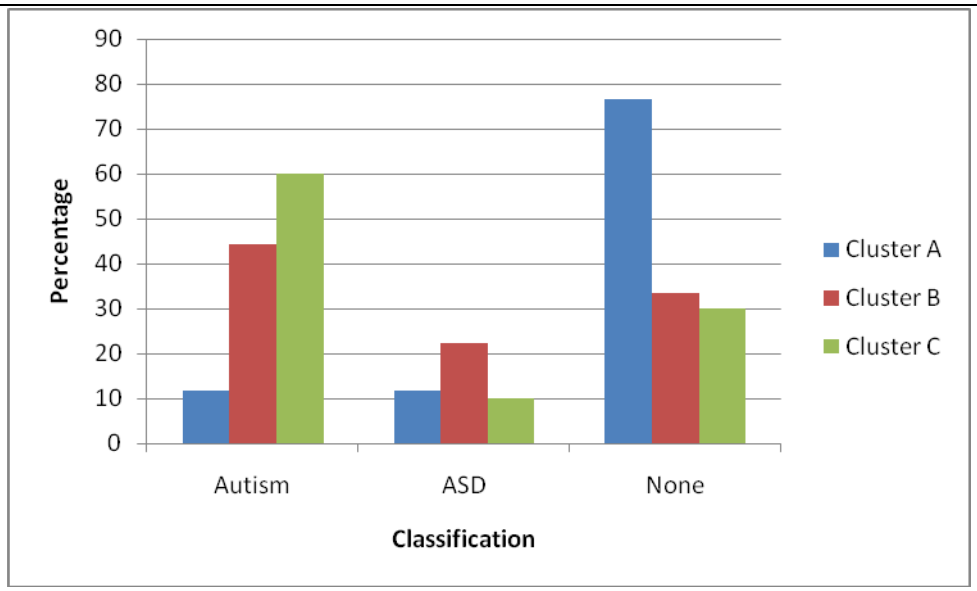


Figure 3. Percentage of diagnostic thresholds met on the ADOS social interaction subscale within each cluster.

Aim 2: Explore the Properties of the Emergent Subgroups

Figure 4 shows the distributions of diagnostic labels in the three clusters. Interestingly, whilst each cluster contained a dominant diagnostic proportion, all three clusters contained at least one participant with each diagnostic label. Further, all three groups contained a significant proportion of participants with a diagnosis of Asperger's Syndrome. Cluster A was predominantly TD participants and half of the participants in Cluster C had a diagnosis of autism. Cluster B had a more even spread, but the largest group was participants with a diagnosis of ASD.

Figure 4. Pie charts indicating the proportion of diagnoses within the clusters

The distribution of diagnoses in the clusters raises the question of why some typically developing participants fell into the clusters characterised by impairments (B and C), and what differences existed between the participants with ASD across the three clusters. Table 4 shows the properties of the diagnostic outliers in the three clusters. Unfortunately a large proportion of missing data for these participants makes it difficult to draw many conclusions. However, highlighted in green are the properties that are in line with those of the cluster overall.

All of the outlying participants had cognitive abilities that were in line with the averages for their cluster, and all participants with data in Clusters A and B demonstrated normal language development and no regression. However three of the participants with ASD in Cluster A demonstrated a clinical level of communication and social interaction difficulties on the ADOS. Further, five of the six fell into WSQ subgroups that suggest an unusual social interaction style. Whilst unsurprising in the context of their diagnoses, these findings suggest that cognitive ability may have been the most influential variable in the cluster analysis. This is supported by the pattern of results for the TD participant who was included in Cluster C; in contrast with the average for Cluster C, this participant demonstrated a non-clinical level of social interaction and communication skills on the ADOS, but had a low level of cognitive functioning in line with this cluster. The TD participants included in Cluster B were less surprising as they demonstrated some impairment in social interaction skills alongside intact communication skills, which was comparable with the average for this cluster.

It is important to note that 50% of the outliers in Cluster A did not have an SCQ score due to non-return of this questionnaire by parents. It is therefore

possible that their placement in Cluster A could represent that their ASD diagnoses were not valid. This may be particularly true for the participants labelled ASD3 and ASD4 who did not meet the diagnostic cut offs on the ADOS social or communication scales. Similarly, two of the the TD participants that were grouped into Clusters B and C did not have SCQ scores (TD2 and TD3), and may have had undiagnosed ASD. This is largely unsupported by the ADOS scores for TD4, but TD3 did demonstrate some unusual social interaction.

Table 4

Characteristics of outlying ASD participants in Cluster A and TD participants in Clusters B and C

Cluster	Participant	Co-morbid Developmental Disorder	Physical Health Condition	Normal Language Development	Regression	Age at ASD Diagnosis (years)	Cognitive Ability (GCA)	ADOS Communication Classification	ADOS Social Interaction Classification	SCQ Score*	WSQ Subgroup
A	ASD1	×	×	✓	×	5	116	Autism	Autism	17	Passive
	ASD 2	✓	×	✓	×	7	112	None	None	29	Active but odd
	ASD 3	×	×	✓	×	Missing	117	None	None	Missing	Active but odd
	ASD 4	Missing	Missing	Missing	Missing	Missing	108	None	None	Missing	Missing
	ASD 5	✓	✓	Missing	Missing	Missing	109	ASD	ASD	30	Active but odd
	ASD 6	×	×	✓	×	4	103	ASD	ASD	Missing	Active but odd
B	TD 1	×	×	✓	×	N/A	95	None	ASD	9	Socially appropriate
	TD 2	×	×	✓	×	N/A	92	None	ASD	Missing	Missing
C	TD 3	×	×	Missing	Missing	N/A	76	None	None	Missing	Missing

* Scores over 15 exceed the threshold for ASD
Note: Points of coherence with cluster highlighted in green; points of incoherence with cluster highlighted in red.

Figure 5 indicates the levels of repetitive and stereotyped behaviours observed during the administration of the ADOS. The overall presence of these behaviours was low, however there was a clear trend with the incidence of these behaviours increasing as the clusters increased in autism severity and symptomatology.

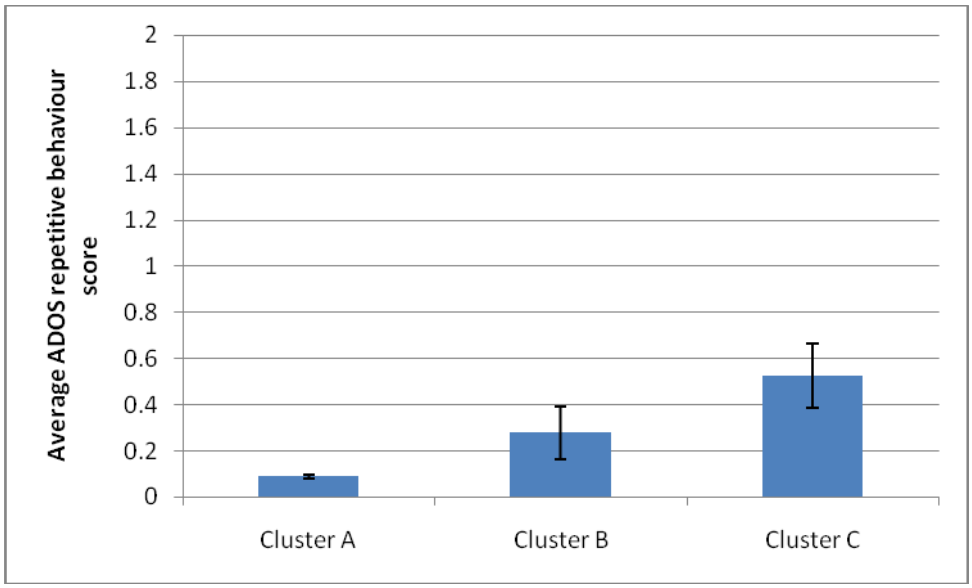


Figure 5. Repetitive behaviours observed during the ADOS.

Figure 6 indicates the percentage of participants in each cluster with non-ASD developmental disorders and physical health conditions. There was a clear trend with the clusters with more severe ASD symptomology, i.e. Clusters B and C, also demonstrating a greater prevalence of both developmental disorders and physical health difficulties.

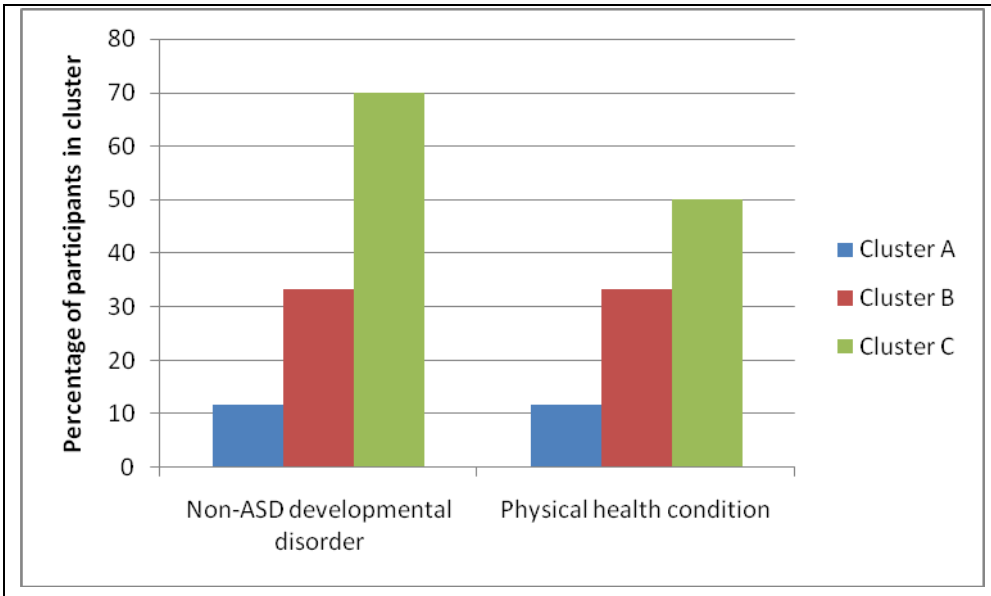


Figure 6. Prevalence of non-ASD developmental disorders and physical health conditions in each cluster.

The absolute alpha power in the frontal brain region for each of the clusters are shown in Figure 7. There was little difference between the three clusters, and the large degree of variation with Cluster B makes it difficult to see any trend.

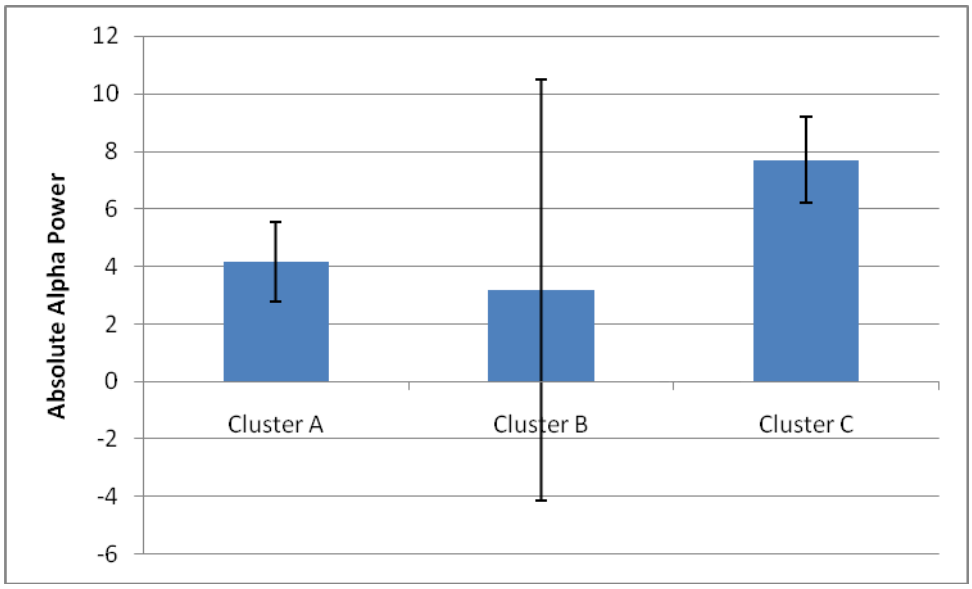


Figure 7. Absolute alpha power in the frontal brain regions in the three clusters. Standard error bars shown.

Table 5 indicates the demographics of the participants in the three clusters. There was little difference in age or distribution of gender, however Cluster C did not include any females. Participants in Cluster C were larger at birth and were more likely to be premature than participants in Clusters B and C. However overall the incidence of premature birth was low, and the sample sizes in each cluster are small therefore these trends should be observed with caution.

Table 5

Developmental Features of the three clusters

Cluster	Age in Years			Male Gender		Birth Weight (Oz)			Premature births	
	M	*SD*	*n*	*%*	*n*	*M*	*SD*	*n*	*%*	*n*
A	12.14	2.14	17	88.20	17	119.29	18.98	14	0	15
B	13.31	2.46	9	88.90	9	113.00	22.72	7	11.10	8
C	13.82	3.95	10	100.00	10	125.34	11.64	6	30.00	7

Note. Number of participants with data included for each variable due to missing data.

Figure 8 displays the language-based developmental variables for the three clusters. In Cluster A most participants demonstrated appropriate language development, producing single words and short phrases at the appropriate time. They did not demonstrate linguistic or non-linguistic regression, and very few demonstrated current difficulties in understanding or producing language. Participants in Cluster B largely began to develop language at the appropriate age, with some evidence of delay in producing short phrases. However they demonstrated the most linguistic regression, and continued around 40% currently experience difficulties in producing and

understanding language. Further, this group demonstrated some non-linguistic regression. Finally, Cluster C demonstrated the most impairment, but also had a large proportion of missing data due to parents not returning the questionnaires. The existing data suggests that the majority began to use single words at the appropriate age, but there was some delay in the use of short phrases. There was evidence of linguistic and non-linguistic regression. Cluster C demonstrated the greatest current impairment in understanding and producing language.

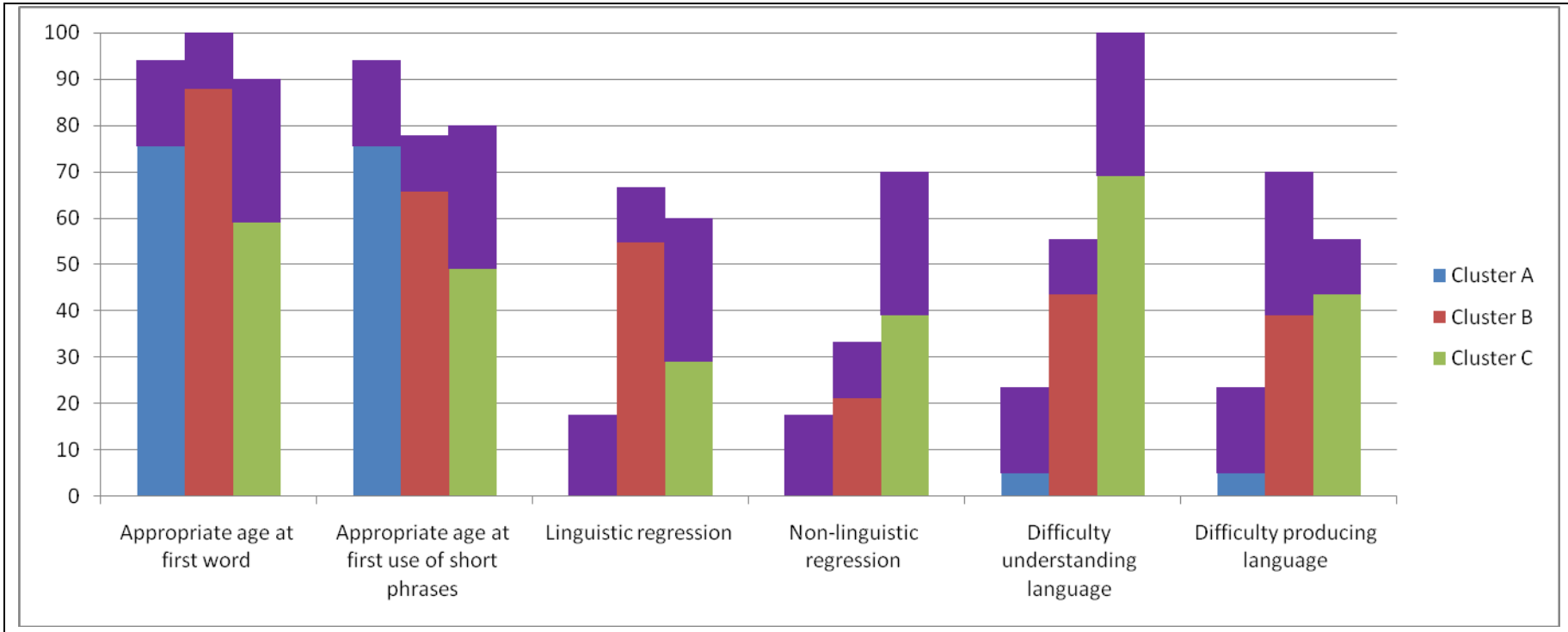


Figure 8. Comparisons between the three clusters on language-based developmental variables. Missing data shown in purple.

Aim 3: Explore Whether the Emergent Subgroups Relate to the Existing Model Proposed by Wing and Gould (1979) Including the Subgroups of Social Aloofness, Active-but-odd Interaction, Passive Interaction, and Appropriate Interaction, and Explore the Relationships with Alpha Power in the Frontal Region and Symptom Severity

A chi-square test was carried out between the Wing Subgroups and the three clusters produced, but the expected frequencies were less than five, indicating a loss of statistical power and a violation of the assumptions of the test (Field, 2009). Therefore descriptive results are presented. Figure 9 indicates the proportion of participants in each cluster that fell into each of the WSQ subgroups. The socially appropriate subtype contained the majority of the participants from Cluster A, and did not include any participants from Cluster C. Participants in Cluster B were spread across the four WSQ subtypes. Participants in Cluster C were predominantly divided between the active-but-odd and aloof subtypes, with a small group falling into the passive subtype. None of the participants in Cluster A were categorised as aloof. The proportion of missing data is indicated under the graph.

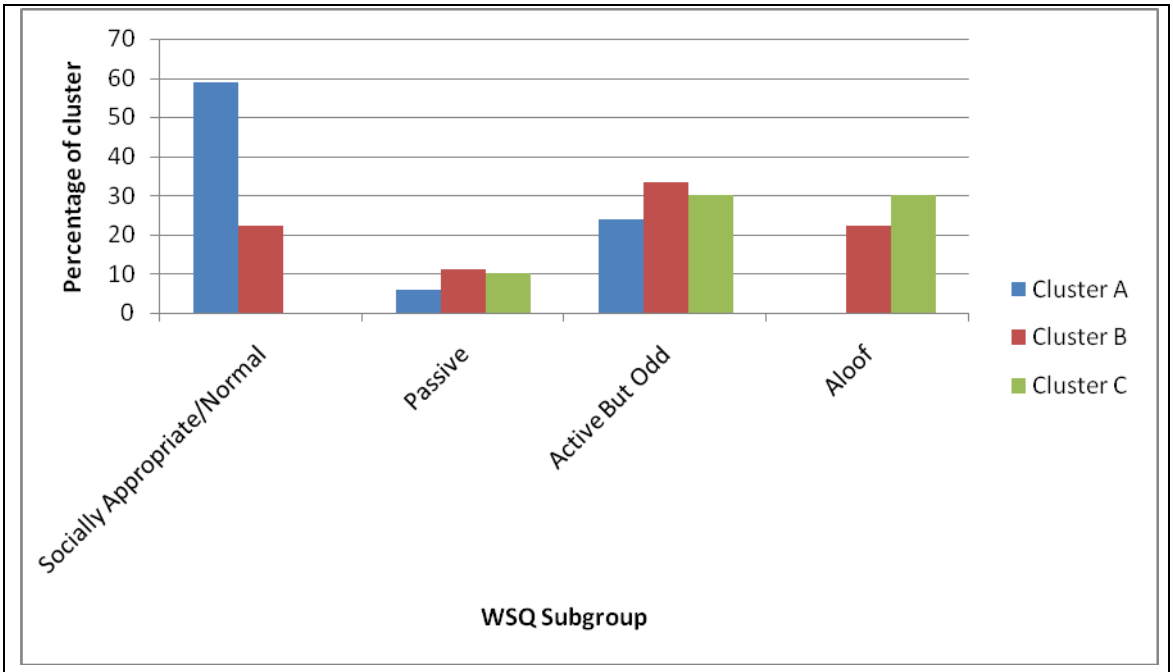


Figure 9. The proportion of participants in each cluster that were categorised into each of the four WSQ subtypes. Note: 11.8% of data missing for Cluster A, 11.1% missing for Cluster B, and 30% missing for Cluster C.

