

COGNITIVE PROFILES IN ASPERGER'S DISORDER AND AUTISM

ROSIE HURLSTON

JULY 1997

D. CLIN. PSY.

UNIVERSITY COLLEGE LONDON

ProQuest Number: 10045843

All rights reserved

INFORMATION TO ALL USERS

The quality of this reproduction is dependent upon the quality of the copy submitted.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if material had to be removed, a note will indicate the deletion.



ProQuest 10045843

Published by ProQuest LLC(2016). Copyright of the Dissertation is held by the Author.

All rights reserved.

This work is protected against unauthorized copying under Title 17, United States Code.
Microform Edition © ProQuest LLC.

ProQuest LLC
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106-1346

CONTENTS

VOLUME ONE: RESEARCH THESIS

Acknowledgments	vi
Abstract	vii
I. INTRODUCTION	1
WHAT IS AUTISM?	2
DESCRIPTION OF IMPAIRMENTS IN AUTISM	3
DIAGNOSTIC SYSTEMS	5
ASPERGER'S DISORDER	6
COGNITIVE PSYCHOLOGY APPROACHES TO AUTISM	11
<i>Group profiles on Standardised Intelligence Tests</i>	12
<i>Theory of Mind</i>	20
<i>Executive Function</i>	25
<i>Weak Central Coherence and Field Dependent and Independent Cognitive Style</i>	29
RELATIONSHIPS BETWEEN COGNITIVE FINDINGS AND THEORIES	33
RATIONALE FOR PRESENT STUDY	36
II. METHOD	
SUBJECTS	38
MEASURES	
Main Study: 1. <i>Kaufman Assessment Battery for Children</i>	45

Subsidiary Study:	2. <i>Luria Hand-Game</i>	48
	3. <i>Segmented Block Design</i>	49
	4. <i>Test for Reception of Grammar</i>	51
	5. <i>Wing Subgroup Behavioural Development Questionnaire</i>	
	6. <i>Theory of Mind:</i>	52
	i) Sally-Ann Task	
	ii) Smarties Task	
	iii) Ice-cream Van Story	

PROCEDURE		54
-----------	--	----

III. RESULTS

MAIN STUDY		55
<i>Sequential versus Simultaneous Processing Preference</i>		57
<i>Profile Analysis</i>		59
<i>Ipsative Analysis</i>		65
SUBSIDIARY STUDY		67
<i>Theory of Mind</i>		69
<i>Executive Function</i>		71
<i>Central Coherence</i>		74
<i>Associations between Experimental Tasks</i>		79
<i>Wing Social Behaviour Subgroups</i>		81

IV. DISCUSSION	83
MAIN STUDY	
<i>Sequential / Simultaneous Processing</i>	84
<i>Performance on individual subtests relative to mean subtest score</i>	86
<i>Profile Analysis: extent of intersubtest variability within each group</i>	87
<i>Field Dependence / Independence and Central Coherence</i>	88
<i>Characteristic Peak on Triangles Task</i>	90
SUBSIDIARY STUDY	91
<i>Theory of Mind</i>	92
<i>Executive Function</i>	93
<i>Weak Central Coherence and Field Independence</i>	95
<i>Social Behaviour</i>	97
LIMITATIONS OF THE PRESENT STUDY	98
AREAS FOR FUTURE RESEARCH	103
SUMMARY AND CLINICAL IMPLICATIONS	105
V. REFERENCES	107
VI. APPENDICES	
1. Ethical Approval	120
2. Letter to Participants	123
3. Consent Form	125
4. Sample questions from Wing Subgroup Questionnaire	127
5. Stimuli for Block Design	130

LIST OF TABLES

1. DSM-IV diagnostic criteria for autism	39
2. DSM-IV diagnostic criteria for Asperger's disorder	41
3. Sample characteristics: main study	44
4. Sample characteristics: subsidiary study	44
5. Brief descriptions of K-ABC subtests	47
6. K-ABC mean scores for each group	56
7. Cross-classification of processing preference by DSM-IV diagnosis	58
8. Mean group deviation scores	66
9. Subsidiary study: mental processing scores and verbal mental age of samples	68
10. Smarties task	70
11. Sally-Ann task	70
12. Theory of mind success according to strict criteria	70
13. Ice-cream Van story	70
14. Executive function performance	73
15. Executive function pass rates at different levels of verbal ability	73
16. Central coherence: scores on block design tasks	75
17. Comparison of Triangles-mean deviation score and Block Design performance	77
18. Performance on executive function and central coherence status	80
19. Mean group scores on Wing subgroupings	82

LIST OF FIGURES

1. Mean group profiles across K-ABC subtests for Asperger's disorder and autism 62
2. Profiles across K-ABC subtests for Asperger's disorder and three autism samples 63
3. Mean K-ABC summary scores for Asperger's disorder and three autism samples 64

ABSTRACT

The profiles of 16 children with autism and 23 children with Asperger's disorder were compared on the Kaufman-Assessment Battery for Children (K-ABC), a standardised instrument used to measure general intelligence. Children's diagnoses were assigned in accordance with DSM-IV criteria for Pervasive Developmental Disorders. Significant differences in absolute terms were seen between the two groups. Subjects with Asperger's disorder had significantly higher Mental Processing Composite Scores (considered the best measure of overall intelligence provided by the K-ABC). The groups' profiles were compared using chi-square, anovas of deviation from mean subtest scores and repeated measures anova to examine differences in the relative strengths and weaknesses characteristic of each group. A number of findings pointed to possible qualitative differences between the two groups. Asperger's disorder showed a preference for sequential over simultaneous processing, and the possibility that a field dependent cognitive style impaired performance on a group of three subtests. In contrast, a less pervasive preference in the opposite direction was seen for autism (simultaneous over sequential), and no impairment was seen on the three subtests, supporting the notion that individuals with autism may have field independent styles or weak central coherence. A subsidiary study of nine subjects with Asperger's disorder and eleven subjects with autism examined performance on theory of mind, executive function and central coherence measures, and placed the individuals in subgroups according to social type. Conclusions from this part of the study were severely limited by sampling problems.