Initially non-parametric bivariate correlational analyses were carried out to explore the relationships between total scores on the WSQ subscales with the variables of interest in the cluster analysis: ADOS communication and social interaction scores, SCQ scores (as an indicator of symptom severity), repetitive behaviour, and absolute alpha frontal power. However due to the strong associations between WSQ subscales and cognitive ability, as shown in Table 6, the correlational analyses were revised as discussed below. Despite the known association between behavioural presentation of ASD and severity of symptoms with chronological age (e.g. Georgiades et al., 2012), the relationship between the WSQ subscale scores and age was not significant (p=.363-.830).

Table 6

Correlations Between the WSQ Subscale Scores and Cognitive Functioning (Spearman's rho, r_s)

WSQ Subscale	Cognitive Functioning (GCA) (*n*=28)
Socially Appropriate/Normal	.673**
Passive	-.747**
Active But Odd	-.420*
Aloof	-.751**

**Correlation is significant at the .01 level (2-tailed)

Due to these associations and the known relationship between presentation and severity of autism and IQ (Beglinger & Smith, 2001), partial correlations were then carried out. These explored the correlations between the WSQ subgroups and ADOS communication, social interaction, and repetitive behaviours scores, SCQ, and alpha power while controlling for GCA score. The results of the partial correlation are shown in Table 7 and indicated that the only remaining correlations between the ADOS and the WSQ subscales once these variables had been controlled for were positive associations between the aloof subscale and social interaction scores ($r(26)=.462$, $p=.015$) and repetitive behaviour scores ($r(26)=.529$, $p=.005$). The associations between the SCQ and the WSQ subscales remained strong ($r(26)=.581$ to -.822. There were no relationships between absolute alpha frontal power and the WSQ subscale scores.

Table 7

Correlations Between the WSQ Subscale Scores, the Variables Entered into the Cluster Analysis, and Alpha Frontal Power (Pearson's Correlation Co-efficient, r)

WSQ Subscale	ADOS Average Communication Score (*n*=26)		ADOS Social Interaction Score (*n*=26)		ADOS Average Repetitive Behaviours Score (*n*=26)		SCQ Score (*n*=24)		Alpha Frontal Power (*n*=22)	
	r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
Socially Appropriate	-.202	.313	-.377	.052	-.212	.289	-.822***	<.001	-.170	.437
Passive	.336	.087	.368	.059	.323	.100	.562**	.003	.278	.198
Active But Odd	-.112	.578	-.058	.775	-.131	.515	.581	.002**	.170	.438
Aloof	.346	.077	.462*	.015	.529**	.005	.814	<.001	.316	.142

* Correlation is significant at the .05 level (2-tailed); **Correlation is significant at the .01 level (2-tailed); *** Correlation is significant at <.001 level (2-tailed)

Discussion

Emergent Clusters and Their Properties

The current study used cluster analysis to explore whether there are subtypes within the autism spectrum based on communicative and social behaviours and cognitive ability. Three subgroups were produced which differed in cognitive ability, communication skills, and social interaction skills, with one group (Cluster A) demonstrating scores within the range of normal functioning, and the other groups displaying increasing degrees of impairment across all variables. Cluster B displayed low average intelligence, impaired communication skills, but relatively intact social interaction skills, and largely represented a group of higher-functioning people with ASD whilst Cluster C displayed lower cognitive, communication, and social functioning.

Of the 42 total participants, 36 had data enabling them to be included in the cluster analysis (22 with ASD). The predominant reason for exclusion of participants with ASD was that they were unable to complete the BAS-II component. Appendix L compares the demographics of those included and excluded. Those that were excluded had poorer social interaction and communication behaviours and lower alpha power in the frontal region of the brain. There was little difference in terms of age or gender. The proportion of participants with ASD was slightly higher in the group that were included (61%) than in the group that were excluded (50%).

The correspondence between the clusters produced in the current study and clinical diagnoses was not straightforward. Whilst each cluster had a majority of one specific diagnosis (Cluster A was predominantly TD, Cluster B predominantly ASD, and Cluster C predominantly autism), each cluster also contained a large proportion of people with each of the other reported

diagnoses. For example despite Cluster A being the most high functioning, this still included participants with a diagnosis of autism, and Cluster C included TD participants despite being the most impaired group. Exploration into these anomalies suggests that the most influential variable in the cluster analysis was cognitive ability.

This salience of cognitive ability in subgrouping people with ASD is consistent with previous research using exploratory cluster analysis methodology within ASD (Beglinger & Smith, 2001). Some studies have found only two groups: one high functioning and one low functioning in the domains of language, cognitive ability, and social skills (Eagle et al., 2010; Stevens et al., 2000). It is possible that these groups are comparable to Clusters B and C within this study, representing a high and a low functioning group of people with ASD, alongside Cluster A which was more representative of typical functioning. Other studies have identified a greater number of groups. Eaves et al. (1994) found four clusters within a group of 166 people with ASD, each of which was representative of a different level of cognitive and behavioural presentations. Similarly, these demonstrated a continuum of cognitive ability, but in addition to a high and low functioning group they found a typically autistic group who were passive and aloof and showed the verbal stereotypes associated with autism (e.g. echolalia) and a hard-to-diagnose group with mild-moderate learning difficulties and a family history of learning difficulties. The increased variation in the findings of this study may have been due to their larger sample size, which could have enabled more subtle differences to emerge.

Despite this, there is some evidence to suggest that subgroups exist in ASD over and above the effect of cognitive ability. Prior and colleagues (1998) carried out a cluster analysis on a group of young people with high-functioning

autism. Despite the group's relative homogeneity in term of their cognitive ability, three clusters still emerged. These clusters appeared to be based on social behaviours. A continuum of social impairment emerged, with variation on both the individual's interest in interacting with others, and their skills in doing so.

In the present study there was a relationship between the emergent clusters and the presence of comorbid developmental disorders and physical health conditions, with the frequency of both increasing in the more impaired clusters. To some extent the relationship with other developmental disorders is unsurprising as many of the participants had learning difficulties or disabilities, which would have been reflected in their cognitive ability scores, and therefore would have influenced which cluster they were grouped in. However the relationship with other developmental disorders may also raise questions about whether there is overlap with the diagnostic criteria for conditions such as attention deficit hyperactivity disorder (ADHD) and dyspraxia. The relationship with physical health conditions is particularly interesting. These conditions ranged from asthma to metabolic and digestive system difficulties to hormonal conditions. This raises two questions: firstly whether these physical health difficulties could be indicators of an underlying physical cause for the symptoms of ASD, or specific subtypes of ASD. Many of these conditions may be related to immunological difficulties and digestive problems that have been previously implicated in ASD (e.g. Ashwood, Wills, & Van de Water, 2006; Wang, Tancredi, & Thomas, 2011; Yazbak, 2002). Secondly it is possible that some of these difficulties arise as a result of behaviours associated with ASD such as fussy eating (e.g. Ibrahim, Voigt, Katusic, Weaver & Barbaresi, 2009), and the

consequences of such behaviours should be considered in a biopsychosocial way when considering care plans for people with ASD.

There were some interesting findings in terms of language development. Whilst the most impaired group (Cluster C) demonstrated the greatest current impairments in understanding and producing language, there was variation in the course of the development of their language with some participants displaying delays in producing language in their infancy and others displaying normal early development followed by linguistic regression. Whilst Cluster B did not show the greatest current language impairments they demonstrated the greatest incidence of linguistic regression, although due to non-return of questionnaires from parents there was a lot of missing data for Cluster C therefore this comparison may not be valid and should be explored further in future research.

There was very little difference between the alpha power in the frontal brain regions between the three clusters, and there was great variation within clusters. Further, there were no significant differences between alpha frontal power when the TD and ASD participants were compared. These results corroborated the findings from Coben et al. (2008) who explored differences in EEG recordings between 20 typically developing children and 20 children with autism. They found significant differences in absolute delta power in the frontal regions, but no differences in absolute alpha power in the frontal, central, or posterior regions. This suggests that there may be frontal system abnormalities in the brains of people with ASD, but alpha power would not be a useful biomarker.

The results of the present study also indicated a trend in which repetitive behaviours were highest in the group with the most social and communication

difficulties and the lowest cognitive ability (Cluster C) and lowest in the group with the least impairments (Cluster A). This straightforward association contrasts with the recent findings from Georgiades et al. (2012) who used a mixed modelling approach to develop subgroups within a group of 391 children with ASD employing the new DSM-5 criteria (social and communicative deficits and fixated interests and repetitive behaviours) and severity of symptoms. This study found three clusters, one of which showed the highest impairments in social and communication behaviours and the highest number of repetitive behaviours and fixed interests. However the other two clusters did not show the same association, with the group with the highest social and communication impairments of the two showing lower fixed interests and repetitive behaviours.

Relationships with the Wing Subgroups

The relationships between the Wing subgroups – socially appropriate/normal, aloof, passive, and active but odd – and the emergent clusters were explored. There were clear relationships with the socially appropriate group, which included the majority of the participants in the least impaired Cluster A, and a significant proportion of participants from Cluster B. The aloof subgroup contained only participants from Clusters B and C. The active but off and passive subgroups contained a fairly even spread of participants from the three clusters, with the passive group being the least prevalent.

Whilst the relationships between the clusters and the Wing subgroups were not very clear, there were strong correlations between the severity of autism symptoms and the Wing subgroups. Autism severity, as indicated by SCQ scores, was strongly negatively correlated with the socially appropriate subscale, moderately positively associated with the active but odd and passive

subscales, and strongly positively related to the aloof subscale. This effect remained once age and cognitive ability had been controlled for. These results are similar to Scheeren, Koot, and Begeer's (2012) findings in a sample of 214 children with high functioning ASD, who reported significant positive associations with all subscales except the socially appropriate subscale where they found a significant negative association. However they reported that the association between severity and the passive subscale was no longer significant once verbal IQ, gender and other social interaction styles were taken into account.

There were also some interesting relationships between the subgroups and symptoms of ASD. Initially there were strong correlations between the ADOS average communication score and the socially appropriate, passive, and aloof subgroups, however these effects were no longer significant once age and cognitive ability had been controlled for. Similarly, the correlations between the ADOS social interaction score and the socially appropriate and passive subgroups were not significant once these variables had been controlled for. However a significant positive correlation remained between the ADOS social interaction score and the aloof subgroup. These results differ to those found by Scheeren et al. (2012) who found a significant negative association between the overall ADOS score and the active but odd subgroup, and a significant negative association with the socially appropriate subscale. The explanation offered by these authors with regards to the overall lack of relationship between the ADOS and the Wing subgroups is that ADOS is used to distinguish between children with and without ASD and not to distinguish between subtypes therefore may not be sensitive to differences in social presentations. The present findings appear to support that the ADOS cannot reliably distinguish between different

social presentations. A clinical implication of this is that it should be used in conjunction with a number of other assessments of behavioural presentations in order to determine which interventions may be most appropriate.

To date most studies have shown consistency with the Wing subgroups. Usually the most autistic children fall into the aloof group and the least autistic fall into the active-but-odd group, and intellectual ability has been a key predictor of group membership (Beglinger and Smith, 2001). Similarly in the current study cognitive ability was a key correlate with group membership. However severity of autism symptoms as measured on the SCQ was strongly related to group membership over and above the effects of cognitive ability.

Limitations

The greatest limitation of this study was the small sample size and the incompleteness of the data. These were partly affected by the inclusion criteria and the testing conditions. In order to have a full data set the participants needed to be able to participate in prolonged testing sessions and needed to be comfortable wearing the EEG cap and having their face and head touched. In an attempt to control for this to some extent, those participants that did attend but did not feel comfortable with the EEG component were still able to contribute cognitive and behavioural data. Further, the sessions were adapted in length and location to meet their needs. Therefore, the participants included are unlikely to represent the full range of severity with the autism spectrum. The sample was further limited by the need for the participants to have some expressive language in order to be able to complete the tests used, and again this does not capture full range of presentations of ASD. Finally, not all parents returned their questionnaires, which added to the incompleteness of the data set. One key implication of this was that the membership of the participants in

the TD or ASD group was not validated for 24% of the TD group and 36% of the ASD group. This could mean that some of the outliers between the clusters may have been misdiagnosed with ASD, or some of the TD participants may have been eligible for a diagnosis of ASD.

The implications of the small sample size were that it restricted the number of variables, and thus the level of detail that could be entered into the cluster analysis. For example, it would have been interesting to include repetitive behaviours in the cluster analysis, and more specific communication (e.g. verbal and gestures) and social (e.g. eye contact and reciprocity) behaviours. Further, the small number of statistical tests that were performed are likely to be under powered, and should be interpreted with caution.

Most studies that have used cluster analysis and included both cognitive functioning and social behaviours have found four clusters (Beglinger & Smith, 2001). However, the contrast with this study may have been due to the small sample size. A larger sample may have added weight to additional clusters, and enabled further subtle differences to emerge. As the results were very much influenced by intellectual ability it would have been useful to have larger number of participants in each range of ability to enable exploration of the impact of this in more depth, and to see whether more differences would emerge based on social abilities (e.g. Prior et al., 1998).

A further limitation of the sample was that it was self-selecting. As with much research on ASD, due to the need for a pre-existing clinical diagnosis it was not possible to employ any random sampling techniques. Therefore parents and young people over the age of 16 were required to opt in to the study. It is possible that those that volunteered may have been those with unusual experiences or presentations, or particular interests in research and so

again this may have impacted on how representative this group were of the population of children with ASD.

Unfortunately data of the ethnicity and socioeconomic status of the participants and their families were not collected. Therefore it was not possible to explore how these variables related to the emergent clusters.

Clinical implications

The three clusters identified in this study were on a clear continuum of severity in terms of both behavioural presentations and cognitive ability. Cognitive ability appeared to be the most influential variable in producing the clusters. It is of note that no studies have found clusters that match the diagnostic labels that were included in DSM-IV. Whilst there may be trends towards diagnoses falling in to specific clusters, there has always been a significant proportion of people with the same diagnoses falling in to other groups (e.g. Prior et al., 1998), as occurred in the present study. Lord et al. (2012) propose that conceptualising ASD as a unitary behavioural disorder and understanding the interaction between cognitive ability and the behavioural symptoms may be more helpful in forwarding understanding of ASD and developing and selecting appropriate interventions from the behavioural, neurological, genetic, and biological perspectives. Therefore this would support the DSM-V conceptualisation of ASD as a unitary condition rather than a group of related but distinct conditions. This is further supported by the findings from Stevens et al. (2000) who argued that cognitive ability appeared to be indicative of improvements in functioning as in their study those children with higher cognitive abilities had shown improvements in their language and social skills since pre-school whereas those with lower cognitive abilities had not shown improvements.

Taking this perspective would suggest that historically cognitive ability would have been a key factor in distinguishing between the pervasive developmental disorders. For example in the case of autism and Asperger's Syndrome the latter would only be a higher-functioning version of the former rather than a distinct concept (Eagle, Romanczyk, & Lenzenweger, 2010; Prior et al., 1998). Whilst this may be more useful for conceptualisation of the disorder, and for research purposes, there is debate around whether the debunking of the Asperger's Syndrome classification could have a negative impact on the identity and wellbeing of people that were historically provided with this diagnosis (e.g. Wallis, 2009).

Further, whilst this study lends evidence to the concept of ASD as a continuum, it is known that there is not one unitary intervention that works for all people with ASD (e.g. Stahmer et al., 2011). This highlights the importance of continuing to explore the cognitive, behavioural and biological factors that impact upon prognoses and treatment responsiveness for people with ASD.

Future research

Due to the limitations imposed by the sample size and the measures employed, it was not possible to explore specific language-based variables within this study. There is evidence to suggest that these may also have a key role in subtyping people with ASD (e.g. Stevens et al., 2000; Eagle et al., 2010), therefore future research should endeavour to explore this link further. Additionally, it would be beneficial to explore more specific verbal and non-verbal cognitive variables and their role in clustering people with ASD.

This study highlighted that linguistic and non-linguistic regression do not appear to fit the same continuum of severity as cognitive ability, social and communication behaviours, co-morbid developmental and physical health

difficulties, repetitive behaviour and severity of autism symptoms. To date the role of regression and its impact on presentations and prognoses is poorly understood, and this should be explored in more depth (Rogers, 2004).

Similarly the relationship between ASD and physical and developmental co-morbidities continues to be poorly misunderstood, and yet there are clear trends towards greater prevalence in ASD. This area should be explored further, particularly as it may open doors to an understanding of biological factors that could be implicated in the development of ASD, and biological markers that could improve diagnosis of ASD (Rutter, 2005).

References

American Psychiatric Association. (1994). *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.). Washington, DC: Author.

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). Washington, DC: Author.

Ashwood, P., Wills, S., & Van de Water, J. (2006). The immune response in autism: a new frontier for autism research. *Journal of Leukocyte Biology, 80*, 1-15. doi:10.1189/jlb.1205707

Avdi, E., Griffin, C., & Brough, S. (2000). Parents' constructions of the 'problem' during assessment and diagnosis of their child for an autistic spectrum disorder. *Journal of Health Psychology, 5*, 241-254. doi:10.1177/135910530000500214

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). The Autism-Spectrum Quotient (AQ): evidence from Asperger Syndrome/high-functioning autism, males and females, scientists and mathematicians. *Journal of Autism and Developmental Disorders, 31*, 5-17. doi:10.1023/A:1005653411471

Beglinger, L. J., & Smith, T. H. (2001). A review of subtyping in autism and proposed dimensional classification model. *Journal of Autism and Developmental Disorders*, *31*, 411-22. doi:10.1023/A:1010616719877

Berument, S. K., Rutter, M., Lord, C., Pickles, A., & Bailey, A. (1999). Autism screening questionnaire: diagnostic validity. *British Journal of Psychiatry*, *175*, 444-51. doi:10.1192/bjp.175.5.444

Betancur, C. (2011). Etiological heterogeneity in autism spectrum disorders: more than 100 genetic genomic disorders and still counting. *Brain Research, 1380*, 42-77. doi:10.1016/j.brainres.2010.11.078

Bitsika, V., Sharpley, C. F., & Orapeleng, S. (2008). An exploratory analysis of the use of cognitive, adaptive and behavioural indices for cluster analysis of ASD subgroups. *Journal of Intellectual Disability Research*, *52*, 973-85. doi:10.1111/j.1365-2788.2008.01123.x

Bristol-Power, M.M., & Spinella, G. (1999). Research on screening and diagnosis in autism: a work in progress. *Journal of Autism and Developmental Disorder*, *29*, 435-438. doi:10.1023/A:1021991718423

Brookman-Frazee, L., Baker-Ericzén, M., Stadnick, N., & Taylor, R. (2012). Parent perspectives on community mental health services for children with autism spectrum disorders. *Journal of Child and Family Studies, 21*, 533-544. doi:10.1007/s10826-011-9506-8

Cantor, D. S., Thatcher, R. W., Hrybyk, M., & Kaye, H. (1986). Computerized EEG Analyses of Autistic Children. *Autism*, *16*, 169-187. doi:10.1007/BF01531728

Castelloe, P., & Dawson, G. (1993). Subclassification of children with autism and pervasive developmental disorder: A questionnaire based on Wing's

Subgrouping scheme. *Journal of Autism and Developmental Disorders*, *23*, 229-241. doi:10.1007/BF01046217

Chamak, B., Bonniau, B., Oudaya, L., & Ehrenberg, A. (2011). The autism diagnostic experiences of French parents. *Autism*, *15*, 83-97. doi:10.1177/1362361309354756

Chandler, S., Charman, T., Baird, G., Simonoff, E., Loucas, T., Meldrum, D., Scott, M., et al. (2007). Validation of the social communication questionnaire in a population cohort of children with autism spectrum disorders. *Journal of the American Academy of Child and Adolescent Psychiatry*, *46*, 1324-32. doi:10.1097/chi.0b013e31812f7d8d

Charman, T., Baird, G., Simonoff, E., Loucas, T. O. M., Chandler, S., Meldrum, D., & Pickles, Andrew. (2007). Efficacy of three screening instruments in the identification of autistic-spectrum disorders. *British Journal of Psychiatry*, *191*, 554-559. doi:10.1192/bjp.bp.107.040196

Coben, R., Clarke, A.R., Hudspeth, W., & Barry, R.J. (2008). EEG power and coherence in autistic specreum disorder. *Clinical Neuropsychology*, *119*, 1002-1009. doi:10.1016/j.clinph.2008.01.013

Constantino, J.N., & Todd, R.D. (2003). Autistic traits in the general population. *Archives of General Psychiatry, 60*, 524-530. doi:10.1001/archpsyc.60.5.524

Daoust, A.M., Limoges, E., Bolduc, C., Mottron, L., & Godbout, R. (2004). EEG spectral analysis of wakefulness and REM sleep in high functioning autistic spectrum disorders. *Clinical Neuropsychology*, *112*, 1368-1373. doi:10.1016/j.clinph.2004.01.011

Dawson, G., Klinger, L. G., Panagiotides, H., Lewy, A., & Castelloe, P. (1995). Subgroups of autistic children based on social behavior display distinct

patterns of brain activity. *Journal of Abnormal Child Psychology*, *23*, 569-583. doi:10.1007/BF01447662

Delorme, A., & Makeig, S. (2004). EEGLAB: an open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. *Journal of Neuroscience Methods*, *134*, 9-21. doi:10.1016/j.jneumeth.2003.10.009

Eagle, R.F., Romanczyk, R.G., & Lenzenweger, M.F. (2010). Classification of children with autism spectrum disorders: a finite mixture modeling approach to heterogeneity. *Research in Autism Spectrum Disorders, 4*, 772-781. doi:10.1016/j.rasd.2010.02.001

Eaves, L. C., Ho, H. H., & Eaves, D. M. (1994). Subtypes of autism by cluster analysis. *Journal of Autism and Developmental Disorders*, *24*, 3-22. doi:10.1007/BF02172209

Elliott, C. D., Smith, P., & McCulloch, K. (1996). *British Ability Scales II: Administration and Scoring Manual*. Windsor: NFER-Nelson.

Everitt, B. S., Landau, S., & Leese, M. (2001). *Cluster Analysis* (4th ed.). London: Arnold.

Field, A. (2009). *Discovering Statistics Using SPSS* (3rd ed). London: SAGE Publications Ltd.

Filipek, P.A., Accardo, P.J., Baranek, G.T., Cook Jr., E.H., Dawson, G., Gordon, B., Gravel, J.S., Johnson, C.P., Kallen, R.J., Levy, S.E., Minshew, N.J., Prizant, B.M., Rapin, I., Rogers, S.J., Stone, W.L., Teplin, S., Tuchman, R.F., & Volkmar, F.R. (1999). The screening and diagnosis of autistic spectrum disorders. *Journal of Autism and Developmental Disorder, 29*, 439-484. doi: 10.1023/A:1021943802493

Georgiades, S., Szatmari, P., Boyle, M., Hanna, S., Duku, E., Zwaigenbaum, L., Bryson, S., Fombonne, E., Volden, J., Mirenda, P., Smith, I., Roberts, W., Vaillancourt, T., Waddell, C., Bennett, T., Thompson, A., & Pathways in ASD Study Team (2012). Investigating phenotypic heterogeneity in children with autism spectrum disorder: a factor mixture modelling approach. *Journal of Child Psychology and Psychiatry, 54*, 206-215. doi:10.1111/j.1469-7610.2012.02588.x

Geschwind, D.H., & Levitt, P. (2007). Autism spectrum disorders: developmental disconnection syndromes. *Current Opinion in Neurobiology*, *17*, 103-111. doi:10.1016/j.conb.2007.01.009

Hetherington, E. M., Parke, R. D., Gauvain, M., & Locke, V. O. (2006). *Child Psychology: A Contemporary Viewpoint* (6th ed.). New York: McGraw-Hill.

Honsbeek, R., Kuiper, T., & van Rijn, C. M. (n.d.). *Biosemi.* Retrieved November 4, 2011, from http://www.biosemi.com/

Howlin, P., & Moore, A. (1997). Diagnosis in autism: a survey of over 1200 patients in the UK. *Autism*, *1*, 135-162. doi: 10.1177/1362361397012003

Hutton, A.M., & Caron, S.L. (2005). Experiences of families with children with autism in rural New England. *Focus on Autism and Other Developmental Disabilities, 20*, 180-189. doi:10.1177/10883576050200030601

Ibrahim, S.H., Voigt, R.G., Katusic, S.K., Weaver, A.L., & Barbaresi, W.J. (2009). Incidence of gastrointestinal symptoms in children with autism: a population-based study. *Pediatrics*, *124*, 680-686. doi: 10.1542/peds.2008-2933

Jegatheesan, B., Fowler, S., & Miller, P.J. (2010). From symptom recognition to services: how South Asian Muslim immigrant families navigate autism. *Disability and Society, 25*, 797-811. doi:10.1080/09687599.2010.520894

Jones, W., & Klin, A. (2009). Heterogeneity and homogeneity across the autism spectrum: the role of development. *Journal of the American Academy of Child & Adolescent Psychiatry*, *48*, 471-473. doi:10.1097/CHI.0b013e31819f6c0d

Keenan, M., Dillenburger, K., Doherty, A., Byrne, T., & Gallagher, S. (2010). The experiences of parents during diagnosis and forward planning for children with autism spectrum disorder. *Journal of Applied Research in Intellectual Disabilities, 23*, 390-397. doi:10.1111/j.1468-3148.2010.00555.x

Lam, K. S. L., Bodfish, J. W., & Piven, J. (2008). Evidence for three subtypes of repetitive behavior in autism that differ in familiality and association with other symptoms. *Journal of Child Psychology and Psychiatry*, *49*, 1193-1200. doi:10.1111/j.1469-7610.2008.01944.x

Lenne and Waldby (2011). Sorting out autism spectrum disorders: evidence-based medicine and the complexities of the clinical encounter. *Health Sociology Review, 20*, 70-83. doi:10.5172/hesr.2011.20.1.70

Lord, C., Rutter, M., DiLavore, P. C., & Risi, S. (1999). *Autism Diagnostic Observation Schedule: Manual.* Los Angeles: Western Psychological Services.

Lord, C., Rutter, M., & Le Couteur, A. (1994). Autism Diagnostic Interview-Revised: A Revised Version of a Diagnostic Interview for Caregivers of Individuals with Possible Pervasive Developmental Disorders. *Journal of Autism and Developmental Disorders*, *24*, 659-685. doi:10.1007/BF02172145

Lord, C., Petkova, E., Hus, V., Gan, W., Lu, F., Martin, D.M., Ousley, O., Guy, L., Bernier, R., Gerdts, J., Algermissen, M., Whitaker, A., Sutcliffe, J.S., Warren, Z., Klin, A., Saulnier, C., Hanson, E., Hundley, R., Piggot, J., Fombonne, E., Steiman, M., Miles, J., Kanne, S.M., Goin-Kochel, E.P., Peters, S.U., Cook, E.H., Guter, S., Tjernagel, J., Green-Snyder, L.A., Bishop, S., Esler, A., Gotham, K., Luyster, R., Miller, F., Olson, J., Richler, J., Risi, S. (2012). A multisite study of the clinical diagnosis of different autism spectrum disorders. Archives of General Psychiatry, *69*, 306-313. doi:10.1001/archgenpsychiatry.2011.148

Midence, K., & O'Neill, M. (1999). The experience of parents in the diagnosis of autism: a pilot study. *Autism, 3*, 273-285. doi:10.1177/1362361399003003005

Minnes, P., & Steiner, K. (2009). Parent views on enhancing the quality of health care for their children with fragile X syndrome, autism or Down syndrome. *Child: Care, Health and Development, 35*, 250-256. doi:10.1111/j.1365-2214.2008.00931

Moh, T.A., & Magiati, I. (2012). Factors associated with parental stress and satisfaction during the process of diagnosis of children with autism spectrum disorders. *Research in Autism Spectrum Disorders, 6*, 293-303. doi:10.1016/j.rasd.2011.05.011

Mouzourou, C., Santos, R.M., & Gaffney J.S. (2011). At home with disability: one family's three generations narrate autism. *International Journal of Qualitative Studies in Education, 24*, 693-715. doi:10.1080/9518398.2010.529841

Mulligan, J., MacCulloch, R., Good, B., & Nicholas, D.B. (2012). Transparency, hope and empowerment: a model for partnering with parents of a child with autism spectrum disorder at diagnosis and beyond. *Social Work in Mental Health, 10*, 311-330. doi:10.1080/15332985.2012.664487

O'Brien, S. K. (1996). The Validity and Reliability of the Wing Subgroups Questionnaire. *Journal of Autism and Developmental Disorders*, *26*, 321-335. doi:10.1007/BF02172477

Prior, M., Eisenmajer, R., Leekam, S., Wing, L., Gould, J., Ong, B., & Dowe, D. (1998). Are there subgroups within the autistic spectrum? A cluster analysis of a group of children with autistic spectrum disorders. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, *39*, 893-902. doi:10.1111/1469-7610.00389

Reed, P., & Osborne, L.A. (2012). Diagnostic practice and its impacts on parental health and child behaviour problems in autism spectrum disorders. *Archives of Disease in Childhood, 97*, 927-931. doi:10.1136/archdischild-2012-301761

Renty, J., & Roeyers, H. (2005). Satisfaction with formal support and education for children with autism spectrum disorder: the voices of the parents. *Child: Care, Health & Development, 32*, 371-385. doi: 10.1111/j.1365-2214.2006.00584.x

Rogers, S. J. (2004). Developmental regression in autism spectrum disorders. *Mental Retardation and Developmental Disabilities Research Reviews, 10*, 139-143. doi: 10.1002/mrdd.20027

Rutter, M., Bailey, A., & Lord, C. (2003). *Social Communication Questionnaire.* Los Angeles: Western Psychological Services.

Rutter, M. (2005). Autism research: lessons from the past and prospects for the future. *Journal of Autism and Developmental Disorders, 35*, 241-257. doi: 10.1007/s10803-004-2003-9

Sabatino, D. A., Vance, H. B., & Fuller, G. (2001). Pervasive Developmental Disorders. In H. B. Vance & A. Pumariega (Eds.), *Clinical Assessment of Child & Adolescent Behavior* (pp. 188-230). New York: John Wiley and Sons.

Sansosti, F.J., Lavik, K.B., & Sansosti, J.M. (2012). Family experiences through the autism diagnostic process. *Focus on Autism and Other Developmental Disabilities*, *27*, 81-92. doi:10.1177/1088357612446860

Schall, C. (2000). Family perspectives on raising a child with autism. *Journal of Child and Family Studies, 9*, 409-423. doi:10.1023/A:1009456825063

Scheeren, A.M., Koot, H.M., & Begeer, S. (2012). Social interaction style of children and adolescents with high-functioning autism spectrum disorder. *Journal of Autism and Developmental Disorders, 42*, 2046-2055. doi:10.1007/s10803-012-1451

Sherer, M. R., & Schreibman, L. (2005). Individual behavioral profiles and predictors of treatment effectiveness for children with autism. *Journal of Consulting and Clinical Psychology*, *73*, 525-38. doi:10.1037/0022-006X.73.3.525

Smith, B., Chung, M. C., & Vostanis, P. (1994). The path to care in autism: is it better now? *Journal of Autism and Developmental Disorders, 24*, 551-563. doi:10.1007/BF02172137

Smith, P. K., Cowie, H., & Blades, M. (2003). *Understanding Children's Development* (4th ed.). Oxford: Blackwell Publishing.

Stahmer, A.C., Schreibman, L., & Cunningham, A.B. (2011). Toward a technology of treatment individualisation for children with autism spectrum disorders. *Brain Research, 1380*, 229-239. doi:10.1016/j.brainres.2010.09.043

Stevens, M. C., Fein, D. A., Dunn, M., Allen, D., Waterhouse, L. H., Feinstein, C., & Rapin, I. (2000). Subgroups of Children with Autism by Cluster Analysis: A Longitudinal Examination. *Journal of the American Academy of Child & Adolescent Psychiatry*, *39*, 346-352. doi:10.1097/00004583-200003000-00017

Toal, F., Daly, E.M., Page, L., Deeley, Q., Hallahan, B., Bloemen, E., Cutter, W.J., Brammer, M.J., Curran, S., Robertson, D., Murphy, C., Murphy, K.C., Murphy, D.G.M. (2009). Clinical and anatomical heterogeneity in autistic spectrum disorder: a structural MRI study. *Psychological Medicine*, *40*, 1171–1181. doi:10.1017/S0033291709991541

Wallis, C. (2009, November 2). A powerful identity, a vanishing diagnosis. *The New York Times.* Retrieved from http://www.nytimes.com.

Wang, L.W., Tancredi, D.J., & Thomas, D.W. (2011). The prevalence of gastrointestinal problems in children across the United States with autism spectrum disorders from families with multiple affected members. *Journal of Developmental and Behavioral Pediatrics, 32*, 351-360. doi:10.1097/DBP.0b013e31821bd06a

Wing, L., & Gould, J. (1979). Severe impairments of social interaction and associated abnormalities in children: epidemiology and classification. *Journal of Autism and Developmental Disorders*, *9*, 11-29. doi:10.1007/BF01531288

Yazbak, K. (2002). The new autism: one family's perspective. *Clinical Child Psychology and Psychiatry, 7*, 505-517. doi:10.1177/1359104502007004003

Section 3: Appendices

List of Appendices

Appendix A. Spencer, Ritchie, Lewis, and Dillon's (2003) Framework for Assessing Qualitative Evaluations

	a) Appraisal questions	b) Quality indicators (possible features for consideration)	c) Notes on study being appraised
1 FINDINGS	How credible are the findings?	Findings/conclusions are supported by data/study evidence *(i.e. the reader can see how the researcher arrived at his/her conclusions; the 'building blocks' of analysis and interpretation are evident)* Findings/conclusions 'make sense'/have a coherent logic Findings/conclusions are resonant with other knowledge and experience *(this might include peer or member review)* Use of corroborating evidence to support or refine findings (i.e. other data sources have been used to examine phenomena; other research evidence has been evaluated: see also Q14)	
2 FINDINGS	How has knowledge/ understanding been extended by the research?	Literature review (where appropriate) summarising knowledge to date/key issues raised by previous research Aims and design of study set in the context of existing knowledge/ understanding; identifies new areas for investigation *(for example, in relation to policy/practice/ substantive theory)* Credible/clear discussion of how findings have contributed to knowledge and understanding *(e.g. of the policy, programme or theory being reviewed)*; might be applied to new policy developments, practice or theory Findings presented or conceptualised in a way that offers new insights/alternative ways of thinking Discussion of limitations of evidence and what remains unknown/unclear or what further information/research is needed	

	a) Appraisal questions	b) Quality indicators (possible features for consideration)	c) Notes on study being appraised
3 FINDINGS	How well does the evaluation address its original aims and purpose?	Clear statement of study aims and objectives; reasons for any changes in objectives Findings clearly linked to the purposes of the study – and to the initiative or policy being studied Summary or conclusions directed towards aims of study Discussion of limitations of study in meeting aims *(e.g. are there limitations because of restricted access to study settings or participants, gaps in the sample coverage, missed or unresolved areas of questioning; incomplete analysis; time constraints?)*	
4 FINDINGS	Scope for drawing wider inference – how well is this explained?	Discussion of what can be generalised to wider population from which sample is drawn/case selection has been made Detailed description of the contexts in which the study was conducted to allow applicability to other settings/contextual generalities to be assessed Discussion of how hypotheses/ propositions/findings may relate to wider theory; consideration of rival explanations Evidence supplied to support claims for wider inference *(either from study or from corroborating sources)* Discussion of limitations on drawing wider inference *(e.g. re-examination of sample and any missing constituencies: analysis of restrictions of study settings for drawing wider inference)*	
5 FINDINGS	How clear is the basis of evaluative appraisal?	Discussion of how assessments of effectiveness/evaluative judgements have been reached *(i.e. whose judgements are they and on what basis have they been reached?)* Description of any formalised appraisal criteria used, when generated and how and by whom they have been applied Discussion of the nature and source of any divergence in evaluative appraisals Discussion of any unintended consequences of intervention, their impact and why they arose	

	a) Appraisal questions	b) Quality indicators (possible features for consideration)	c) Notes on study being appraised
6 DESIGN	How defensible is the research design?	Discussion of how overall research strategy was designed to meet aims of study Discussion of rationale for study design Convincing argument for different features of research design *(e.g. reasons given for different components or stages of research; purpose of particular methods or data sources, multiple methods, time frames etc.)* Use of different features of design/data sources evident in findings presented Discussion of limitations of research design and their implications for the study evidence	
7 SAMPLE	How well defended is the sample design/target selection of cases/documents?	Description of study locations/areas and how and why chosen Description of population of interest and how sample selection relates to it *(e.g. typical, extreme case, diverse constituencies etc.)* Rationale for basis of selection of target sample/settings/documents *(e.g. characteristics/features of target sample/settings/documents, basis for inclusions and exclusions, discussion of sample size/number of cases/setting selected etc.)* Discussion of how sample/selections allowed required comparisons to be made	
8 SAMPLE	Sample composition/case inclusion – how well is the eventual coverage described?	Detailed profile of achieved sample/case coverage Maximising inclusion *(e.g. language matching or translation; specialised recruitment; organised transport for group attendance)* Discussion of any missing coverage in achieved samples/cases and implications for study evidence *(e.g. through comparison of target and achieved samples, comparison with population etc.)* Documentation of reasons for non-participation among sample approached/non-inclusion of selected cases/documents Discussion of access and methods of approach and how these might have affected participation/coverage	

	a) Appraisal questions	b) Quality indicators (possible features for consideration)	c) Notes on study being appraised
9 DATA COLLECTION	How well was the data collection carried out?	Discussion of: • who conducted data collection • procedures/documents used for collection/recording • checks on origin/status/authorship of documents Audio or video recording of interviews/discussions/conversations *(if not recorded, were justifiable reasons given?)* Description of conventions for taking fieldnotes *(e.g. to identify what form of observations were required/to distinguish description from researcher commentary/analysis)* Discussion of how fieldwork methods or settings may have influenced data collected Demonstration, through portrayal and use of data, that depth, detail and richness were achieved in collection	
10 ANALYSIS	How well has the approach to and formulation of the analysis been conveyed?	Description of form of original data *(e.g. use of verbatim transcripts, observation or interview notes, documents, etc.)* Clear rationale for choice of data management method/tool/package Evidence of how descriptive analytic categories, classes, labels etc. have been generated and used *(i.e. either through explicit discussion or portrayal in the commentary)* Discussion, with examples, of how any constructed analytic concepts/typologies etc. have been devised and applied	
11 ANALYSIS	Contexts of data sources – how well are they retained and portrayed?	Description of background or historical developments and social/organisational characteristics of study sites or settings Participants' perspectives/observations placed in personal context *(e.g. use of case studies/vignettes/individual profiles, textual extracts annotated with details of contributors)* Explanation of origins/history of written documents Use of data management methods that preserve context *(i.e. facilitate within case description and analysis)*	

	a) Appraisal questions	b) Quality indicators (possible features for consideration)	c) Notes on study being appraised
12 ANALYSIS	How well has diversity of perspective and content been explored?	Discussion of contribution of sample design/case selection in generating diversity Description and illumination of diversity/multiple perspectives/alternative positions in the evidence displayed Evidence of attention to negative cases, outliers or exceptions Typologies/models of variation derived and discussed Examination of origins/influences on opposing or differing positions Identification of patterns of association/linkages with divergent positions/groups	
13 ANALYSIS	How well has detail, depth and complexity (i.e. richness) of the data been conveyed?	Use and exploration of contributors' terms, concepts and meanings Unpacking and portrayal of nuance/subtlety/intricacy within data Discussion of explicit and implicit explanations Detection of underlying factors/influences Identification and discussion of patterns of association/conceptual linkages within data Presentation of illuminating textual extracts/observations	
14 REPORTING	How clear are the links between data, interpretation and conclusions – i.e. how well can the route to any conclusions be seen?	Clear conceptual links between analytic commentary and presentations of original data *(i.e. commentary and cited data relate; there is an analytic context to cited data, not simply repeated description)* Discussion of how/why particular interpretation/significance is assigned to specific aspects of data – with illustrative extracts of original data Discussion of how explanations/ theories/conclusions were derived – and how they relate to interpretations and content of original data *(i.e. how warranted)*; whether alternative explanations explored Display of negative cases and how they lie outside main proposition/theory/ hypothesis etc.; or how proposition etc. revised to include them	

	a) Appraisal questions	b) Quality indicators (possible features for consideration)	c) Notes on study being appraised
15 **REPORTING**	How clear and coherent is the reporting?	Demonstrates link to aims of study/research questions Provides a narrative/story or clearly constructed thematic account Has structure and signposting that usefully guide reader through the commentary Provides accessible information for intended target audience(s) Key messages highlighted or summarised	
16 **REFLEXIVITY & NEUTRALITY**	How clear are the assumptions/theoretical perspectives/values that have shaped the form and output of the evaluation?	Discussion/evidence of the main assumptions/hypotheses/theoretical ideas on which the evaluation was based and how these affected the form, coverage or output of the evaluation *(the assumption here is that no research is undertaken without some underlying assumptions or theoretical ideas)* Discussion/evidence of the ideological perspectives/values/philosophies of research team and their impact on the methodological or substantive content of the evaluation *(again, may not be explicitly stated)* Evidence of openness to new/ alternative ways of viewing subject/ theories/assumptions *(e.g. discussion of learning/concepts/ constructions that have emerged from the data; refinement restatement of hypotheses/theories in light of emergent findings; evidence that alternative claims have been examined)* Discussion of how error or bias may have arisen in design/data collection/analysis and how addressed, if at all Reflections on the impact of the researcher on the research process	

	a) Appraisal questions	b) Quality indicators (possible features for consideration)	c) Notes on study being appraised
17 ETHICS	What evidence is there of attention to ethical issues?	Evidence of thoughtfulness/sensitivity about research contexts and participants Documentation of how research was presented in study settings/to participants *(including, where relevant, any possible consequences of taking part)* Documentation of consent procedures and information provided to participants Discussion of confidentiality of data and procedures for protecting Discussion of how anonymity of participants/sources was protected Discussion of any measures to offer information/advice/services etc. at end of study *(i.e. where participation exposed the need for these)* Discussion of potential harm or difficulty through participation, and how avoided	
18 AUDITABILITY	How adequately has the research process been documented?	Discussion of strengths and weaknesses of data sources and methods Documentation of changes made to design and reasons; implications for study coverage Documentation and reasons for changes in sample coverage/data collection/ analytic approach; implications Reproduction of main study documents *(e.g. letters of approach, topic guides, observation templates, data management frameworks etc.)*	