ACKNOWLEDGMENTS

I am very grateful for the extensive and helpful input provided by Dr Tony Charman in all aspects of the research. The clinical and administrative team at Harper House Child Development Service were most supportive in relation to both theoretical and practical aspects of the study. The teachers at the two National Autistic Society schools, Radlett Lodge and Sybil Elgar, the school psychologist, Pilar Martin, the parents and the children themselves were unfailingly patient throughout the demanding assessment procedure. I am especially grateful their generous contribution. I would also like to acknowledge the assistance of the University of London Central Research Fund.

INTRODUCTION

Pervasive Developmental Disorders (PDD; APA, 1994), of which autism is considered the prototype, constitute a class of childhood onset disorders that are diagnosed by behavioural symptoms relating to communication, social relationships, play and interests. The nature of the diagnostic criteria has tended to produce considerable heterogeneity both within individual diagnostic categories and within the class as a whole: age of onset, presence or absence of some behavioural features, variations in social behaviour, language ability and general intelligence are commonly seen. A number of attempts have been made to parse the heterogeneous population in a way that may relate meaningfully to aetiology, prognosis or management. Within diagnostic manuals (DSM-IV, APA, 1994; ICD-10, WHO, 1992) onset criteria and symptomatology differentiate Asperger's disorder and atypical autism from core autism.

In addition to the behaviourally oriented diagnostic systems, the population has been described in terms of cognitive attributes, both on standardised clinical instruments designed to assess intelligence and within a recent tradition of experimental psychology which tends to focus on more narrowly defined domains. This study aims to address the question of whether subgroups of children with pervasive developmental disorders can be identified on the basis of distinct patterns of cognitive abilities, in order to add to understanding of the validity of differentiating between autism and Asperger's disorder.

This chapter will provide a discussion of the main characteristics of autism, and how diagnostic descriptions including the identification of Asperger's disorder have developed. A review of evidence from cognitive psychology applied to the study of autism will be presented focusing on standardised clinical intelligence assessments, and three deficit hypotheses of autism: 'theory of mind', executive dysfunction and weak central coherence.

WHAT IS AUTISM?

Pervasive Developmental Disorders (PDD), of which autism is considered prototypic, constitute a group of childhood onset disorders characterised by behavioural impairments in communication, social relationships, play and interests. Autism was first diagnosed in 1943 by Leo Kanner. He noticed a range of co-occurring behaviours, but focused on 'autistic aloneness' and an 'obsessive desire for sameness' as marking off a group of specifically impaired children. Successive observations have lent some coherence to the early, unordered descriptions. In particular, a wide range of behavioural impairments have come to be organised into three overarching domains: socialisation, communication and imagination. The validity of grouping children on the basis of co-occurring impairments in these domains has been established in epidemiological studies (Wing and Gould, 1979). A strong tendency for these three areas of impairment to occur in the same individual was shown, when the individual was originally selected for impaired social development. Prevalence of autism is now estimated at 2 -5 per 10,000 with numbers increasing to 10 -20 per thousand if broader definitions are used (Wing and Gould, 1979; Bryson, Clark and Smith, 1988). In addition to the behavioural

characteristics, autism is frequently associated with general intellectual delay (75% of autistic individuals have IQs below 70; Rutter, 1979) and late onset epilepsy (Volkmar and Nelson, 1990). Family and twin studies suggest a strong genetic component, including the possibility of a broader autistic phenotype found among relatives of autistic individuals (Bolton, Macdonald, Pickles, Rios, Goode *et al.*, 1994; Rutter, Bailey, Bolton and Le Couteur, 1993). The broader phenotype would seem to involve similar but milder language and social impairments, but an absence of any general cognitive delay. Thus autism has come to be seen as a biologically based, neurodevelopmental disorder in which genetic factors play an important aetiological role (Bailey, Phillips and Rutter, 1996).

DESCRIPTION OF IMPAIRMENTS IN AUTISM

Social impairment is manifest by lack of reciprocity in interactions and an impoverished ability to develop interpersonal relationships. Social interactions are likely to lack a give and take quality, being instead one-sided or stilted. Predominant style of social behaviour may be seen to fit one of three suggested subtypes (Wing and Gould, 1979). 'Aloof' individuals rarely approach others spontaneously for social purposes and tend to reject unsolicited social interactions. 'Passive' individuals will tolerate others approaching them but not initiate social activity. 'Active but odd' individuals will readily approach others but do so in a manner that is idiosyncratic and one-sided.

Communication is impaired both at the level of intent and in application. Language may be severely delayed or absent and where this is the case, compensatory gestures are minimal. When language is present it is typically deviant in some respects e.g. prosody, idiosyncrasy and especially pragmatics. That is, where an individual does have fully grammatical language, they may nevertheless be limited in their ability to put it to use. Difficulties in initiating or sustaining conversation are often seen.

Imagination impairments may be reflected in a lack of spontaneous pretend play, insistence on sameness and routine and the development of narrow and restricted areas of interest.

How each area of impairment is manifest within a given individual is determined in part by developmental and intellectual levels. Whereas an 18 month old may not use pointing to share an object of interest with an adult, a 10 year old child may fail to take a listener's knowledge base into account in conversation. An individual with more profound learning disabilities may spin the wheels on a toy car rather than play with it imaginatively; an able child with autism may recount train routes that have been learnt by rote. In addition, impairments in each of the domains are likely to interact. Thus someone with autism might engage in a monologue about a special interest of their own and be blind to another's attempts to introduce a different perspective or signals of boredom.