Appendix B. Downs and Black's (1998) Checklist for Quality Rating

Quantitative Research – Adapted Version

Reporting

1. *Is the hypothesis/aim/objective of the study clearly described?*

Yes	1
No	0

2. *Are the main outcomes to be measured clearly described in the Introduction or Methods section?* If the main outcomes are first mentioned in the Results section, the question should be answered no.

Yes	1
No	0

3. *Are the characteristics of the patients included in the study clearly described?* In cohort studies and trials, inclusion and/or exclusion criteria should be given. In case-control studies, a case-definition and the source for controls should be given.

Yes	1
No	0

4. *Are the main findings of the study clearly described?* Simple outcome data (including denominators and numerators) should be reported for all major findings so that the reader can check the major analyses and conclusions. (This question does not cover statistical tests which are considered below).

Yes	1
No	0

5. *Does the study provide estimates of the random variability in the data for the main outcomes?* In non-normally distributed data the inter-quartile range of results should be reported. In normally distributed data the standard error, standard deviation or confidence intervals should be reported. If the distribution of the data is not described, it must be assumed that the estimates used were appropriate and the question should be answered yes.

Yes	1
No	0

6. *Have all important adverse events that may be a consequence of the intervention been reported?* This should be answered yes if the study demonstrates that there was a comprehensive attempt to measure adverse events. (A list of possible adverse events is provided).

Yes	1
No	0

7. *Have the characteristics of patients lost to follow-up been described?* This should be answered yes where there were no losses to follow-up or where losses to follow-up were so small that findings would be unaffected by their inclusion. This should be answered no where a study does not report the number of patients lost to follow-up.

Yes	1
No	0

8. *Have actual probability values been reported(e.g. 0.035 rather than <0.05) for the main outcomes except where the probability value is less than 0.001?*

Yes	1
No	0

External validity

All the following criteria attempt to address the representativeness of the findings of the study and whether they may be generalised to the population from which the study subjects were derived.

9. *Were the subjects asked to participate in the study representative of the entire population from which they were recruited?* The study must identify the source population for patients and describe how the patients were selected. Patients would be representative if they comprised the entire source population, an unselected sample of consecutive patients, or a random sample. Random sampling is only feasible where a list of all members of the relevant population exists. Where a study does not report the proportion of the source population from which the patients are derived, the question should be answered as unable to determine.

Yes	1
No	0
Unable to determine	0

10. *Were those subjects who were prepared to participate representative of the entire population from which they were recruited?* The proportion of those asked who agreed should be stated. Validation that the sample was representative would include demonstrating that the distribution of the main confounding factors was the same in the study sample and the source population.

Yes	1
No	0
Unable to determine	0

11. *Were the staff, places, and facilities where the patients were treated, representative of the treatment the majority of patients receive?* For the question to be answered yes the study should demonstrate that the intervention was representative of that in use in the source population. The question should be answered no if, for example, the intervention was undertaken in a specialist centre unrepresentative of the hospitals most of the source population would attend.

Yes	1
No	0
Unable to determine	0

Internal validity – bias

12. *Was an attempt made to blind study subjects to the intervention they have received?* For studies where the patients would have no way of knowing which intervention they received, this should be answered yes.

Yes	1
No	0
Unable to determine	0

13. *Was an attempt made to blind those measuring the main outcomes of the intervention?*

Yes	1
No	0
Unable to determine	0

14. *If any of the results of the study were based on "data dredging", was this made clear?* Any analyses that had not been planned at the outset of the study should be clearly indicated. If no retrospective unplanned subgroup analyses were reported, then answer yes.

Yes	1
No	0
Unable to determine	0

15. *In trials and cohort studies, do the analyses adjust for different lengths of follow-up of patients, or in case-control studies, is the time period between the intervention and outcome the same for cases and controls?* Where follow-up was the same for all study patients the answer should yes. If different lengths of follow-up were adjusted for by, for example, survival analysis the answer should be yes. Studies where differences in follow-up are ignored should be answered no.

Yes	1
No	0
Unable to determine	0

16. *Were the statistical tests used to assess the main outcomes appropriate?* The statistical techniques used must be appropriate to the data. For example nonparametric methods should be used for small sample sizes. Where little statistical analysis has been undertaken but where there is no evidence of bias, the question should be answered yes. If the distribution of the data (normal or not) is not described it must be assumed that the estimates used were appropriate and the question should be answered yes.

Yes	1
No	0
Unable to determine	0

17. *Were the main outcome measures used accurate (valid and reliable)?* For studies where the outcome measures are clearly described, the question should be answered yes. For studies which refer to other work or that demonstrates the outcome measures are accurate, the question should be answered as yes.

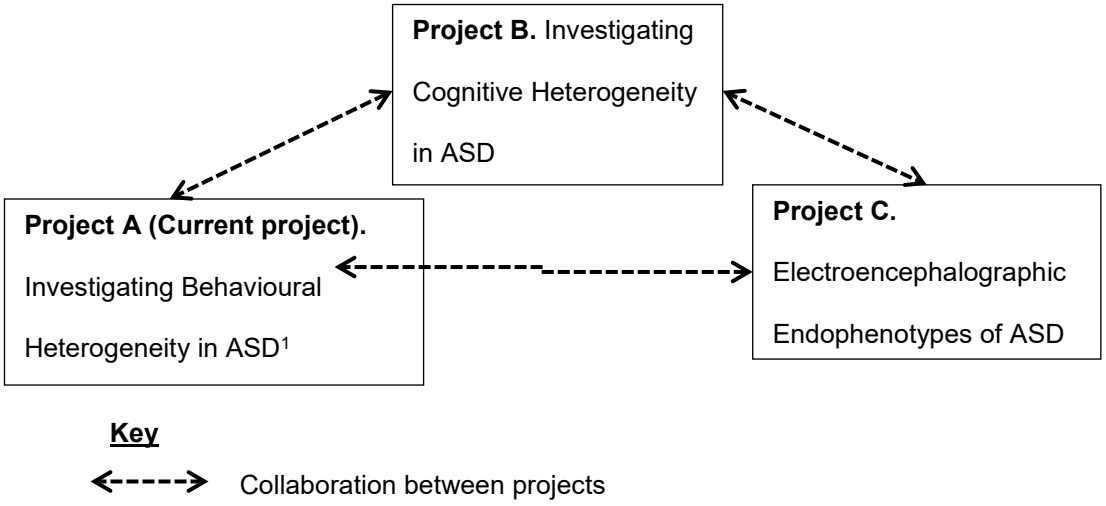
Yes	1
No	0
Unable to determine	0

Power

18. *Did the study have sufficient power to detect a clinically important effect where the probability value for a difference being due to chance is less than 5%?*

Yes	1
No	0

Appendix C. Related Research Projects



[1]ASD is autism spectrum disorders

Figure C.1. Relationship between the three projects

Table C.1

The Related Studies, and the Roles of the Researchers Involved

	Project Title	Lead Researcher	Academic Supervisor	NHS Supervisor	Collaborators
Project A (Current Project)	Investigating Behavioural Heterogeneity in ASD	Jen Gallagher	Elizabeth Milne/ Megan Freeth	Natalie Taylor	Holly Johnson Luisa Rosas Martinez
Project B	Investigating Cognitive Heterogeneity in ASD	Holly Norbron	Elizabeth Milne/ Megan Freeth	Natalie Taylor	Jen Gallagher Luisa Rosas Martinez
Project C	Electroencephalographic Endophenotypes of ASD	Elizabeth Milne	Elizabeth Milne/ Ying Zheng	N/A	Luisa Rosas-Martinez Jen Gallagher Holly Norbron

Projects A and B will contribute towards the Doctorate in Clinical Psychology (DClinPsy) qualification and will be led by Trainee Clinical Psychologists, as detailed in Table C.1. Project C is a project being led by a PhD student in the Department of Psychology, and will contribute towards this qualification.

Material Collaboration

In order to reduce the amount of time that participants must be tested for, the researchers consulted with each other to decide whether some of the measures could be used for multiple purposes across the projects. **Table C.2** details the measures that were employed, the variables that were or will be extracted from them, and the aims that they relate to. For example, rather than using an additional Weschler scale to obtain an indicator of intellectual functioning for Project A, and equivalent will be extracted from the British Ability Scales, which is already being used substantially in Project B. Similarly, the Autism Diagnostic Observation Schedule (ADOS) will be used in detail in Project A, but will also be employed as an indicator of severity of autism in Project B.

The demographic information for all three projects will be collected using two questionnaires developed for Project C, the Brief Medical History Questionnaire and the Developmental History Questionnaire. These questionnaires collect all of the relevant demographics highlighted in previous projects in the evidence base, and this data will be used descriptively.

Table C.2

Aims, Variables and Measures Used in the Three Projects

Project	Aims	Variables	Measure
Project A	***Aim 1.*** Explore how social and communicative behavioural presentations cluster with intellectual functioning to form subgroups of autism.	Social Behaviour	ADOS[1] Social Interaction Scale
		Communication Behaviour	ADOS Communication Scale
		Intellectual Functioning	The GCA[2] or SNC[3] from BAS-II[4]
	Aim 2. Explore the properties of the emergent subgroups.	Various demographic variables, e.g. diagnosis, age of onset, birth complications.	Brief Medical History Questionnaire Developmental History Questionnaire
		Frontal brain activity	Alpha band frontal power from the EEG[5] recording
		Repetitive behaviour	ADOS repetitive behaviour average score
		Wing subgroup	Categorical variable from WSQ[6]
		Autism Severity	SCQ[7] total score
		Intellectual functioning, communication and social behaviour as for Aim 1	As above
	Aim 3. Explore whether the emergent subgroups relate to the existing model proposed by Wing & Gould (1979) including the subgroups of social aloofness, active-but-odd interaction, passive interaction, and appropriate interaction, and explore the relationships with alpha power in the frontal region and symptom severity.	Frontal brain activity, Wing subgroups, Clusters from Aim 1, intellectual functioning, social and communication behaviour, autism severity	As above

Project	Aims	Variables	Measure
Project B	***Aim 1.*** Use correlational and descriptive techniques to explore the cognitive heterogeneity within a group of children with and without ASD based on their performance on a test of general cognitive ability, profiles of EEG activity and measures of head circumference.	General intellectual ability	The GCA or SNC from the BAS-II
		Verbal-nonverbal IQ discrepancy	Verbal and non-verbal scores from the BAS-II
		Visuo-spatial ability	Spatial ability score from the BAS-II
		Head circumference	Physical measurement
		Neural activity in the visual cortex	Gamma band frequency in visual cortex from EEG recordings.
	Aim 2. To investigate the presence of cognitive subgroups in the sample based on the above variables using cluster analysis methods and provide a description of these profiles to inform future research.	Clusters extracted from aim 1.	As above
	Aim 3. To explore the demographics of the emergent subgroups such as type and severity of diagnosis, age, gender and developmental history.	Various demographic variables, e.g., Type and severity of diagnosis, age and gender	ADOS total domain scores Brief Medical History Questionnaire Developmental History Questionnaire

Project	Aims	Variables	Measure
Project C	***Aim 1.*** Define an EEG-based measure to determine the degree of connectivity among regions.	Neural complexity	Entropy Coherence Frequency Spectrum
	Aim 2. Analyse the scale of brain connectivity along neurodevelopment.	Neural complexity	As above
		Intellectual ability	The GCA or SNC from the BAS-II
		Various demographic variables, e.g. age, gender and diagnosis	Brief Medical History Questionnaire Developmental History Questionnaire ADOS total domain scores
		Head circumference	Physical measurement
	Aim 3. Analyse the degree of affectation of autism based on EEG connectivity measurements.	Neural complexity	As above

[1] Autism Diagnostic Observation Schedule (ADOS)
[2] General Conceptual Ability Score (GCA)
[3] Special Non-Verbal Composite Score (SNC)
[4] British Ability Scales, 2nd edition (BAS-II)
[5] Electroencephalograph (EEG)
[6] Wing Subgrouping Questionnaire (WSQ)
[7] Social Communication Questionnaire (SCQ)

Physical Collaboration

To maximise the number of participants that could take part within the time constraints imposed by the DClinPsy course, there was collaboration between Jen Gallagher, Holly Norbron and Luisa Rosas Martinez. This also aimed to reduce fatigue effects and increase comfort for participants, as testing took up to two to three hours in total. Some of the data was collected by bringing the equipment to a school or service where this was more convenient for the participants. This collaboration also meant that there was less demand on the resources provided by the service (e.g. room bookings) as the testing could be carried out over a shorter period of time.

At all testing sessions there were at least two researchers present to ensure that transitions between the tests were smooth, the child was continuously engaged by at least one researcher, and additional tests and equipment could be accessed should any modifications be required. For example, if it emerged that a different module of the ADOS would be more appropriate, this could easily be set up by one researcher whilst the other proceeded with one of the other tests. The EEG equipment was always set up by Luisa, who was trained in using the equipment in order to maximise the quality of the recordings.

Appendix D. Letter from School for Children with ASD

The University Of Sheffield.

Department Of Psychology.

Sheffield Autism Research Lab (ShARL)
Department of Psychology University of Sheffield

Dear Parent,

We are contacting you because you have a child with an autistic spectrum disorder and your child's school have given their consent for us to contact you regarding participation in a research project. This research is being conducted as part of three Doctoral Theses in Psychology at the University of Sheffield in collaboration with the Sheffield Autism Research Lab (ShARL).

Autism affects many people in the UK, roughly 1 in every 100 people have the disorder. While there is no known cure for autism, early diagnosis, improved understanding and treatment can make a big difference in how people with autism and their families cope.

We have enclosed an information sheet giving details of an on-going research study at the University of Sheffield, and we would like to invite your child to take part. If you would like your child to take part, please complete the form below and return it to us in the pre paid envelope. The research will take place at your child's school and an appointment will be made for them to attend a session during school time. After reading the information enclosed, if you would like your child to participate, please complete the consent form and return to us in the envelope provided. Your child will not be able to take part without your prior consent. It is not necessary for you to be present at the session; however, if you would like to attend, please contact us and we will try to accommodate this.

Children who take part in our studies usually find them interesting and enjoyable and will be contributing to something that is very important. Our research would not be possible without the support of parents. We hope you consider assisting us in gaining a better understanding of autism.

Thank you for your interest.

Holly Norbron and Jen Gallagher
(Trainee Clinical Psychologists)
HNorbron1@Sheffield.ac.uk
JGallagher2@sheffield.ac.uk

Sheffield Autism Research Lab
Director - Dr Elizabeth Milne
E.Milne@sheffield.ac.uk
(0114) 2226558

Department of Psychology
University of Sheffield
S10 2TN

www.autismresearchlab.group.shef.ac.uk

Appendix E. Letter from CAMHS for Children with ASD

The University Of Sheffield.

Department Of Psychology.

Sheffield Autism Research Lab (ShARL)
Department of Psychology University of Sheffield

Dear Parent,

We are contacting you because you have a child with an autistic spectrum disorder and the CAMHS team you are involved with have given their consent for us to contact you regarding participation in a research project. This letter has been send to you directly from your CAMHS team and we do not currently you're your personal details. This research is being conducted as part of three Doctoral Theses in Psychology at the University of Sheffield in collaboration with the Sheffield Autism Research Lab (ShARL).

Autism affects many people in the UK, roughly 1 in every 100 people have the disorder. While there is no known cure for autism, early diagnosis, improved understanding and treatment can make a big difference in how people with autism and their families cope.

We have enclosed an information sheet giving details of an on-going research study at the University of Sheffield, and we would like to invite your child to take part. If you would like your child to take part, please complete the form below and return it to us in the pre paid envelope. We will then contact you in order to ask a few questions which will enable us to ensure that your child is eligible for the study, and if so, to arrange an appointment for you and your child to attend. At this appointment, you will be asked to sign a consent form before your child can participate in the study.

Children who take part in our studies usually find them interesting and enjoyable and will be contributing to something that is very important. Our research would not be possible without the support of parents. We hope you consider assisting us in gaining a better understanding of autism.

Thank you for your interest.

Holly Norbron and Jen Gallagher
(Trainee Clinical Psychologists)
HNorbron1@Sheffield.ac.uk
JGallagher2@sheffield.ac.uk

Sheffield Autism Research Lab
Director - Dr Elizabeth Milne
E.Milne@sheffield.ac.uk
(0114) 2226558

Department of Psychology
University of Sheffield
S10 2TN

www.autismresearchlab.group.shef.ac.uk

Appendix F. Information Sheet from School for Children with ASD

The University Of Sheffield.

Department Of Psychology.

Investigating Subtypes in Autistic Spectrum Disorder

You and your child are being invited to take part in a research project. This project is funded by the Clinical Psychology Unit at the University of Sheffield with the Sheffield Autism Research Lab (ShARL). Your taking part will help develop a greater understanding of autism. We are investigating the brain activity, behaviour and intellectual ability (cognition) of people with Autistic Spectrum Disorders (ASD) to explore whether there are different types within the spectrum. People with ASD can present themselves in very different ways e.g., some people with ASD can be very talkative whereas others do not speak at all; some can have very high intelligence whereas others have severe learning difficulties. The long-term goals of this research are to identify and define the sub-types of ASD. This will help earlier diagnosis of ASD and to develop intervention / support programs to the specific needs of an individual.

We have found that children generally enjoy being involved in research projects such as this; the experimenters make the tasks fun and interesting, and participants get to see patterns of their brain activity on screen. The experimenters explain, in simple terms, the processes behind this which really helps to bring the science to life. This can be a great learning opportunity – especially for children who are interested in science and the human body.