DIAGNOSTIC SYSTEMS

As might be inferred from the above discussion of behavioural impairments and how they are manifest in diverse ways within any individual, the population of individuals with autism has tended to encompass a heterogeneity of behaviour patterns which many have seen as problematic. A number of attempts have been made to parse the population to create more homogeneous subgroups which relate meaningfully to aspects of aetiology, prognosis or management. Important questions in creating satisfactory diagnostic categories include: what constitutes an 'impairment'; is it possible to define different levels of severity of a given impairment; and, if so, how do different levels of impairment relate to each other and to normal behaviour?

One way in which successive diagnostic systems have differed is in the coverage they afford. The *Diagnostic and Statistical Manual of Mental Disorders*, 3rd edition (DSM-III: American Psychiatric Association, 1980) gave a relatively narrow coverage, that was replaced with a much broader approach in the next revision, DSM-III-R (APA, 1987) (Hertzog, Snow, New and Shapiro, 1990). Restrictions of the diagnosis to individuals who showed such symptoms as onset before age 30 months, a pervasive lack of responsiveness to other people, and gross deficits in language development were relaxed. Thus a study which classified a group of subjects according to both DSM-III (APA, 1980) and DSM-III-R (APA, 1987) found that diagnoses of autism were given to 51% and 91% of subjects respectively (Waterhouse, Morris, Allen, Dunn, Feinstein *et al.*, 1996). Breadth or narrowness of the diagnosis reflects how much deviation from the norm and from other disorders is required to confer membership. Narrowness is likely

to preserve homogeneity and therefore may increase the confidence with which the label is considered to apply to a distinct and usefully identified group. However, gains in this respect are made at the cost of inclusiveness. A number of individuals are likely to be excluded whose difference from the norm may still be problematic in terms of functioning. Without the recognition that a label confers, access to resources may be hindered (Rutter and Schopler, 1992). If the definition broadens to cover such individuals, the diagnostic group necessarily becomes more heterogeneous. In general this dilemma is best answered by considering the explanatory power of the diagnosis at different levels of coverage. In addition, a way of balancing the potentially opposing demands of inclusiveness and homogeneity, is to delineate subgroups within the broader classification. As with the broad classifications, subtypes should represent a hypothesis about relationships to domains of normal and disordered behaviour. In order to be valid, a subtype should provide a meaningful explanation of why certain symptoms co-occur, by pointing to a unifying construct below the level of observable behaviour. Thus a subtype should ultimately aim beyond phenomenology to theory (Pennington, 1991).

ASPERGER'S DISORDER

At a time when diagnostic systems provided their most narrow definition of autism (DSM-III, APA 1980), the complementary strategies discussed above - broadening and subtyping - were advocated by Wing (1981,1988). She introduced the concept of a broad autistic continuum, differentiated in terms of *severity*, but held together by the characteristic *triad* of impairments. In addition, she suggested that a subgroup of individuals on that continuum might usefully be demarcated. Drawing on criteria

suggested by Asperger (1944) for children described as suffering from 'autistic psychopathy' and incorporating modifications from her own clinical experience, Wing outlined six characteristics of individuals with Asperger's syndrome:

1. Language: odd, pedantic and stereotyped though not necessarily delayed;
2. Non-verbal communication: little facial expression, monotone voice, inappropriate gesture;
3. Social interactions: not reciprocal, lacking empathy;
4. Resistance to change: enjoys repetitive activities;
5. Motor coordination: gait and posture odd, gross movements clumsy, stereotypies;
6. Skills and interests: good rote memory, circumscribed special interests.

Although the notion of a continuum would imply that any cut-off is necessarily arbitrary, Wing (1981) justified the division as serving to highlight the variety of manifestations that nevertheless were caused by a common underlying disorder. Thus her approach is directly critical of the narrow diagnosis offered by DSM-III (APA, 1980). Indeed, her concept of the continuum, and emphasis on the variety of behavioural manifestations suggests that the narrowness of the DSM-III (APA, 1980) diagnosis represented a false homogeneity, based at the level of phenomenology rather than causes. Such an approach fails to see underlying commonalities, focusing on insignificant behavioural differences. DSM-III-R (APA, 1987) provided a way of operationalising the interplay between different behaviours with the same underlying cause, by specifying that impairments should be identified where behaviour is deviant relative to a person's mental age.

Thus, paradoxically, Wing may have differentiated 'Asperger's syndrome' from autism in order to emphasise their similarity. Such a distinction has clear pragmatic value not least in providing a way of reawakening clinical interest. However, a more stringent theory-driven approach would demand that the division is proved valid in terms of both internal and external criteria. It should define a group with reliably co-occurring symptomatology (type and severity) and there should be a differential relationship to criteria at a level other than that originally used to distinguish the groups. Subtypes should be seen to differ in primary symptoms (those symptoms that are universal, specific and persistent in the disorder) or underlying neuropsychological deficit (Pennington, 1991). Moreover, the differences between the two groups need to have significant clinical implications in order to be of value. Thus the diagnostic question is to distinguish between heterogeneity that is the random result of individual variation, and that which is clinically informative.

Current diagnostic criteria differ somewhat both from Asperger's original (1944) and Wing's modified description (1981). Indeed, it has been suggested that many of the individuals originally described by Asperger (1944) would now receive a diagnosis of autism (Miller and Ozonoff, 1997). The diagnostic protocol according to DSM-IV (APA, 1994) is presented in the Method section below (Tables 2 and 3). For a diagnosis of autism, a minimum of six symptoms is required, reflecting impairment in each of three domains (social interaction, communication and interests / activities), in addition to onset before three years of age. A diagnosis of Asperger's disorder may be given even if the individual does not meet any impairments within the communication domain,

(indeed they must not meet the criterion relating to early delay in language acquisition). The minimum number of symptoms required for Asperger's disorder is three, across the social interaction and interests / activities domains. Exclusion criteria are more important in relation to Asperger's disorder. In addition to normal language acquisition, cognitive development, self-help skills, non-social adaptive behaviour and curiosity about the environment should be unimpaired. Any impairments should be clinically significant in their impact on the individual's functioning. Most importantly Asperger's disorder is not diagnosed if sufficient criteria are met for a diagnosis of autism. Although the relationship between Asperger's disorder and autism has not been fully clarified, either theoretically or experimentally, both DSM-IV (APA, 1994) and ICD-10 (1992) ascribe a hierarchical relationship.