If this sounds like something your child may like to be involved in, please read the rest of this information sheet which gives you more details. If, after reading this you have further questions, please don't hesitate to get in touch.

Why have I been contacted?

This information sheet has been sent to you from your child' s school. The teachers working with your child have identified you because your child may be able to take part in this research project. Your child has been invited to take part because they have a diagnosis of an ASD.

Who can take part?

To take part in this study, your child must have a diagnosis of autism, Asperger's syndrome, atypical autism or pervasive developmental disorder not otherwise specified (PDD-NOS).

Children must be at least five years old and no older than 18 years old to take part. In order to complete some of the activities, it is important that your child has some expressive language (i.e. can talk in at least single-words or short phrases).

Is there any reason why my child should not take part?

Part of the study involves looking at images on a computer screen. Some of the images contain flickering black and yellow, and green and red vertical lines. If you know that your child is sensitive to flickering images, if your child has epilepsy, has ever had a seizure or suffers from migraines then they should not take part in this study. This is because looking at these images may trigger their symptoms. However, if your child has never had a seizure, does not have epilepsy, does not suffer from migraines and is not sensitive to flickering images then there is no reason why they should not take part.

The EEG component of this study requires your child to wear a cap on their head. If you think your child would be distressed by wearing this, or by the researchers touching their head and face to set up the equipment, then you may not wish to take part in the study. If you do decide to take part and your child appears uncomfortable on the day, we will stop.

We expect that most children will need to take breaks during testing. However, if you feel that your child would be very restless or would be distressed by the length of this study (up to two hours) then you may not wish to take part.

What will happen if my child does take part?

We will be visiting your child' s school between XX and XX. If you have consented for your child to take part in this research then we will carry out the testing in school during this time. The study is made up of three parts:

1. We will have a play session. During this time an experimenter will talk to your child and ask them to complete a number of short tasks (e.g. looking at a picture book, describing a picture). To help us with our scoring this part will be video recorded.
2. We will ask your child to complete some general ability tests. This consists of solving a number of verbal and non-verbal puzzles.
3. We will measure your child's brain activity while they look at patterns that appear and disappear on a computer screen. This will be done using electroencephalogram (EEG). Here is a picture of what the equipment looks like:

An EEG helps us to understand how the brain works. EEG is a harmless and painless procedure which involves placing a flexible head cap onto the head. A small amount of gel is used so your child's hair may get wet in places. Once the cap and sensors have been placed onto the head we will ask your child to sit still on a comfy chair and watch the computer screen. This part will take about 40 minutes: 20-30 minutes to put the cap on, then 10 minutes watching the screen. It will help us if your child does not wear any products in their hair on the day of the testing, and if they can arrive with dry hair.

If they are not comfortable or if you or the researchers feel that your child is distressed then the testing will be stopped.

How long will it take?

The study will take about two hours all together. We will aim to accommodate whatever arrangement is most convenient for you and most suitable for your child. It is possible to book two one-hour sessions if you feel that this would be more manageable for your child. This may be two sessions spread out across one day with a break in the middle, or it may be two sessions on different days.

As a parent what will I have to do?

You will be asked to accompany your child to the testing session. As your child is under 16, you will need to give written consent for them to take part.

We will also ask you to complete some questionnaires about your child's development and behaviour.

Appendix G. Parent Consent Form

Parent Consent form. Version 2. 24th July 2012.

Parent Consent Form

Title of Research Project: Investigating Subtypes in Autism Spectrum Disorder

Researchers: Holly Norbron and Jen Gallagher (Trainee Clinical Psychologists); Luisa Rosas-Martinez (PhD Student); Dr Elizabeth Milne (Supervisor).

Participant Name:_____

Please Initial Box

1. I confirm that I have read and understand the information sheet dated 23rd July 2012 explaining the above research project and I have had the opportunity to ask questions about the project. ☐
2. I understand that mine and my child's participation is voluntary and that we are free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I or my child not wish to participate on the day or decide not to answer any particular question or questions, we are free to decline. ☐
3. I understand that mine and my child's responses will be kept strictly confidential within the research team. I give permission for members of the research team to have access to my and my child's anonymised responses. I understand that neither my name nor my child's name will be linked with the research materials, and we will not be identified or identifiable in the report or reports that result from the research. ☐
4. I agree for my child to be video recorded for the purpose of accurate assessment. ☐
5. I understand that relevant sections of data collected during the study may be looked At by individuals from regulatory authorities or from the NHS Trust, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records. ☐
6. I agree for my child to take part in the above research project. ☐

	Yes	No
7. Please answer the following medical questions (please tick yes or no):		
a. Has your child ever had an epileptic fit?	☐	☐
b. Has your child ever had a migraine?	☐	☐
c. Has your child ever had any type of seizure?	☐	☐
d. To your knowledge does your child display sensitivity to flickering lights?	☐	☐

Name of Parent or legal guardian	Date	Signature

Name of Researcher	Date	Signature

Please contact us if you have any further questions:

Holly Norbron (Trainee Clinical Psychologist)
HNorbron1@Sheffield.ac.uk

Jen Gallagher (Trainee Clinical Psychologist)
JGallagher2@Sheffield.ac.uk

Clinical Psychology Unit
The University of Sheffield
Western Bank
Sheffield
S10 2TN
Tel: 0114 2226558

Appendix H. Information Sheet for Participants Over 16 Years Old

The University Of Sheffield.

Department Of Psychology.

Investigating Subtypes in Autistic Spectrum Disorder

You are invited to take part in a research project. We are investigating the brain activity, behaviour and intellectual ability of people with Autistic Spectrum Disorders (ASD) to explore whether there are different types. This will help earlier detection of ASD and to provide help and support for people.

We have found that people generally enjoy research projects such as this; we make the tasks fun and interesting, and you get to see patterns of your brain activity on screen. We explain, in simple terms, the processes behind this which really helps to bring the science to life. This can be a great learning opportunity – especially for people who are interested in science and the human body.

If this sounds like something you may like to be involved in, please read the rest of this information sheet which gives you more details. If you have further questions please don't hesitate to get in touch.

Why have I been contacted?

This information sheet has been sent to you from your school. Your teachers have identified that you may be able to take part because you have a diagnosis of an ASD, and because you are 18 years old or younger.

Is there any reason why I should not take part?

Part of the study involves looking at images on a computer screen. Some of the images contain flickering black and yellow, and green and red vertical lines. If you are sensitive to flickering images, if you have epilepsy, have ever had a seizure or suffer from

migraines then you should not take part in this study. This is because looking at these images may trigger your symptoms.

During the EEG you need to wear a cap on your head. We will also need to touch your head and face. If this might upset you then you may not wish to take part in the study. If you do decide to take part and you seem uncomfortable on the day, we will stop.

You will be able to take breaks during testing. However, if you would feel very restless or if taking part for two hours would upset you then you may not wish to take part.

What will happen if I do take part?

We will be visiting your school between XX and XX.

There will be three kinds of activity:

1. We will have play session. We will talk with you and ask you to do some tasks. This will be video recorded.
2. We will ask you to solve some puzzles.
3. We will measure your brain activity while you look at patterns that appear and disappear on a computer screen. This will be done using electroencephalogram (EEG). Here is a picture of what the equipment looks like:

EEG is a harmless and painless. You will wear a flexible head cap on your head. A small amount of gel is used so your hair may get wet in places. This part will take about 40 minutes: 20-30 minutes to put the cap on, then 10 minutes watching the screen. It will help us if you do not wear any products in their hair on the day of the testing, and if you can arrive with dry hair.

If you are not comfortable or if we feel that you are distressed then the testing will be stopped.

How long will it take?

The study will take about two hours all together. You can have two one-hour sessions if you would prefer. This may be two sessions spread out across one day with a break in the middle, or it may be two sessions on different days.

What will my parents have to do?

Your parents will be asked to complete some questionnaires about your development, behaviour and health.

Do I have to take part?

It is up to you to decide whether or not to take part. If you choose not to take part this will not have any negative effects for you and it will not affect the service you receive from school. Even if you agree to take part now, you can withdraw at any time without giving a reason.

What are the possible disadvantages and risks?

In a very small number of people (less than 1 in 4000), looking at the flickering lines used in this study can trigger a photosensitive seizure. This will only happen in people who have photosensitive seizure disorder, i.e. people who are sensitive to flashing, intermittent light, and visual patterns. This is why we will not let you participate in this study if you have epilepsy, any seizure history or if you are prone to migraines. If you do not have photosensitive seizure disorder, or epilepsy, and if you do not suffer with migraines, then there are no risks involved in the procedures.

Your hair may become messy with gel deposits during the EEG. This gel will wash out easily with shampoo.

What are the possible benefits?

There are no direct benefits of taking part. However you may find it interesting to learn how researchers study brain activity. Most participants find this fun and interesting. You may also feel pleased that you have contributed to autism research.

Will you be able to diagnose unusual brain activity?

These tests are for research purposes only. We are not trained to interpret EEG recordings for clinical purposes, and so we will not be able to advise whether your brain activity is normal or unusual.

If you are concerned, we recommend that you consult your General Practitioner.

What will happen to my information?

All information that is collected about you during the study will be kept strictly confidential within this research team. You will not be identified in any reports or publications related to this research.

Paper records and video recordings will be stored securely with the Department of Psychology. These will be destroyed once they are no longer being used.

We will inform your GP that you are taking part in this research.

What if something goes wrong?

If you are unhappy about the treatment that you receive from the researchers, you can contact the project supervisor Dr Elizabeth Milne on (0114) 222 6558. If you feel that your complaint has not been handled to your satisfaction, you can contact the University's Registrar and Secretary. In the unlikely event of an adverse incident during your child's visit, we will report this according to University guidance.

What will happen to the results of the research project?

The results of the study will be analysed by Holly Norbron, Jen Gallagher, Dr Elizabeth Milne and Luisa Rosas-Martinez. The results are likely to be published in scientific journals up to two years after the research has taken place and written up as three doctoral-level theses. No information about any individuals will be available from this report. We will not be providing individual feedback. However you will be able to get a summary of the findings of the project from any of the researchers involved if you wish.

Who has ethically reviewed the project?

The project has been reviewed and given a favourable ethical opinion by South Yorkshire Research Ethics Committee.

I want to take part, what do I do now?

Please complete the enclosed form and return it to your teacher. Please ensure that you answer all questions on the consent form and sign and date the form. We will then include you in our study when we visit the school.

Thank you for taking the time to read this information sheet.

Appendix I. Consent Form for Participants Over 16 Years Old

16 Years+ Participant consent form. Version 2. 23rd July 2012.

16 Years+ Participant Consent Form

Title of Research Project: Investigating Subtypes in Autism Spectrum Disorder

Researchers: Holly Norbron and Jen Gallagher (Trainee Clinical Psychologists); Luisa Rosas-Martinez (PhD Student); Dr Elizabeth Milne (Supervisor).

Participant Name:_____

	Please Initial Box
1. I have read the information sheet dated 27th July 2012 and I have been able to ask questions about it.	☐
2. I understand that I do not have to take part if I don't want to.	☐
3. I understand that I can stop at any time.	☐
4. I understand that my information will not be shared with anyone outside of the research team without my permission.	☐
5. I agree to take part in this project.	☐
6. I agree for the research team to contact my parent or guardian to gather further information about my development and my health.	☐
7. I agree to be video recorded.	☐

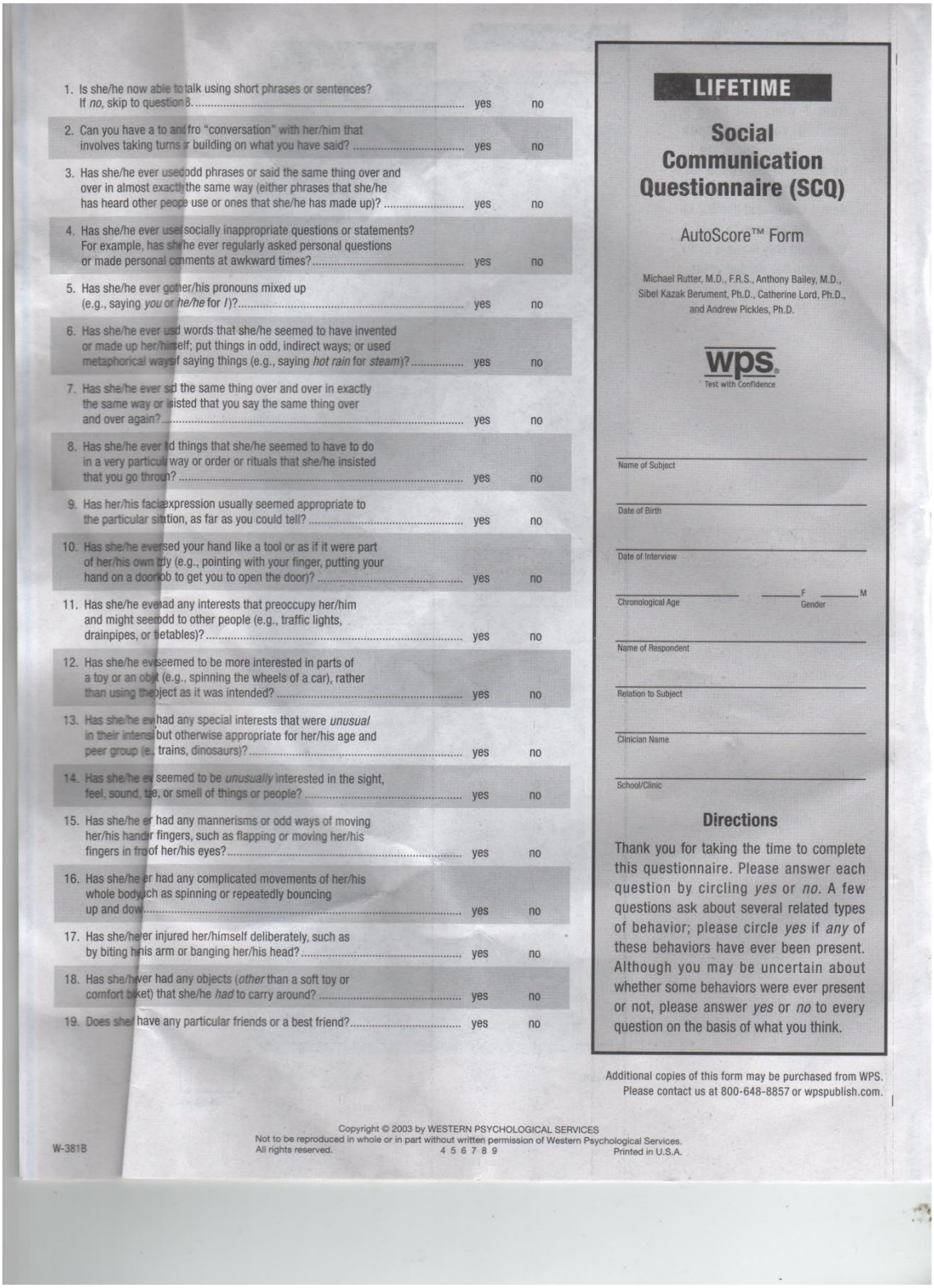
8. I understand that relevant sections of data collected during the study may be looked at by individuals from regulatory authorities or from the NHS Trust, where it is relevant to my taking part in this research. I give permission for these individuals to have access to my records. ☐

Name of Participant	Date	Signature

Name of Researcher	Date	Signature

Appendix J. Exemplar Measures

Appendix J.1 Social Communication Questionnaire Lifetime Version



1. Is she/he now able to talk using short phrases or sentences? If *no*, skip to question 8. ..... yes no
2. Can you have a to and fro "conversation" with her/him that involves taking turns or building on what you have said? ..... yes no
3. Has she/he ever used odd phrases or said the same thing over and over in almost exactly the same way (either phrases that she/he has heard other people use or ones that she/he has made up)? ..... yes no
4. Has she/he ever used socially inappropriate questions or statements? For example, has she/he ever regularly asked personal questions or made personal comments at awkward times? ..... yes no
5. Has she/he ever gotten/his pronouns mixed up (e.g., saying *you* or *he/he* for *I*)? ..... yes no
6. Has she/he ever used words that she/he seemed to have invented or made up her/himself; put things in odd, indirect ways; or used metaphorical ways of saying things (e.g., saying *hot rain* for *steam*)? ..... yes no
7. Has she/he ever said the same thing over and over in exactly the same way or insisted that you say the same thing over and over again? ..... yes no
8. Has she/he ever had things that she/he seemed to have to do in a very particular way or order or rituals that she/he insisted that you go through? ..... yes no
9. Has her/his facial expression usually seemed appropriate to the particular situation, as far as you could tell? ..... yes no
10. Has she/he ever used your hand like a tool or as if it were part of her/his own body (e.g., pointing with your finger, putting your hand on a doorknob to get you to open the door)? ..... yes no
11. Has she/he ever had any interests that preoccupy her/him and might seem odd to other people (e.g., traffic lights, drainpipes, or vegetables)? ..... yes no
12. Has she/he ever seemed to be more interested in parts of a toy or an object (e.g., spinning the wheels of a car), rather than using the object as it was intended? ..... yes no
13. Has she/he ever had any special interests that were *unusual* in their intensity but otherwise appropriate for her/his age and peer group (e.g., trains, dinosaurs)? ..... yes no
14. Has she/he ever seemed to be *unusually* interested in the sight, feel, sound, taste, or smell of things or people? ..... yes no
15. Has she/he ever had any mannerisms or odd ways of moving her/his hands or fingers, such as flapping or moving her/his fingers in front of her/his eyes? ..... yes no
16. Has she/he ever had any complicated movements of her/his whole body, such as spinning or repeatedly bouncing up and down ..... yes no
17. Has she/he ever injured her/himself deliberately, such as by biting her/his arm or banging her/his head? ..... yes no
18. Has she/he ever had any objects (*other* than a soft toy or comforter/blanket) that she/he *had* to carry around? ..... yes no
19. Does she/he have any particular friends or a best friend? ..... yes no

LIFETIME

Social Communication Questionnaire (SCQ)

AutoScore™ Form

Michael Rutter, M.D., F.R.S., Anthony Bailey, M.D., Sibel Kazak Berument, Ph.D., Catherine Lord, Ph.D., and Andrew Pickles, Ph.D.

WPS
Test with Confidence

Name of Subject

Date of Birth

Date of Interview

Chronological Age ____ F ____ M Gender

Name of Respondent

Relation to Subject

Clinician Name

School/Clinic

Directions

Thank you for taking the time to complete this questionnaire. Please answer each question by circling *yes* or *no*. A few questions ask about several related types of behavior; please circle *yes* if *any* of these behaviors have ever been present. Although you may be uncertain about whether some behaviors were ever present or not, please answer *yes* or *no* to every question on the basis of what you think.

Additional copies of this form may be purchased from WPS. Please contact us at 800-648-8857 or wpspublish.com.

W-381B

For the following behaviors, please focus on the time period between the child's fourth and fifth birthdays. You may find it easier to remember how things were at that time by focusing on key events, such as starting school, moving house, Christmastime, or other specific events that are particularly memorable for you as a family. If your child is not yet 4 years old, please consider her or his behavior in the past 12 months.