As the above description of necessary and sufficient criteria suggests, Asperger's disorder as classified by DSM-IV (APA, 1994) and the *International Classification of Diseases*, 10th edition (ICD-10, World Health Organisation, 1992) is mainly distinguished from autism by a lack of language or general intellectual delay. IQ and verbal ability have been seen to be good indicators of prognosis (Gillberg, 1991; Ventner, Lord and Schopler, 1992). Distinguishing on the basis of these two factors may therefore provide a valid subgrouping since a differential relationship to the external criterion of clinical prognosis is indicated. However, the hierarchical relationship assigned means that whereas, in general, lack of IQ or language delay may be seen to differentiate the description of Asperger's disorder from core autism, in theory, a diagnosis of autism may be given to an individual who has an IQ in the normal range, has no history of early delay

in language development, but meets sufficient criteria including at least one in the pragmatics of communication (for example, marked impairment in the ability to initiate or sustain a conversation with others).

What is not clearly conceptualised is how the factors which are used to inform differential diagnosis relate to 'autisticness'. Are IQ and verbal ability additional handicaps, without which 'autism' is less disabling or do non-retarded IQ and verbal ability identify a 'less autistic' group? At the present time, there is a lack of theory behind the distinctions, which should aim to address these questions. Frith (1991) suggests that Asperger's disorder and autism may reflect the same core cognitive deficit (theory of mind) but that lesser additional handicaps in those with Asperger's disorder allow compensatory strategies to be used. In this sense, individuals with Asperger's disorder might be speculatively conceptualised as a mid point on a continuum between individuals with prototypic autism and the broader phenotype seen in family members where one relative has autism. Indeed the criteria that their impairments must be of clinical significance, may refer to the presence of less severe, but qualitatively similar impairments within the 'normal' range of functioning.

Measurement issues are important. It may be that some individuals are falsely seen to be different in terms of the presence or absence of symptoms or hypothesised underlying deficit. Apparent differences may be a function of insensitive measures failing to capture the impairments of the less severely affected. The increase in incidence/ prevalence of autism may be seen in this light. The increase reflects change in our ability to detect

autism rather than a true increase in the number of people with these impairments.

In summary, Asperger's disorder remains a contested category. Whether or not the differences between autism and Asperger's disorder are quantitative or qualitative has yet to be determined. Firm conclusions need to be preceded by systematic investigations of well-defined groups (Lord and Rutter, 1994).

COGNITIVE PSYCHOLOGY APPROACHES TO UNDERSTANDING AUTISM

The diagnoses of autism and its hypothesised variant Asperger's disorder are made at the level of behavioural phenomenology. Significant findings at cognitive, biological and genetic levels require integration into the understanding of the disorder, not least in terms of how deficits at these different levels might account for the clinical phenomena (Bailey *et al.*, 1996). Research within cognitive psychology has sought both to identify deficits at a cognitive level which distinguish autism from other developmental disorders, and to show how such cognitive deficits may give rise to the characteristic behavioural impairments. In broad terms, cognitive neuropsychology as applied to children aims to understand clinical populations by explaining their characteristics in relation to models of normal functioning. One advantage of this approach is that it may support more theory-driven remediation (Temple, 1997). Within a general framework that presumes individual differences arise within a common cognitive architecture, research may attempt to identify a limited number of groups which share a cognitive architecture that is distinct in some respects and for which there may be a specific biological marker (e.g. gender, handedness, autism).

Four main strands of cognitive research within the autistic continuum will be discussed: cognitive profiles on standard IQ batteries; theory of mind; weak central coherence; and executive function. The first area is most important within clinical assessments, whereas the remaining three have been the focus of experimental psychology research. In addition to considering how each of these areas seeks to explain the characteristics of autism, the relationships between the different areas of research will be explored.

Group Profiles On Standardised Intelligence Tests

The assessment of cognitive function forms an important part of the clinical assessment of individuals with autism in order to determine if social and communicative behaviour is delayed or deviant relative to the child's developmental level. In addition, broad cognitive assessments assist in identifying developmental potential (Rutter, 1985). From a large number of these individual assessments, observations have been drawn of common patterns of assets and deficits that may differ from the profiles seen within either a normal population or other clinic populations.

Before considering specific findings from studies of individuals with autism, four general approaches to summarising variations in performance on the most widely used standardised assessment batteries will be introduced: verbal versus performance distinctions, distinctions derived from factor analysis, fluid versus crystallised intelligence and finally, sequential versus simultaneous processing.

The Weschler scales which cover pre-school, school-age and adult populations, were designed to assess intelligence as an aggregate of abilities that allow an individual to 'act purposefully, to think rationally and to deal effectively with his or her environment' (Weschler, 1958, p.7). Subtests which attempt to operationalise constructs of psychological functioning such as memory, verbal reasoning and visuo-motor integration, have traditionally been grouped to reflect *verbal* intelligence (VIQ) versus *performance* intelligence (PIQ). More recently, the Weschler subtests have been grouped by statistical analysis into three *factors*: Verbal Comprehension (VC), Freedom from Distractibility (FD) and Perceptual Organisation (PO) (Kaufman, 1979).

The distinction between *fluid* and *crystallised* intelligence attempts to capture the different resources which distinct types of intelligent behaviour draw on. Fluid intelligence is considered to be relatively free of environmental influence, reflecting the individual's basic genetic endowment of intelligence. Crystallised intelligence, in contrast, is the set of skills that are built up through culturally determined learning experiences (Cattell, 1971).

A further broad conceptualisation of abilities underlying intelligent behaviour considers cognitive processing in terms of a dichotomy of *sequential* versus *simultaneous* processing. In contrast to distinctions based on the content of tests as discussed above in relation to the Weschler scales, the sequential / simultaneous dichotomy is based on the mode of processing which is most important in terms of successful task performance. Thus sequential processing tasks involve a problem which must be solved by dealing

with stimuli one at a time, whereas simultaneous processing tasks require a number of stimuli to be manipulated at the same time. To some extent this distinction may be considered as reflecting temporal versus spatial organisation of information during processing. The Kaufman Assessment Battery for Children (K-ABC; Kaufman and Kaufman, 1983) is explicitly designed to reflect the sequential / simultaneous processing model, but the model may also be applied to the Weschler scales (Kaufman, 1979).

A number of studies have used these different groupings to describe the profile seen among samples of individuals with autism. As a group they show greater performance than verbal intelligence ($PIQ > VIQ$) and, in terms of the Kaufman factors, relative strengths in Perceptual Organisation against Verbal Comprehension ($PO > VC$) (Freeman, Lucas, Forness and Ritvo, 1985; Lockyer and Rutter, 1970; see Happe, 1994 for review). In addition to variations in broad distinctions of intellectual abilities, performance of groups of individuals with autism has been characterised by peaks of ability on Block Design and Object Assembly and troughs on Vocabulary and Comprehension subtests. The striking discrepancy between performance on these two sets of subtests may reflect differences in the population of people with autism between *fluid* and *crystallised* intellectual abilities (Lincoln, Courchesne, Kilman, Elmasian and Allen, 1988).

Distinctions derived from studies of general population samples may not sufficiently capture variations in cognitive functioning characteristic of groups of individuals with autism. For example, if a similar factor analysis is carried out on the intelligence profiles

of subjects with autism as was used by Kaufman to establish the VC, PO and FD factors within a normal population, different factors emerge. These have been described as relating to:

- i. language ability
- ii. fluid ability - nonverbal and without the need to integrate meaning or context-relevant information
- iii. intellectual appraisal of meaningful and context relevant information, (Lincoln *et al.*, 1988).

Factors i and iii have been shown to be relatively depressed compared to factor ii. That is, there seems to be relative preservation of fluid skills, where task demands are analytic rather than integrative.

One study has suggested that groups of individuals with autism are more impaired in their ability to process sequentially than simultaneously (Allen, Lincoln and Kaufman, 1991). Scores on both the K-ABC and WISC-R from 20 children with autism were analysed and compared to a group of children with Developmental Receptive Language Disorder (DRLD). All children with autism had non-verbal IQ of at least 70; all the children with DRLD had non-verbal IQ of at least 85. Overall differences in intelligence were seen between the two groups, but both groups contained a majority who showed a significant simultaneous processing preference (12 out of 20 children with autism; 14 out of 20 children with DRLD).

However, despite being supported at a theoretical level (Tanguay, 1984), the finding has not been consistently replicated. Freeman *et al.* (1985) examined the performance of 21 children with autism on the K-ABC (Kaufman and Kaufman, 1983) and WISC-R (Weschler, 1974). Contrary to their own prediction, they did not reveal a preference for simultaneous processing. Indeed, the few individuals in which significant differences were seen favoured sequential over simultaneous processing. Other findings across the assessment instruments, however, were consonant with previous research. Performance IQ was significantly higher than Verbal IQ, and characteristic peaks in visuo-spatial tasks (Block Design and Triangles) and troughs on Comprehension and Photo Series were found.

The impact of verbal ability on sequential processing scores provides one way in which these different findings may be understood. A positive relationship between verbal ability and sequential processing scores has been found (Lincoln, Allen and Kilman, 1995). Although the trough on Comprehension might seem to preclude this interpretation, it is possible to consider the Comprehension subtest as drawing strongly on crystallised intelligence in addition to verbal skills. However, the idiosyncratic nature of profiles amongst individuals with autism may once again preclude summaries derived from investigations in normal samples. Thus, even when an overall simultaneous processing or performance intelligence preference is seen, there may be considerable *intrasubscale scatter*. Thus on the K-ABC (Kaufman and Kaufman, 1983), performance of groups of individuals with autism on the simultaneous processing subscale includes strengths on Triangles and weaknesses on Spatial Memory and Photo Series (for

descriptions of these subtests see Method). Similarly, on the Performance subtests of the Weschler tests, strengths on Block Design and Object Assembly are seen along side weaknesses in Picture Arrangement and Coding. Given that sequential processing deficits may be shared by other language-impaired groups (e.g. Developmental Receptive Language Disorder; Allen *et al.*, 1991), and that sequential preference has not yet been established as universal in autism, it may be that the degree of intrasubtest variability is the most discriminating characteristic of performance on intelligence batteries by individuals with autism (Lincoln *et al.*, 1995).

An additional important issue to consider when interpreting performance within autism on intelligence tests and how it may relate to underlying assets and deficits of cognitive processing, is the fact that relatively few subtests provide a one-to-one match to a specific cognitive ability or process. The majority of tests, are grouped according to the predominant demands they make, but as with the majority of intelligent behaviour are also likely to require integration of other abilities.