20. When she/he was 4 to 5, did she/he ever talk with you just to be friendly (rather than to get something)? ..... yes no

21. When she/he was 4 to 5, did she/he ever *spontaneously* copy you (or other people) or what you were doing (such as vacuuming, gardening, or mending things)? ..... yes no

22. When she/he was 4 to 5, did she/he ever spontaneously point at things around her/him just to show you things (not because she/he wanted them)? ..... yes no

23. When she/he was 4 to 5, did she/he ever use gestures, other than pointing or pulling your hand, to let you know what she/he wanted? ..... yes no

24. When she/he was 4 to 5, did she/he nod her/his head to mean *yes*? ..... yes no

25. When she/he was 4 to 5, did she/he shake her/his head to mean *no*? ..... yes no

26. When she/he was 4 to 5, did she/he usually look at you directly in the face when doing things with you or talking with you? ..... yes no

27. When she/he was 4 to 5, did she/he smile back if someone smiled at her/him? ..... yes no

28. When she/he was 4 to 5, did she/he ever show you things that interested her/him to engage your attention? ..... yes no

29. When she/he was 4 to 5, did she/he ever offer to share things other than food with you? ..... yes no

30. When she/he was 4 to 5, did she/he ever seem to want you to join in her/his enjoyment of something? ..... yes no

31. When she/he was 4 to 5, did she/he ever try to comfort you if you were sad or hurt? ..... yes no

32. When she/he was 4 to 5, when she/he wanted something or wanted help, did she/he look at you and use gestures with sounds or words to get your attention? ..... yes no

33. When she/he was 4 to 5, did she/he show a normal range of facial expressions? ..... yes no

34. When she/he was 4 to 5, did she/he ever spontaneously join in and try to copy the actions in social games, such as *The Mulberry Bush* or *London Bridge Is Falling Down*? ..... yes no

35. When she/he was 4 to 5, did she/he play any pretend or make-believe games? ..... yes no

36. When she/he was 4 to 5, did she/he seem interested in other children of approximately the same age whom she/he did not know? ..... yes no

37. When she/he was 4 to 5, did she/he respond positively when another child approached her/him? ..... yes no

38. When she/he was 4 to 5, if you came into a room and started talking to her/him without calling her/his name, did she/he usually look up and pay attention to you? ..... yes no

39. When she/he was 4 to 5, did she/he ever play imaginative games with another child in such a way that you could tell that they each understood what the other was pretending? ..... yes no

40. When she/he was 4 to 5, did she/he play cooperatively in games that required joining in with a group of other children, such as hide-and-seek or ball games? ..... yes no

Appendix J.2 Brief Medical History Questionnaire

Version 2. 06/11/11.

BRIEF MEDICAL HISTORY
QUESTIONNAIRE

CONFIDENTIALITY – The medical questionnaire and the information contained within will be treated as a confidential document.

Participant code:	Today's date:
Date of Birth:	Male/female (delete as appropriate):
Was your child born prematurely? Yes/No (delete as appropriate): If yes, at how many weeks?	How much did your child weigh at birth?
Completed by Parent/caregiver (delete as appropriate):	

If ASD diagnosed only	
Given clinical diagnosis:	Co-morbid diagnoses:

Please answer ALL of the following questions:

Medical Conditions					
You are asked to indicate whether your child currently has or has ever had any of the following medical conditions:					
1	Epilepsy; fits, blackouts, fainting turns or unexplained loss of consciousness	Yes	☐	No	☐
2	Head injuries leading to loss of consciousness requiring hospital admission	Yes	☐	No	☐
3	Recurrent headache or migraine	Yes	☐	No	☐
4	Anxiety/depression, phobias, mental breakdown or stress related problems	Yes	☐	No	☐
5	Visual impairment needing glasses/contact lenses	Yes	☐	No	☐
6	Injury or surgery to eye(s) including laser eye surgery or any other type of refractive surgery	Yes	☐	No	☐
7	Any visual defect e.g. scotoma, blindness in one eye, night blindness, colour blindness, reduced visual field, blurred vision or detached retina	Yes	☐	No	☐

Family History
Does anyone of your child's close relatives have a mental health condition (e.g. schizophrenia, autism spectrum disorder or any other)? If YES please give details and relationship.

Appendix J.3 Developmental History Questionnaire

Developmental History Questionnaire: ASD.

Version 2 02.05.12

Participant Code: _____

Participant Date of Birth: _____

Today's Date: _____

Please answer this series of questions about your child's developmental history. If you would rather not answer a particular question, feel free to miss it out. The first six questions ask about developmental history, i.e. when particular milestones were achieved. Please provide as much detail as possible. If you can't remember the time-course of these events, then just state this. The last two questions ask about current language abilities. Please provide examples if possible. If you are not sure how to interpret any of the questions, feel free to ask the experimenter.

History

1) How old was your child when they first started to communicate using single words? If you can't remember exactly, please simply indicate whether you feel that this was or was not at an appropriate age compared with other children.

_____

_____

2) How old was your child when they first started to communicate using short phrases? If you can't remember exactly, please simply indicate whether you feel that this was or was not at an appropriate age compared with other children.

_____

_____

3) Did you ever notice that your child regressed in their use of language, i.e. 'lost' certain words from their vocabulary, or stopped using language that had previously been used? _____

If YES, at what age did this occur? _____

Please elaborate if possible

_____

_____

_____

1

Have you felt that your child regressed in other areas of their ability? E.g. making eye contact, showing you how they feel (facial expressions), using gestures (e.g. pointing), showing you their toys etc. By regression, we mean that your child seemed to develop skills in a normal way, but later lost these skills. For example, a child who gestured a lot when they were 2 years old, but who stopped using gestures when they were 3 years old. Note that this is different from a child who never learned to make eye contact.

If YES, at what age did this occur? _____

Please elaborate if possible

_____

_____

_____

4) How old was your child when you first became concerned about their development?

_____

_____

5) How old was your child when they were given a diagnosis of ASD?

_____

_____

Current

1) Does your child currently show difficulties, compared to other children of the same age, in **understanding** spoken language? If so, please provide a description and example if possible.

_____

_____

_____

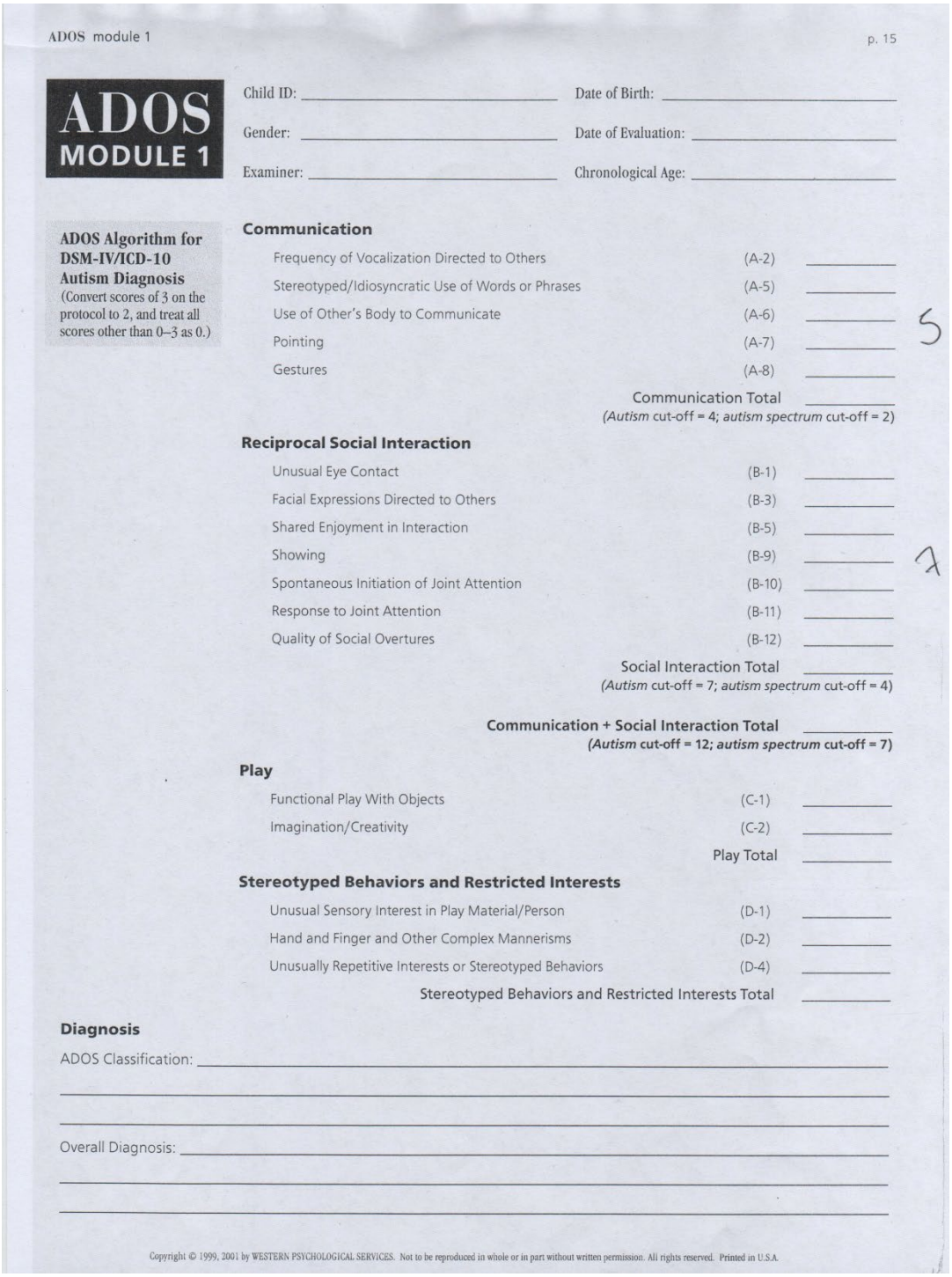
2) Does your child currently show difficulties, compared to other children of the same age, in **producing** spoken language (talking)? If so, please provide a description and example if possible.

_____

_____

_____

Appendix J.4 Autism Diagnostic Observation Schedule Module 1 Score Sheet



ADOS module 1 p. 15

ADOS MODULE 1

Child ID: _____ Date of Birth: _____

Gender: _____ Date of Evaluation: _____

Examiner: _____ Chronological Age: _____

ADOS Algorithm for DSM-IV/ICD-10 Autism Diagnosis
(Convert scores of 3 on the protocol to 2, and treat all scores other than 0–3 as 0.)

Communication

Frequency of Vocalization Directed to Others	(A-2)	_____
Stereotyped/Idiosyncratic Use of Words or Phrases	(A-5)	_____
Use of Other's Body to Communicate	(A-6)	_____
Pointing	(A-7)	_____
Gestures	(A-8)	_____
Communication Total		_____

(Autism cut-off = 4; *autism spectrum* cut-off = 2)

5

Reciprocal Social Interaction

Unusual Eye Contact	(B-1)	_____
Facial Expressions Directed to Others	(B-3)	_____
Shared Enjoyment in Interaction	(B-5)	_____
Showing	(B-9)	_____
Spontaneous Initiation of Joint Attention	(B-10)	_____
Response to Joint Attention	(B-11)	_____
Quality of Social Overtures	(B-12)	_____
Social Interaction Total		_____

(Autism cut-off = 7; *autism spectrum* cut-off = 4)

7

Communication + Social Interaction Total _____

***(Autism* cut-off = 12; *autism spectrum* cut-off = 7)**

Play

Functional Play With Objects	(C-1)	_____
Imagination/Creativity	(C-2)	_____
Play Total		_____

Stereotyped Behaviors and Restricted Interests

Unusual Sensory Interest in Play Material/Person	(D-1)	_____
Hand and Finger and Other Complex Mannerisms	(D-2)	_____
Unusually Repetitive Interests or Stereotyped Behaviors	(D-4)	_____
Stereotyped Behaviors and Restricted Interests Total		_____

Diagnosis

ADOS Classification: _____

_____

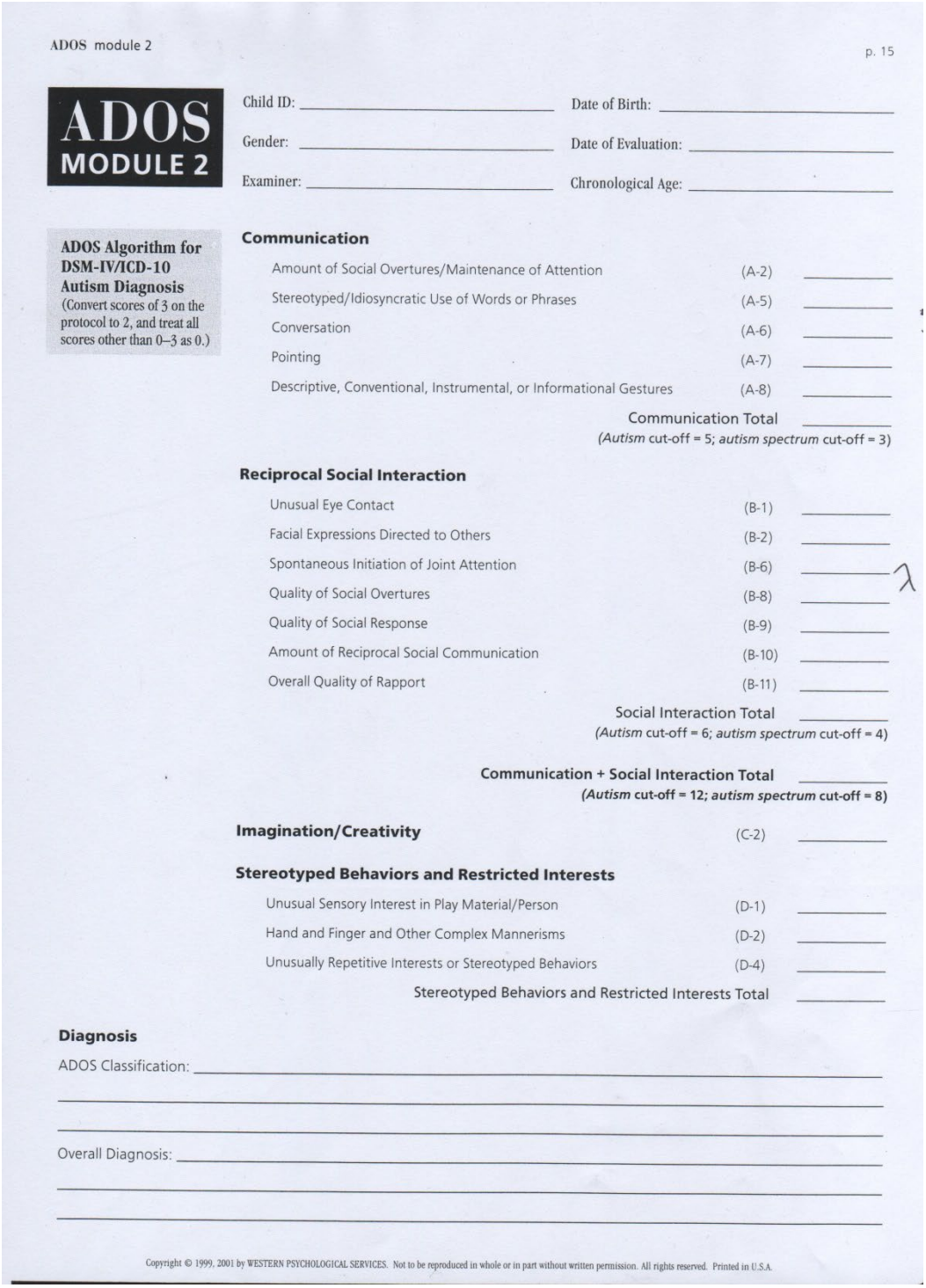
_____

Overall Diagnosis: _____

_____

_____

Appendix J.5 Autism Diagnostic Observation Schedule Module 2 Score Sheet



ADOS module 2 p. 15

ADOS MODULE 2

Child ID: _____ Date of Birth: _____

Gender: _____ Date of Evaluation: _____

Examiner: _____ Chronological Age: _____

ADOS Algorithm for DSM-IV/ICD-10 Autism Diagnosis
(Convert scores of 3 on the protocol to 2, and treat all scores other than 0–3 as 0.)

Communication

Amount of Social Overtures/Maintenance of Attention	(A-2)	_____
Stereotyped/Idiosyncratic Use of Words or Phrases	(A-5)	_____
Conversation	(A-6)	_____
Pointing	(A-7)	_____
Descriptive, Conventional, Instrumental, or Informational Gestures	(A-8)	_____
Communication Total		_____

(Autism cut-off = 5; *autism spectrum* cut-off = 3)

Reciprocal Social Interaction

Unusual Eye Contact	(B-1)	_____
Facial Expressions Directed to Others	(B-2)	_____
Spontaneous Initiation of Joint Attention	(B-6)	_____
Quality of Social Overtures	(B-8)	_____
Quality of Social Response	(B-9)	_____
Amount of Reciprocal Social Communication	(B-10)	_____
Overall Quality of Rapport	(B-11)	_____
Social Interaction Total		_____

(Autism cut-off = 6; *autism spectrum* cut-off = 4)

Communication + Social Interaction Total _____

***(Autism* cut-off = 12; *autism spectrum* cut-off = 8)**

Imagination/Creativity (C-2) _____

Stereotyped Behaviors and Restricted Interests

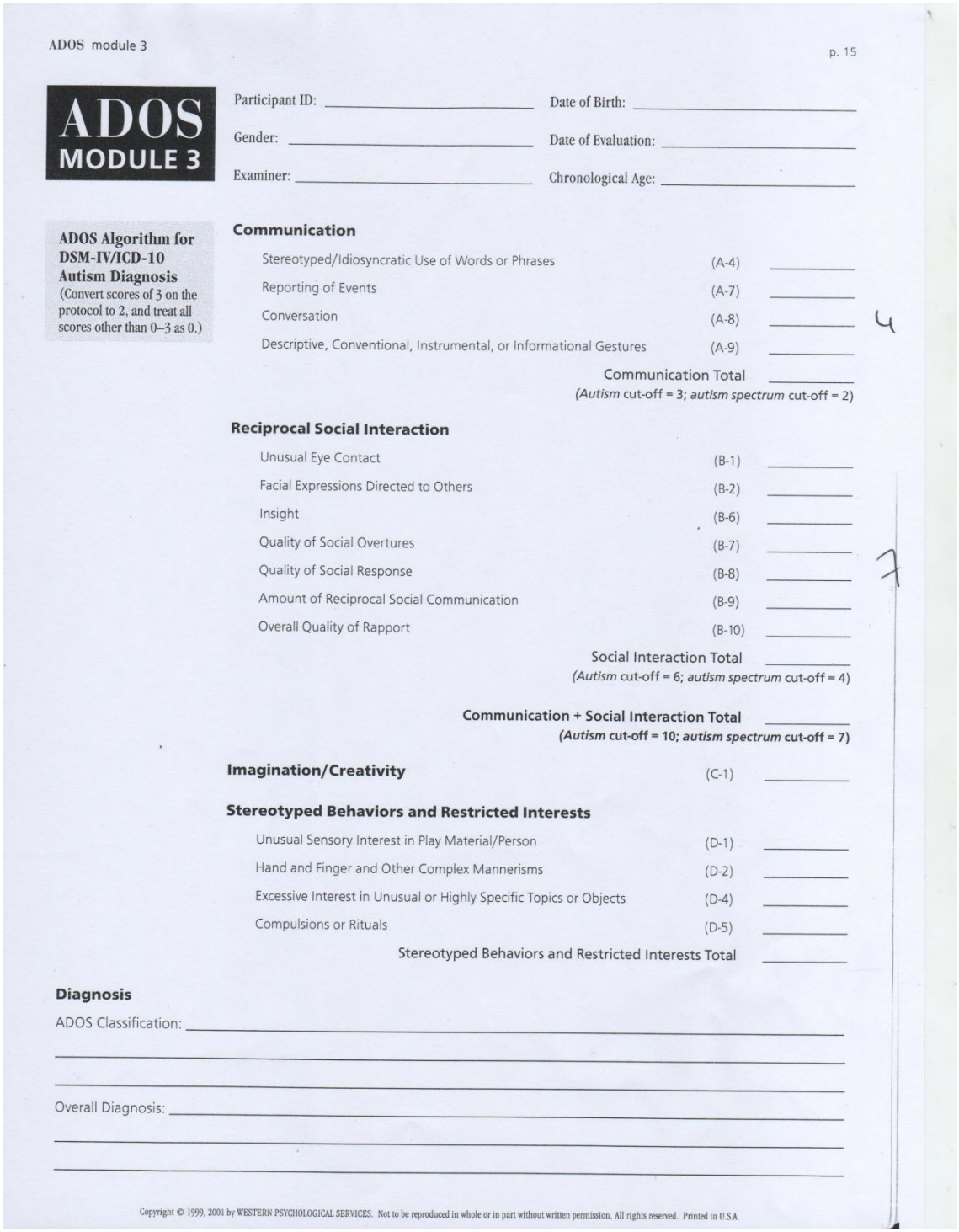
Unusual Sensory Interest in Play Material/Person	(D-1)	_____
Hand and Finger and Other Complex Mannerisms	(D-2)	_____
Unusually Repetitive Interests or Stereotyped Behaviors	(D-4)	_____
Stereotyped Behaviors and Restricted Interests Total		_____

Diagnosis

ADOS Classification: _____

Overall Diagnosis: _____

Appendix J.6 Autism Diagnostic Observation Schedule Module 3 Score Sheet



ADOS module 3 p. 15

ADOS MODULE 3

Participant ID: _____ Date of Birth: _____

Gender: _____ Date of Evaluation: _____

Examiner: _____ Chronological Age: _____

ADOS Algorithm for DSM-IV/ICD-10 Autism Diagnosis
(Convert scores of 3 on the protocol to 2, and treat all scores other than 0–3 as 0.)