What kind of cognitive pattern might be expected in children with a diagnosis of Asperger's disorder rather than core autism? Given the findings of the strong influence of verbal ability on test results, with increases in language ability associated with increments in performance on sequential processing, one would be less likely to predict a simultaneous processing preference. The group of children with autism studied by Freeman *et al.* (1985) had a higher mean VIQ than the Allen *et al.* group (1988). As the children had received diagnoses of autism according to DSM-III (APA, 1980) criteria,

the sample may have included some individuals who would now receive a diagnosis of Asperger's disorder; however, the narrowness of DSM-III would suggest this would not be a significant proportion. In addition, parallels have been drawn between the phenomenology of Asperger's disorder and nonverbal learning disabilities (NVLD, Klin, Volkmar, Sparow, Cicchetti and Rourke, 1995). NVLD are associated with neuropsychological profiles which reflect greater right hemisphere dysfunction (Rourke, 1989), in contrast to the pattern in autism which typically is considered to indicate greater left hemisphere dysfunction (Dawson, 1983; Rumsey, 1992). There is some argument that Kaufman's simultaneous / sequential modes are associated with the right and left hemispheres respectively (Kaufman and Kaufman, 1983) and therefore following from Klin *et al.*'s study (1995), Asperger's disorder and autism might show opposite patterns of preference. However, an alternative hypothesised localisation for the two types of processing was proposed by Luria (Kaufman and Kaufman, 1983) who associated sequential processing with the frontal-temporal regions and simultaneous processing with the occipital-parietal area. Thus as yet it is not possible to locate firmly the different types of processing.

The strength of the findings in Klin *et al.*'s study (1995), (which finds parallels between Asperger's disorder and NVLD and suggests that in contrast to autism, Asperger's disorder is characterised by VIQ >PIQ), is likely to be accounted for in part by the addition of 'motor clumsiness' as one of the distinguishing criteria for Asperger's disorder in the selection procedure for the study. Although motor impairments have been suggested as a characteristic in many proposed diagnostic categorizations (Asperger,

1994; Wing, 1981; Gillberg and Gillberg, 1989; see Ghaziuddin, Tsai and Ghaziuddin, 1992 for review), it is not a diagnostic criteria in either DSM-IV (APA, 1994) or ICD-10 (WHO, 1992). However, despite the possible influence of the additional criterion, comparable findings were seen in a recent study that compared children with autism, Asperger's disorder and children with a disorder characterised by deficits in attention, motor control and perception, (DAMP) on the WISC-R (Ehlers, Nyden, Gillberg, Sandberg, Dahlgren *et al.*, 1997). Whereas the group of individuals with autism showed $PIQ > VIQ$, the opposite pattern was seen for those with Asperger's disorder. Ehlers *et al.* (1997) follow Lincoln *et al.* (1988, 1995) in suggesting that Kaufman's factors may make more sense of discrepancies between the diagnostic groups' performances. Subjects with Asperger's disorder showed strengths on Comprehension and Picture Arrangement in contrast to weak performance on Object Assembly. The group with autism showed the frequently reported peak on Block Design. Ehlers *et al.* (1997) compared their groups to Kaufman's factors and reported a pattern for Asperger's disorder that seems to be opposite to that found for subjects with autism on the three factors derived by Lincoln *et al.*, (1988). In contrast to the pattern seen in autism, Asperger's disorder in this study, was characterised by relatively good performance on tests relying on verbally mediated crystallised ability and the ability to integrate information in a context relevant manner. Moreover, relatively poor performance was seen on at least one test which may be considered to reflect fluid ability within the visuospatial mode.

In summary, children and adults with autism have tended to show peaks on tasks reflecting performance ability and most likely drawing on fluid intelligence. Findings in relation to mode of processing are more equivocal, although strong arguments have been made that simultaneous processing will be relatively stronger in this population. Deficits are seen on verbal tasks, particularly those which reflect crystallised intelligence and this finding is supported by relative deficits on other tasks which require the integration of context-relevant material. The picture for individuals with Asperger's disorder has been less well delineated, due to a dearth of relevant studies. Whereas some studies have suggested minimal if any differences between Asperger's disorder and autism, others have begun to suggest divergence with strengths that might produce sequential advantages, some evidence of preserved crystallised intelligence and possible weaknesses in the visuo-spatial function that is often considered a strength within autism.

Theory of Mind

In contrast to the broad assessment of cognitive ability provided by standardised tests of intelligence, an area of research in autism that has focused on a very specific and modular aspect of cognition has recently become influential. The 'theory of mind' account of autism arose out of investigations into the socio-cognitive development of normal children, which had drawn originally on work in primatology and philosophy (Premack and Woodruff, 1978). The term theory of mind is used to describe the underlying competence which enables people to understand and predict their own and other's behaviour by drawing on knowledge of people's mental states (e.g. beliefs, desires). Put simply, people are usually able to demonstrate an ability to understand from the social

context what other people are likely to be thinking. The term theory is used not to denote an explicit process like scientific understandings, but to capture the sense that the understanding is inferred rather than derived directly from observable factors, and that is used to make predictions. Philosophers of science have suggested that the application of theory of mind can be demonstrated where an accurate prediction of someone's behaviour is made that is based on realising that the individual holds a false belief (Dennet, 1978). As the false belief necessarily differs from reality, correct prediction involves making an inference about the person's mental state. This ability has been shown to develop in normal children between the ages of three to five years (Wimmer and Perner, 1983; Perner, Leekham and Wimmer, 1987). The experimental paradigm involved telling children a story in which one character places an object in a specific location and then leaves the scene. While she is away, another character moves the object to a different location. Children are asked where the original character will look for her object when she returns. At age three, the majority of children rely on their own knowledge of the actual state of the world and predict that the doll will look in the new location. By age five, most children are correctly able to use their knowledge of the doll's now false belief of the object's location to predict that she will look in the original location.

In contrast to the developmental shift seen in normal children, the majority of children with autism have been shown to fail false belief tasks despite a much higher chronological age and a verbal age above that required for success in the normal population. It appears that this deficit in 'theory of mind' is specific to autism, given that

children with Down's syndrome have pass rates more similar to the norm (Baron-Cohen, Leslie and Frith, 1985). Individuals with autism therefore seem to have specific difficulty understanding that people have mental states that are different from the real world and from the person with autism's own mental state. The absence of a 'theory of mind' would seriously hinder the ability to predict others' behaviour, and might make social interactions based on subtle understandings of other people's motivations and points of view seriously limited. One-sided communication in autism, that fails to take into account and adapt to the listener's knowledge base or interests, can be understood as arising from a theory of mind deficit. The aspect of theory of mind which involves decoupling our mental processes from the limits of the actual state of the world, has been hypothesised to underlie pretend play and imaginative abilities. The idea that the triad of impairments in autism arises from a theory of mind deficit can also be used to predict aspects of behaviour in these domains which should be spared in autism e.g. gestures to change someone's behaviour (go away) as opposed to changing someone's mind (look at this with me) (Attwood, Frith and Kermelin, 1988).

The concept of a theory of mind deficit appears to offer a unifying and therefore parsimonious account of the triad of autistic impairments. However, it has been suggested that evidence from other levels such as genetics and biology point to less specific primary deficits (Bailey *et al.*, 1996). Staying at the psychological level, dissent against the theory of mind account has emerged in a number of forms. Does failure on theory of mind tasks reflect competence or performance deficits? Is it the primary deficit responsible for the impairments in autism? To what extent is it truly universal within

autism? Carefully controlled experiments comparing theory of mind tasks to non-theory of mind tasks with similar information-processing demands provide good evidence that failure patterns within autism should not be considered merely artefactual (Sodian and Frith, 1992). In terms of primacy, a number of mechanisms have been suggested that might be impaired in autism and precede the age at which theory of mind comes on line in normal development. Deficits in interpersonal relatedness (Hobson, 1989), triadic representation ability (Baron-Cohen, 1994) and imitation (Meltzoff and Gopnik, 1993) have been suggested as disrupting the availability of experiences essential for social development. The role of developmentally early mechanisms is supported by work on identifying differences in populations at risk for autism at approximately 18 months (Baron-Cohen, Allen and Gillberg, 1992). However, Happe (1994a) suggests that there is not necessarily continuity between infant and later social skills such that early skills may naturally fall away, but fail to be replaced in autism, by more mature abilities.

Universality is a particularly important criterion against which hypotheses claiming to provide a parsimonious account of a disorder must be assessed. The criterion of universality seeks to answer whether in addition to explaining all the features of the disorder, the hypothesis can explain all individuals with the disorder. A proportion of children within the autistic continuum are repeatedly shown to pass theory of mind tasks. The passers have often been associated with Asperger's disorder rather than prototypical autism. Ozonoff, Rogers and Pennington (1991), found that theory of mind task performance was the single discriminator between 13 individuals with autism and 10 individuals with Asperger's disorder, although this difference became marginally non-

significant when verbal ability was taken into account. Bowler (1992), found that adults with Asperger's disorder did not show deficits on theory of mind tasks relative to a control group of patients with schizophrenia. These findings may suggest that, if Asperger's disorder and autism are common disorders, then a theory of mind deficit may not be the primary core deficit.

An alternative explanation for the finding that approximately 20% of people who fit a broad diagnosis of autism (including individuals with Asperger's disorder) pass theory of mind tasks is that current tasks suffer from a ceiling effect. Less severe impairments in higher functioning individuals may not be detected. Passers may use a method to achieve task success that does not require theory of mind but instead involves a more deliberate, consciously learnt method which may not easily generalise to complex real life situations. Such an explanation is attractive in that it would seem to account for the fact that even theory of mind passers show deficits in behaviours that are likely to be supported by real-life mentalising ability (e.g. one-sidedness in social interaction and communication). Another model which allows passers to be incorporated into an understanding of autism in terms of theory of mind involves replacing the idea of a deficit with that of a delay (Happé, 1994 a). This view may be supported by the finding that there is a strong relationship between verbal mental age and pass rates on theory of mind tasks (Happé, 1995). Both normal samples and those from autism may be characterised by a two-point cut off, with a verbal mental age below which everyone fails and one above which everyone passes. Whereas these two ages are two years 10 months and six years 9 months respectively in a normal population, they are five years 6 months and 11 years

7 months within autism (Happe, 1995). Whether the nature of the relationship between verbal ability and theory of mind is the same in the two different populations, and what exactly the nature of the relationship is remains unclear. Within the population of people with autism at least two mechanisms might be considered. On the one hand, the higher mental age of individuals with autism who pass versus normal passers may support the idea that individual success within autism is the result not of true theory of mind but of the application of a voluntarily controlled verbal method. Alternatively, if task success does reflect true theory of mind it may be that theory of mind ability through mechanisms such as joint attention, social referencing and ostention are necessary to provide the experiences needed to achieve a verbal mental age of 11 years or above.

Executive Function

In contrast to the theory of mind hypothesis, which seeks to explain autism in terms of a circumscribed, syndrome-specific deficit, an alternative area of research has attempted to explain autism in terms of a broader deficit in cognitive functioning that has been associated with a number of other disorders, both developmental and acquired. The term *executive function* is used to describe the hypothesised ability underlying a range of purposeful behaviours, which were first noticed to be impaired in adult patients who had sustained brain damage in the frontal lobe region. These patients, while intellectually intact in a broad sense, experienced difficulties planning their actions, could be disinhibited, and perseverate. Pennington and Ozonoff (1996) note the heterogeneity of tasks that have been shown to be disrupted by frontal lesions. In surface characteristics and content they appear diverse. However, they suggest that the tasks can be

conceptualised together as they all require goal-directed activity, usually in novel contexts and where the successful behaviour is in competition with other plausible, but erroneous responses. In order for failure on a goal-directed activity to be attributed to executive function deficits, it should not be attributable to more basic cognitive processes such as memory, perception or language comprehension. Executive function may be seen as playing a pervasive and central role in cognition. It has been described as closely related to the notion of a limited-capacity central processing system (Welsh and Pennington, 1988). Between perception and action, executive function involves selecting and executing context-appropriate action.