Communication

Stereotyped/Idiosyncratic Use of Words or Phrases	(A-4)	_____
Reporting of Events	(A-7)	_____
Conversation	(A-8)	_____ 4
Descriptive, Conventional, Instrumental, or Informational Gestures	(A-9)	_____
Communication Total		_____

(Autism cut-off = 3; *autism spectrum* cut-off = 2)

Reciprocal Social Interaction

Unusual Eye Contact	(B-1)	_____
Facial Expressions Directed to Others	(B-2)	_____
Insight	(B-6)	_____
Quality of Social Overtures	(B-7)	_____
Quality of Social Response	(B-8)	_____ 7
Amount of Reciprocal Social Communication	(B-9)	_____
Overall Quality of Rapport	(B-10)	_____
Social Interaction Total		_____

(Autism cut-off = 6; *autism spectrum* cut-off = 4)

Communication + Social Interaction Total _____

***(Autism* cut-off = 10; *autism spectrum* cut-off = 7)**

Imagination/Creativity (C-1) _____

Stereotyped Behaviors and Restricted Interests

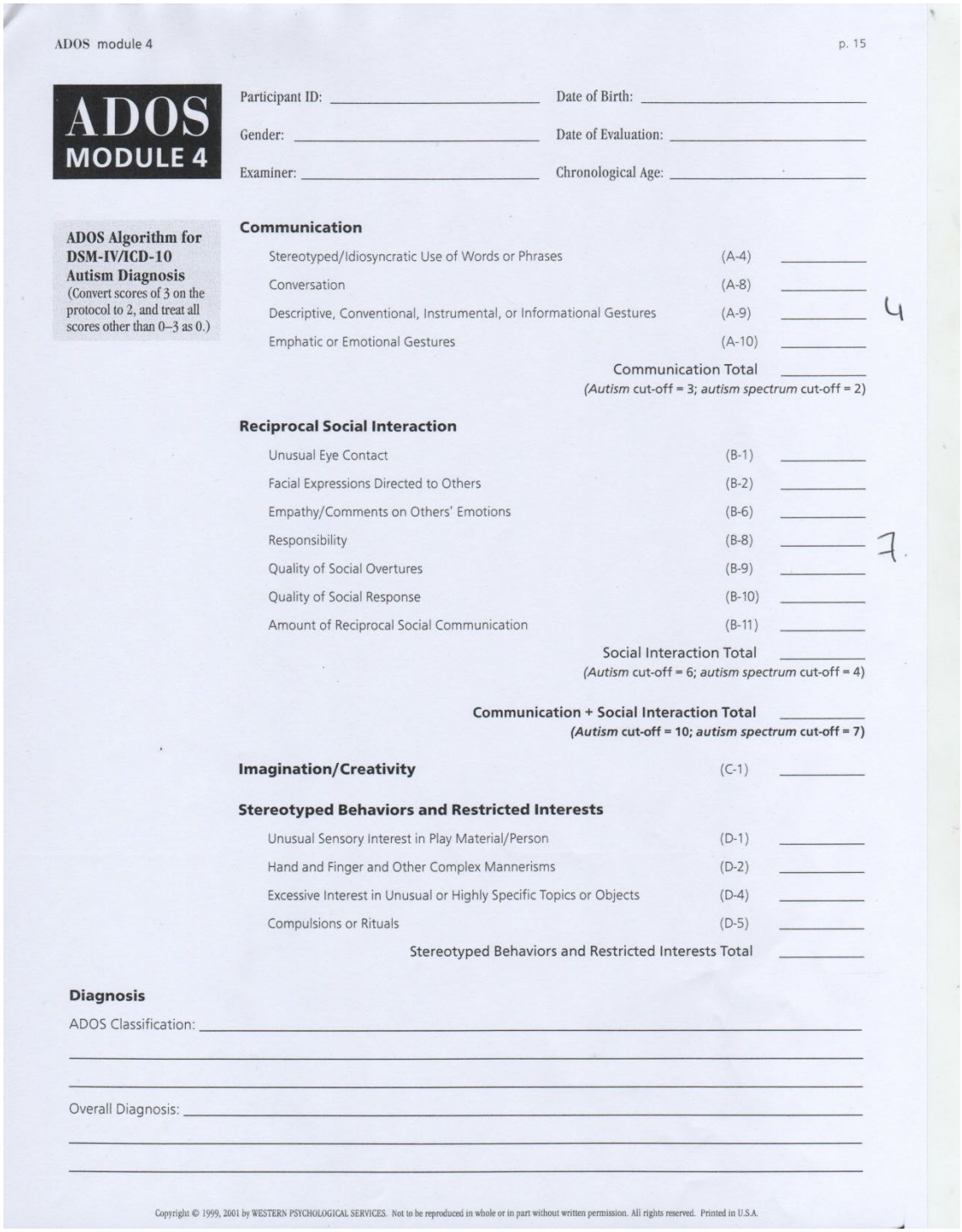
Unusual Sensory Interest in Play Material/Person	(D-1)	_____
Hand and Finger and Other Complex Mannerisms	(D-2)	_____
Excessive Interest in Unusual or Highly Specific Topics or Objects	(D-4)	_____
Compulsions or Rituals	(D-5)	_____
Stereotyped Behaviors and Restricted Interests Total		_____

Diagnosis

ADOS Classification: _____

Overall Diagnosis: _____

Appendix J.7 Autism Diagnostic Observation Schedule Module 4 Score Sheet



ADOS module 4 p. 15

ADOS MODULE 4

Participant ID: _____ Date of Birth: _____

Gender: _____ Date of Evaluation: _____

Examiner: _____ Chronological Age: _____

ADOS Algorithm for DSM-IV/ICD-10 Autism Diagnosis
(Convert scores of 3 on the protocol to 2, and treat all scores other than 0–3 as 0.)

Communication

Stereotyped/Idiosyncratic Use of Words or Phrases	(A-4)	_____
Conversation	(A-8)	_____
Descriptive, Conventional, Instrumental, or Informational Gestures	(A-9)	_____ 4
Emphatic or Emotional Gestures	(A-10)	_____
Communication Total		_____

(Autism cut-off = 3; *autism spectrum* cut-off = 2)

Reciprocal Social Interaction

Unusual Eye Contact	(B-1)	_____
Facial Expressions Directed to Others	(B-2)	_____
Empathy/Comments on Others' Emotions	(B-6)	_____
Responsibility	(B-8)	_____ 7
Quality of Social Overtures	(B-9)	_____
Quality of Social Response	(B-10)	_____
Amount of Reciprocal Social Communication	(B-11)	_____
Social Interaction Total		_____

(Autism cut-off = 6; *autism spectrum* cut-off = 4)

Communication + Social Interaction Total _____

***(Autism* cut-off = 10; *autism spectrum* cut-off = 7)**

Imagination/Creativity (C-1) _____

Stereotyped Behaviors and Restricted Interests

Unusual Sensory Interest in Play Material/Person	(D-1)	_____
Hand and Finger and Other Complex Mannerisms	(D-2)	_____
Excessive Interest in Unusual or Highly Specific Topics or Objects	(D-4)	_____
Compulsions or Rituals	(D-5)	_____
Stereotyped Behaviors and Restricted Interests Total		_____

Diagnosis

ADOS Classification: _____

_____

_____

Overall Diagnosis: _____

_____

_____

Appendix J.8 Components of the British Ability Scales-II

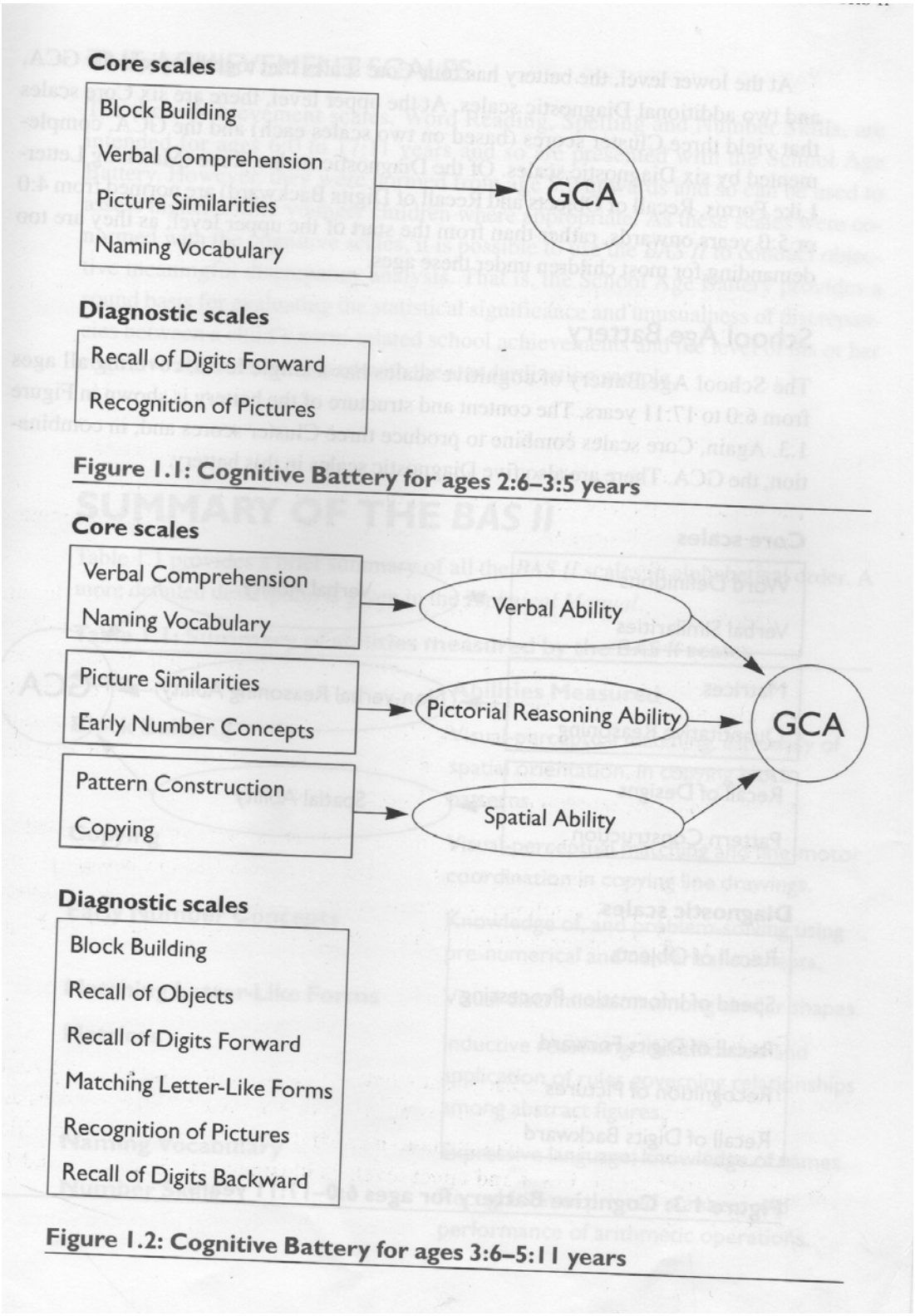


Figure 1.1: Cognitive Battery for ages 2:6–3:5 years

Figure 1.2: Cognitive Battery for ages 3:6–5:11 years

Appendix J.9 Wing Subgrouping Questionnaire

Wing Subgrouping Questionnaire

Instructions:

The groups of items presented below are designed to give us and idea of a person's behaviour in typical, day-to-day situations. For each group of items, please take the time to give us two types of information.

First, for each group, rate how well each item describes the way your son/daughter behaves in everyday activities. Use the scale below:

My son/daughter shows this behaviour:						
Never	Very Rarely	Rarely	Sometimes	Frequently	Very Frequently	Always
0	1	2	3	4	5	6

Second, for each group, select the one item that best describes your son/daughter. For instance, if you thought item number 1 in Group 1 was the most descriptive of the way your son/daughter behaves, you would put a "1" at the end of the group.

Note that some of the groups of questions might seem redundant. Please answer all questions even if you have answered similar questions earlier in the questionnaire.

Thank you for your help.

1

My son/daughter shows this behaviour:						
Never	Very Rarely	Rarely	Sometimes	Frequently	Very Frequently	Always
0	1	2	3	4	5	6

Group Number 1.

Again, please rate each item according to the scale above. Then, at the end of this group of items, please choose the one item that best describes your son/daughter.

Rating:

1. ____ When my son/daughter is with unfamiliar adults or peers he/she does not start interactions, but he/she will interact with others if they pull him/her into activities. He/she will play with others as long as others direct the play but will wander off at the end of a game unless redirected by other people.
2. ____ When my son/daughter is with unfamiliar adults or peers he/she readily approaches others to interact and responds easily to others. His/her manner of interacting is generally appropriate (not awkward or unusual).
3. ____ When my son/daughter is with unfamiliar adults or peers he/she either fails to respond when others approach or turns or walks away from others. He/she only approaches other people to obtain something that he/she needs or to play physical games (for example, roughhousing or tickling); otherwise, he/she does not approach others to interact.
4. ____ When my son/daughter is with unfamiliar adults or peers he/she does approach others to interact but is awkward or unusual in his/her manner of doing so. He/she is not able to change his/her speech or behaviour to adapt to others and continues to pursue his/her own topics or favourite activities, even in the face of active discouragement.

☐ Which of the items in the group above best describes your son/daughter?

My son/daughter shows this behaviour:						
Never	Very Rarely	Rarely	Sometimes	Frequently	Very Frequently	Always
0	1	2	3	4	5	6

Group Number 2

If your son/daughter is beyond the age of playing and imitating, please score this question based on his/her behaviour as a child.

1. ____ My son/daughter does not have difficulty imitating others' actions and creatively engages in make-believe play in an appropriate manner.
2. ____ My son/daughter mimics the actions of others but he/she does so without real understanding. He/she mimics other peers who are using creative make-believe play, but he/she does not create his/her own make-believe play.
3. ____ My son/daughter does not mimic others' actions (i.e. does not imitate facial expressions or simple motions) and does not engage in pretend play.
4. ____ My son/daughter does not have difficulty imitating other people. He/she creates his/her own make-believe play, but this make-believe play lacks real variation or feelings (for example, he/she may pretend that a block is a cookie, but he/she repeats this behaviour without changing it or without showing any real feeling).

☐ Which of the items in the group above best describes your son/daughter?

Group Number 3

1. ____ My son/daughter does approach unfamiliar adults or peers, but he/she approaches them in an unusual, awkward, naïve, one-sided, or repetitive manner. For instance, he/she might talk repeatedly about a particular topic of interest, regardless of whether the other person is interested.
2. ____ My son/daughter does not spontaneously approach unfamiliar adults or peers to interact.
3. ____ When my son/daughter is with unfamiliar adults or peers, he/she readily approaches others to interact. His/her manner of interacting is generally appropriate (not awkward or unusual).

☐ Which of the items in the group above best describes your son/daughter?

My son/daughter shows this behaviour:						
Never	Very Rarely	Rarely	Sometimes	Frequently	Very Frequently	Always
0	1	2	3	4	5	6

Group Number 4

1. ____ If an unfamiliar person walks up to my son/daughter in a social situation, my son/daughter readily responds to this person. His/her manner of interacting is generally appropriate (not awkward or unusual).
2. ____ If an unfamiliar person walks up to my son/daughter in a social situation, my son/daughter will engage the other person and interact with them. However, he/she shows no initiative and only responds to the questions and comments of the other person; if the other person stops structuring the interaction, my son/daughter will lose interest.
3. ____ If an unfamiliar person walks up to my son/daughter in a social situation, my son/daughter will engage the other person and interact with them. However, he/she uses the approach of the other people to indulge his/her own interest, regardless of whether or not the other person shares those interests.
4. ____ If an unfamiliar person walks up to my son/daughter in a social situation, my son/daughter seems unaware of this other person and turns or walks away.

☐ Which of the items in the group above best describes your son/daughter?

Group Number 5

1. ____ My son/daughter's communication skills are not impaired at all.
2. ____ My son/daughter can only respond to simple questions and commands, and these responses can be understood by people who do not know my son/daughter well.
3. ____ My son/daughter has a good vocabulary and can use complete sentences. However, he/she shows subtle problems with communication, such as repetitive speech, low awareness of other people's responses, and poor turn-taking abilities in conversation.
4. ____ My son/daughter does not use spoken language or is only capable of repeating things he/she has heard.

☐ Which of the items in the group above best describes your son/daughter?

My son/daughter shows this behaviour:						
Never	Very Rarely	Rarely	Sometimes	Frequently	Very Frequently	Always
0	1	2	3	4	5	6

Group Number 6

1. ____ When my son/daughter is with unfamiliar adults or peers, he/she will respond readily but inappropriately when others attempt to communicate with him/her (for example, he/she will talk at length on a topic that is of particular interest to him/her regardless of whether it is of interest to the other person, ask questions in an incessant, even pestering manner, or respond in some other awkward or unusual manner).
2. ____ When my son/daughter is with unfamiliar adults or peers, he/she will respond when others attempt to communicate with him/her, but only as long as the other person structures or leads the conversation. He/she will not start conversations or ask questions him/herself.
3. ____ When my son/daughter is with unfamiliar adults or peers, he/she responds readily when others attempt to communicate with him/her. His/her manner of communicating is generally appropriate (not awkward or unusual).
4. ____ When my son/daughter is with unfamiliar adults or peers, he/she does not respond when others speak or gesture to him/her.

☐ Which of the items in the group above best describes your son/daughter?

Group Number 7

1. ____ My son/daughter only uses words and gestures to get things that he/she needs (for example, juice, go to the bathroom, etc.), not to interact socially with another person.
2. ____ My son/daughter spontaneously communicates with others, and his/her manner of communicating is appropriate (not awkward or unusual).
3. ____ My son/daughter spontaneously communicates with others. When he/she communicates, though, his/her language is centred around a narrow range of topics and has a one-sided, awkward, or unusual manner.
4. ____ My son/daughter does not spontaneously initiate communication with others, but he/she will communicate with others if someone else initiates it. This communication lasts only as long as the other person structures or leads it; once the other person stops structuring the communication, the son/daughter will lose interest.

☐ Which of the items in the group above best describes your son/daughter?

My son/daughter shows this behaviour:						
Never	Very Rarely	Rarely	Sometimes	Frequently	Very Frequently	Always
0	1	2	3	4	5	6

Group number 8

1. ____ My son/daughter uses no make-believe or pretend play, either alone or with other people. He/she may dismantle and/or rebuild objects, but he/she shows no signs of pretending that toys represent real things.
2. ____ My son/daughter creates his/her own make-believe play, but this play lacks real variation or feeling (for example, he/she may pretend that a block is a cookie, but he/she repeats this behaviour without changing it or without showing any real feeling).
3. ____ My son/daughter does not show truly creative make-believe play. He/she only mimics other peers who are using creative make-believe play.
4. ____ My son/daughter uses pretend play that is appropriately spontaneous, varied and creative.

☐ Which of the items in the group above best describes your son/daughter?

Group number 9

If your son/daughter if beyond the age of playing and imitating, please score this question based on his/her behaviour as a child.

1. ____ My son/daughter has no impairments in his/her ability to imitate or mimic the gestures, expressions, or motions of others, and he/she mimics the behaviours of others spontaneously and appropriately.
2. ____ My son/daughter mimics others/ simple gestures, expressions or motions, but he/she has difficulty mimicking complex gestures, expressions or motions (such as clapping behind one's back). His/her imitation abilities are moderately impaired, and he/she does not mimic others' motions or gestures spontaneously.
3. ____ My son/daughter does not mimic simple motions or gestures (such as clapping or waving bye-bye) and does not mimic simple facial expressions.
4. ____ My son/daughter's imitation of mimicking abilities are only slightly impaired, if at all. He/she can mimic complex gestures, expression and imitations. However, he/she does not typically mimic the movement, gestures, or expressions of others spontaneously.

☐ Which of the items in the group above best describes your son/daughter?

My son/daughter shows this behaviour:						
Never	Very Rarely	Rarely	Sometimes	Frequently	Very Frequently	Always
0	1	2	3	4	5	6

Group Number 10

1. ____ My son/daughter shows at least one of the following unusual behaviours or body movements: lining up objects, spinning things or watching things spin, body-rocking, hand-flapping, finger-flicking, unawareness of events around him/her, engaging in the same activities for a long time, unusual responses to pain.
2. ____ My son/daughter shows no unusual behaviours except during times of stress. During times of stress, unusual behaviours (such as hand-flapping, spinning things, lining things up, etc.) are seen.
3. ____ My son/daughter shows no unusual bodily behaviours (such as hand-flapping, spinning things, lining things up, etc.) but he/she does show unusual patterns of conversation or social interaction, such as persistent questioning, constant talk about particular topics, and lack of understanding of social rules (for example he/she stands too close to other people, is not able to take turns in a conversation, etc.).
4. ____ My son/daughter does not show unusual bodily behaviours (such as hand-flapping, spinning things, etc.). Also he/she does not show unusual patterns of conversation or social interaction (such as persistent questioning, persistent talk about one topic, etc.). His/her behaviour is not unusual and is generally appropriate.

☐ Which of the items in the group above best describes your son/daughter?

My son/daughter shows this behaviour:						
Never	Very Rarely	Rarely	Sometimes	Frequently	Very Frequently	Always
0	1	2	3	4	5	6

Group Number 11

1. ____ My son/daughter does not insist on any inflexible daily routines, and he/she has a variety of appropriate interests.
2. ____ My son/daughter insists on certain inflexible daily routines or arrangements of the environment (for example, he/she prefers to go through events in the same sequence every day, or he/she prefers to drive to school by exactly the same route every day, or he/she prefers that the furniture be arranged the same way every day, etc.). However, he/she does not become upset (or becomes upset then is easily calmed) when these routines are disrupted or the environment is changed.
3. ____ My son/daughter is adaptable to changes in daily routine. However he/she tends to show a restricted range of interests or a preoccupation with one narrow interest. For example, he/she may be overly interested in amassing facts about the weather or about trains.
4. ____ My son/daughter insists on certain inflexible daily routines or arrangements of the environment (for example, his/her daily schedule must be exactly the same, or one must drive to school by exactly the same route, or the furniture must be arranged the same way, etc.), and he/she becomes very upset when routines are disrupted or the environment is changed.

☐ Which of the items in the group above best describes your son/daughter?

Group Number 12

1. ____ My son/daughter is neither noticeably agile nor noticeably clumsy.
2. ____ My son/daughter is somewhat uncoordinated. He/she is somewhat clumsy and awkward when walking, wary of climbing and balancing, or shows a "puppet like" gait when he/she walks.
3. ____ My son/daughter is agile in climbing and balancing, or walks with a springy, graceful gait. He/she is particularly well-coordinated and graceful and enjoys climbing and balancing.

☐ Which of the items in the group above best describes your son/daughter?

My son/daughter shows this behaviour:						
Never	Very Rarely	Rarely	Sometimes	Frequently	Very Frequently	Always
0	1	2	3	4	5	6

Group Number 13

1. ____ My son/daughter is generally well-behaved, except on rare occasions, such as times of extreme stress, when he/she may show physical behaviours that are irritating or difficult to handle (such as tantrums, aggression, odd body movements, hand-flapping). Also, during times of stress he/she might show difficult or bothersome behaviours related to conversation or social interaction (such as persistent questioning or long-windedness).
2. ____ My son/daughter is as easy or as difficult to manage as the typical son/daughter of his/her age.
3. ____ For my son/daughter, difficult or bothersome behaviours are related to conversation and social rules rather than to physical aggression or tantrums. For instance, he/she engages in persistent, inappropriate questioning; he/she is unaware of certain social rules (might stand too close to a person or touch a person inappropriately); or he/she is long-winded.
4. ____ My son/daughter is often difficult to control physically. He/she throws temper tantrums; he/she shows inappropriate behaviour (screaming in public places, for instance); and/or is aggressive.

☐ Which of the items in the group above best describes your son/daughter?

Appendix K. Ethical Approval

Appendix K.1 NHS Ethical Approval

NHS
Health Research Authority

NRES Committee Yorkshire & The Humber - South Yorkshire
Millside
Mill Pond Lane
Meanwood
Leeds
LS6 4RA

Telephone: 0113 30 50128
Facsimile: 0113 85 56191

08 August 2012

Ms Jen Gallagher
Trainee Clinical Psychologist
University of Sheffield
Clinical Psychology Unit
Western Bank
Sheffield
S10 2TN

Dear Ms Gallagher

Study title:	**Investigating the Behavioural Heterogeneity in Autistic Spectrum Disorder**
REC reference:	**12/YH/0306**
Protocol number:	**URMS 134167**

Thank you for your letter of 07 August 2012, responding to the Committee's request for further information on the above research and submitting revised documentation.

The further information has been considered on behalf of the Committee by the Chair.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Ethical review of research sites

NHS 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).

Non-NHS sites

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).

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	Version	Date
Covering Letter		29 May 2012
Covering Letter		07 August 2012
Evidence of insurance or indemnity		28 March 2012
Investigator CV		30 March 2012
Letter from Sponsor		25 May 2012
Letter of invitation to participant	2	02 May 2012
Other: CV Dr Elizabeth Milne (Supervisor 1)		
Other: CV Megan Freeth (Supervisor 2)		
Other: Instructions For Use Of Medical Device	6	31 January 2007
Other: Letter From Sponsor- Amendments		25 May 2012
Other: Letter From Sponsor- Non- Sheffield Trusts		02 April 2012
Other: ADOS Score Sheet		
Other: Components of the British Ability Scales		
Other: Letter of invitation from school - ASD		
Other: Letter of invitation from school - TD		
Other: Letter of invitation from CAMHS		
Other: GP letter	1	24 July 2012
Other: Introduction Storyboard	1	24 July 2012
Other: Storyboard - EEG	1	24 July 2012
Other: Storyboard - ADOS	1	24 July 2012
Other: Storyboard - BAS	1	24 July 2012

Participant Consent Form: 16 +	2	24 July 2012
Participant Consent Form: Parent	2	24 July 2012
Participant Information Sheet: CAMHS	3	23 July 2012
Participant Information Sheet: ASD	3	23 July 2012
Participant Information Sheet: 16+	1	24 July 2012
Participant Information Sheet: TD	3	23 July 2012
Protocol	3	02 May 2012
Questionnaire: Brief Medical History Questionnaire	2	06 November 2011
Questionnaire: Development History Questionnaire ASD	2	02 May 2012
Questionnaire: Developmental History Questionnaire TD	2	02 May 2012
Questionnaire: Wing Subgrouping Questionnaire		
REC application		29 May 2012
Response to Request for Further Information		07 August 2012

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.

Further information is available at National Research Ethics Service website > After Review

12/YH/0306	**Please quote this number on all correspondence**

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

Yours sincerely

[redacted]

Ms Jo Abbott
Chair

Email: sinead.audsley@nhs.net

Enclosures: "After ethical review – guidance for researchers"

Copy to: *Dr Andrew Thompson, University of Sheffield*
Dr Riadh Abed, Rotherham Doncaster and South Humber Mental Health NHS Foundation Trust

Appendix K.2 Research and Development Approval from Sheffield Children's NHS Foundation Trust

CCRF children's clinical research facility

Sheffield Children's NHS Foundation Trust

D Floor Stephenson Wing
Western Bank
Sheffield S10 2TH

Tel: 0114 271 7417
Fax: 0114 2267844
Email: crf@sch.nhs.uk
Web: www.sheffieldchildrenscrf.nhs.uk

17 December 2012

Ms Jen Gallagher
Trainee Clinical Psychologist
Clinical Psychology Unit
University of Sheffield
Western Bank
Sheffield
S10 2TN

Dear Ms Gallagher

ID: SCH/12/052 **Investigating the Behavioural Heterogeneity in Autistic Spectrum Disorder**

I am pleased to confirm no objection for you to proceed with your study using our Trust as a participant identification centre in accordance with the EU Directive on Clinical Trials, The Medicines for Human Use (Clinical Trials) Regulations 2004, ICH GCP, the Declaration of Helsinki and the NHS Research Governance Framework (Second Edition).

I would like to take this opportunity to wish you every success with this study.

Yours sincerely

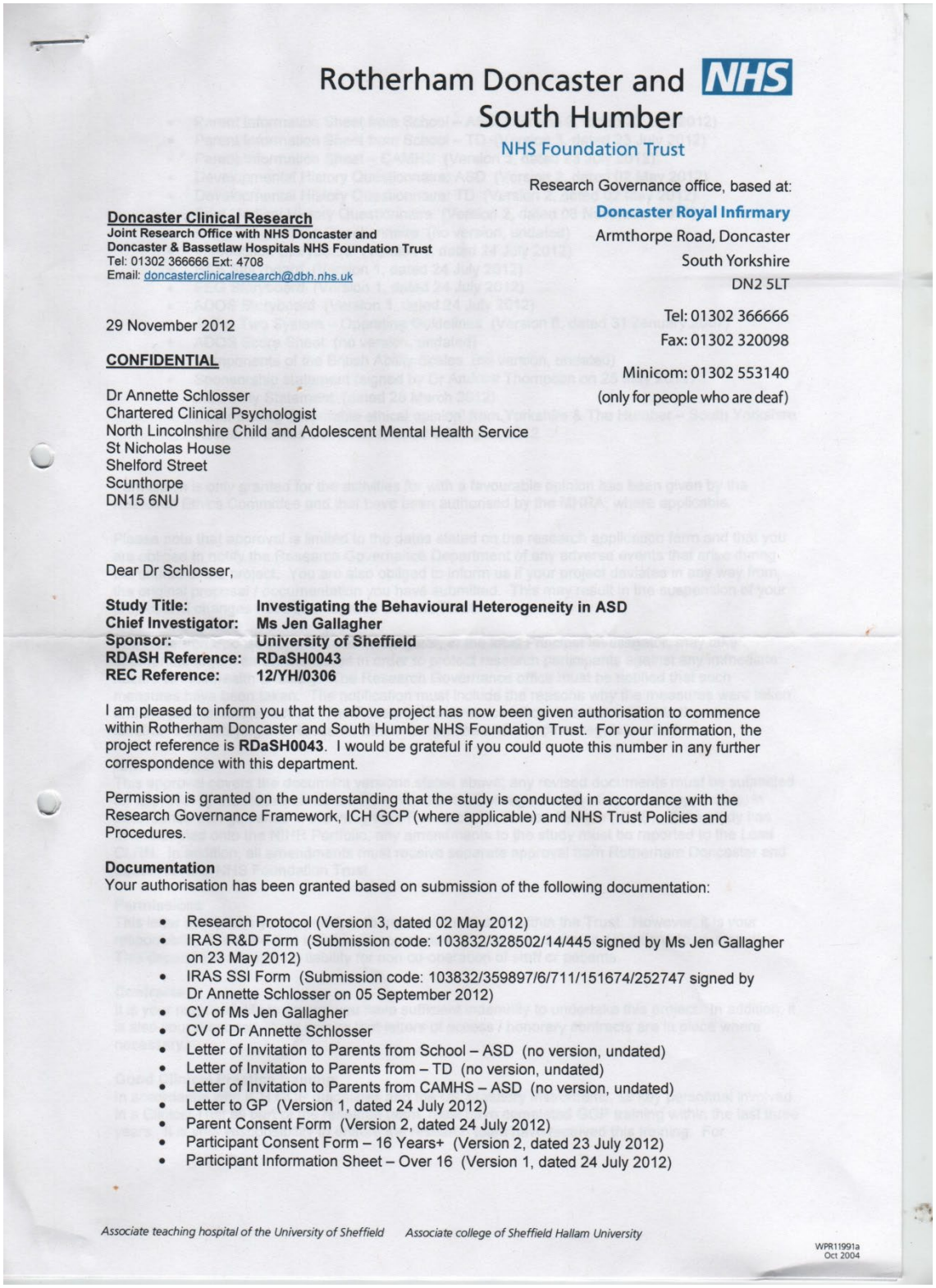
[redacted]

Dr Paul Dimitri
Research Director

Sheffield Children's Hospital Charity

The University Of Sheffield.

Appendix K.3 Research and Development Approval from Rotherham, Doncaster and South Humber Doncaster NHS Foundation Trust



Rotherham Doncaster and South Humber NHS
NHS Foundation Trust

Research Governance office, based at:
Doncaster Royal Infirmary
Armthorpe Road, Doncaster
South Yorkshire
DN2 5LT

Tel: 01302 366666
Fax: 01302 320098

Minicom: 01302 553140
(only for people who are deaf)

Doncaster Clinical Research
Joint Research Office with NHS Doncaster and Doncaster & Bassetlaw Hospitals NHS Foundation Trust
Tel: 01302 366666 Ext: 4708
Email: doncasterclinicalresearch@dbh.nhs.uk

29 November 2012

CONFIDENTIAL

Dr Annette Schlosser
Chartered Clinical Psychologist
North Lincolnshire Child and Adolescent Mental Health Service
St Nicholas House
Shelford Street
Scunthorpe
DN15 6NU

Dear Dr Schlosser,

Study Title:	**Investigating the Behavioural Heterogeneity in ASD**
Chief Investigator:	**Ms Jen Gallagher**
Sponsor:	**University of Sheffield**
RDASH Reference:	**RDaSH0043**
REC Reference:	**12/YH/0306**

I am pleased to inform you that the above project has now been given authorisation to commence within Rotherham Doncaster and South Humber NHS Foundation Trust. For your information, the project reference is **RDaSH0043**. I would be grateful if you could quote this number in any further correspondence with this department.

Permission is granted on the understanding that the study is conducted in accordance with the Research Governance Framework, ICH GCP (where applicable) and NHS Trust Policies and Procedures.

Documentation
Your authorisation has been granted based on submission of the following documentation:

- Research Protocol (Version 3, dated 02 May 2012)
- IRAS R&D Form (Submission code: 103832/328502/14/445 signed by Ms Jen Gallagher on 23 May 2012)
- IRAS SSI Form (Submission code: 103832/359897/6/711/151674/252747 signed by Dr Annette Schlosser on 05 September 2012)
- CV of Ms Jen Gallagher
- CV of Dr Annette Schlosser
- Letter of Invitation to Parents from School – ASD (no version, undated)
- Letter of Invitation to Parents from – TD (no version, undated)
- Letter of Invitation to Parents from CAMHS – ASD (no version, undated)
- Letter to GP (Version 1, dated 24 July 2012)
- Parent Consent Form (Version 2, dated 24 July 2012)
- Participant Consent Form – 16 Years+ (Version 2, dated 23 July 2012)
- Participant Information Sheet – Over 16 (Version 1, dated 24 July 2012)

Associate teaching hospital of the University of Sheffield *Associate college of Sheffield Hallam University*

WPR11991a
Oct 2004

- Parent Information Sheet from School – ASD (Version 3, dated 23 July 2012)
- Parent Information Sheet from School – TD (Version 3, dated 23 July 2012)
- Parent Information Sheet – CAMHS (Version 3, dated 23 July 2012)
- Developmental History Questionnaire: ASD (Version 2, dated 02 May 2012)
- Developmental History Questionnaire: TD (Version 2, dated 02 May 2012)
- Brief Medical History Questionnaire (Version 2, dated 06 November 2011)
- Wing Subgrouping Questionnaire (no version, undated)
- Introduction Storyboard (Version 1, dated 24 July 2012)
- BAS Storyboard (Version 1, dated 24 July 2012)
- EEG Storyboard (Version 1, dated 24 July 2012)
- ADOS Storyboard (Version 1, dated 24 July 2012)
- Active Two System – Operating Guidelines (Version 6, dated 31 January 2007)
- ADOS Score Sheet (no version, undated)
- Components of the British Ability Scales (no version, undated)
- Sponsorship statement (signed by Dr Andrew Thompson on 25 May 2012)
- Indemnity Statement (dated 28 March 2012)
- Letter stating 'favourable ethical opinion' from Yorkshire & The Humber – South Yorkshire Research Ethics Committee, dated 08 August 2012.

Permission is only granted for the activities for with a favourable opinion has been given by the Research Ethics Committee and that have been authorised by the MHRA, where applicable.

Please note that approval is limited to the dates stated on the research application form and that you are obliged to notify the Research Governance Department of any adverse events that arise during the course of the project. You are also obliged to inform us if your project deviates in any way from the original proposal / documentation you have submitted. This may result in the suspension of your project until changes have been agreed with the Trust.

The Research Sponsor, or the Chief Investigator, or the local Principal Investigator, may take appropriate urgent safety measures in order to protect research participants against any immediate hazard to their health or safety. The Research Governance office must be notified that such measures have been taken. The notification must include the reasons why the measures were taken and the plan for further action. The Research Governance office must be notified in the same timeframe as notifying the Research Ethics Committee and any other regulatory bodies.

Amendments
This approval covers the document versions stated above; any revised documents must be submitted for approval by the Research Ethics Committee and other regulatory bodies, where applicable, in accordance with guidance in the Integrated Research Application System (IRAS). If the study has been adopted onto the NIHR Portfolio, any amendments to the study must be reported to the Lead CLRN. In addition, all amendments must receive separate approval from Rotherham Doncaster and South Humber NHS Foundation Trust.

Permissions
This letter authorises you in principle to undertake research within the Trust. However, it is your responsibility to ensure that individuals appropriate to your work have no objections to your studies. This department accepts no liability for non co-operation of staff or patients.

Contracts
It is your responsibility to ensure you have sufficient indemnity to undertake this project. In addition, it is also your responsibility to ensure that letters of access / honorary contracts are in place where necessary.

Good Clinical Practice training
In accordance with ICH GCP guidelines and the UK Statutory Instruments, all key personnel involved in a Clinical Trial as part of the research team, must have completed GCP training within the last three years. It is your responsibility to ensure the research team have received this training. For

information regarding upcoming GCP training courses, please contact the Research Governance team.

Auditing
I would strongly urge you to maintain an accurate and up to date site file for your documentation, as the Trust randomly audits projects to assess compliance with the relevant legal frameworks and legislation. If your study is selected, you will be notified in writing not less than two weeks prior to the required submission date of documentation. In addition, where monitoring and auditing procedures are carried out by the Sponsor, you will be required to cooperate, where appropriate.

Monitoring
In order to ensure adequate monitoring of ongoing studies, the Research Governance department will send through periodic monitoring forms which require completion by the Principal Investigator or delegated individual. These will be in two formats. The first is a monthly letter requesting recruitment information. The second form is an annual study progress report. These forms need to be completed and sent through to the Research Governance department as a condition of the approval of this study.

I would like to take this opportunity to wish you well with your project. If you have any questions or if I can be of any further assistance to you, please do not hesitate to contact me.

Yours sincerely

[redacted]

pp Amy Beckitt
Clinical Research Development Manager

cc Ms Jen Gallagher
Clinical Psychology Unit
University of Sheffield
Western Bank
Sheffield
S10 2TN

cc Dr Andrew Thompson
Clinical Psychology Unit
University of Sheffield
Western Bank
Sheffield
S10 2TN

Appendix L. A Comparison of Those Included and Excluded from the Cluster Analysis

Table L.1

Comparison of Demographic Variable and Variables Included in the Cluster Analysis Between those who were Included and Excluded from the Analysis

Included or Excluded from Cluster Analysis		ASD		Age		Male Gender		ADOS Average Communication Score		ADOS Social Interaction Score		Alpha Frontal Power	
		n	%	*M*	*SD*	*n*	%	*M*	*SD*	*M*	*SD*	*M*	*SD*
Excluded		3	50	11.90	4.50	6	100	0.83	0.88	6.40	6.35	-3.45	12.01
	N	6		5		6		5		5		4	
Included		22	61	12.90	2.84	33	92	0.50	0.50	3.97	3.71	4.39	6.86
	N	36		36		36		36		36		27	

Note. *N* included to demonstrate where data missing for the excluded group.