Three areas of impaired behaviour in autism - motor stereotypies and puppet-like gait, language impairments especially mutism and poverty of initiation, and abnormalities of attentional focus - originally prompted comparison with the adult frontal lobe-damaged group (Damasio and Maurer, 1978). Current research supports the focus on a function which is considered to play a pervasive and central in cognition, following from the observation that children with autism display a wide range of problems in processing information. However, it is important to remember that the connection of autism with frontal lobe impairments has the status of a metaphor. It may be used to organise questions about preserved and impaired functions in autism while actual structural or functional pathology remains unknown.

There are some problems in applying the executive function and frontal lobe metaphor to autism. On the one hand, the adult lesion model cannot account for the interaction with developmental processes that occurs in childhood onset disorders. In addition, whereas children who acquire frontal lobe injury do show dramatic and lasting social and cognitive effects, they do not present with a diagnosable disorder of autism. Indeed, the broadness of the function hinders the specificity which is traditionally sort in scientific explanations. A number of other childhood disorders - Tourette's syndrome, conduct disorder and ADHD (Attention Deficit Hyperactivity Disorder) - have also been shown to relate to executive function impairments.

Despite these reservations, how well do executive function deficits explain the features of autism? The precise causal links between executive function and both impaired reciprocal social interaction and delayed or abnormal communication are not clear. Executive function deficits (impoverished generativity and inability to disengage from the external environment) have been drawn on to explain pretend play (Harris, 1993; Jarrold *et al.*, 1994). Whereas, the above areas may be considered weak examples of the role of executive function in autism, executive function offers a more cogent explanation for the repetitive behaviours, circumscribed interests and resistance to change that have been largely left unexplained by 'theory of mind' explanations. These associated features of autism, would be predicted where an impaired central executive entails the loss of flexible control over behaviour (Shallice, 1988) or reduces the ability to generate alternative behaviours.

Does the concept of executive function impairments assist in differentiating autism from Asperger's disorder? Ozonoff *et al.* (1991) found that subjects diagnosed as having autism or Asperger's disorder did not differ in their performance on executive function tasks, despite differences in verbal IQ and 'theory of mind' task performance. From this, they proposed that executive function should be considered the central deficit in autism, since it was seen to span the continuum. An executive function task developed by Hughes (1996) based on a Luria hand-game, has enabled younger and less able children with autism to be assessed. She found that subjects with autism were impaired relative to a control population of children with moderate learning difficulties. However, within the autism group, performance was strongly related to verbal ability. Given that Asperger's disorder is currently distinguished in part from core autism by the absence of delayed early language, it may be that they will display differences on executive function tasks. However, the nature of the relationship between language ability and executive function, as with theory of mind, is unclear. In addition, difficulties in comparing individuals with autism and Asperger's disorder on executive function tasks may arise in relation to methodological problems with current tasks. Executive function tasks show both floor and ceiling effects. Many of the tasks have been identified as simply 'difficult' tasks, and control tasks of equal difficulty which do not involve executive function are required. However, even these 'difficult' tasks show ceiling effects, so that success may not require fully intact executive function (Pennington and Ozonoff, 1996).

Weak Central Coherence and Field Independent/Dependent Cognitive Style

A third strand of thinking about autism has developed from the observation that individuals with autism often show a peak performance on the block design subtest in Weschler intelligence scales. The task, which involves reproducing a pattern using a specified number of identical blocks, was originally devised by Koh's (1923) and has been used as a central tool in neuropsychological assessments. It is a non-verbal task, generally considered to assess problem-solving within the right hemisphere (Lezak, 1976). The observation of this peak ability has been discussed above in relation to the overall cognitive profile seen in autism on standardised intelligence tests. However, other questions raised by this ability are how does it relate to the deficits and assets used to describe autism diagnostically, and how does it relate to what we understand of problem-solving by people who do not have autism?

Shah and Frith (1983, 1993) compared subjects with autism to a control group on an embedded figure task and on a variation of the block design task. In the first study, they showed that subjects with autism were quicker at spotting a figure hidden within a distractor picture. The second study manipulated the presentation of the block design task, with the finding that subjects with autism outperformed controls on the original designs but not when the designs were pre-segmented. Thus, Shah and Frith concluded that people with autism must by default approach the task in a presegmented manner, that is they see the design in terms of its constituent parts rather than seeing the image as a whole.

Frith and Happe (1994) hypothesised that the anti-holistic approach that seems to characterise performance of people with autism results from 'weak central coherence'. Seminal work in cognitive psychology (Bartlett, 1932) suggested that the natural default setting for processing incoming information is to discard detail and encode in terms of overall impression, or in some way which captures meaning. In contrast, people with autism seem to take in information in a more raw, unprocessed form which preserves constituent detail. Whereas this might often be to their disadvantage, it has a facilitating effect on tasks that require analysis and breaking down of a gestalt into its components.

The term *weak central coherence* as used to characterise information processing seems to share similarities with the concepts of *field dependence* and *independence* which are identified as cognitive styles (Witkin and Goodenough, 1977). *Field independence* describes a style whereby information is processed in a way that is relatively uninfluenced by context. In contrast, a *field dependent* style relies heavily on context in interpreting or responding to incoming information. Whereas central coherence is viewed as the norm, the literature on cognitive style has placed more emphasis on the dimensions of field dependence and independence as being relative, and value-free (Globerson, 1989). No one style is more advantageous or cognitively sophisticated than the other. They are likely to be more or less useful depending on the nature of the task to be solved. Therefore, flexibility within an individual, such that cognitive style may be moderated according to task requirements, is likely to characterise the most successful performers when ability across a range of tasks is considered.

Both the literatures on '*central coherence*' and '*field dependence/independence*' provide possible links between this aspect of cognition and behavioural presentation in autism. The 'weak central coherence' hypothesis (Frith and Happe, 1994; Happe, 1994b) aims to explain the non-triad features of autism, which are largely unexplained by the 'theory of mind' literature. The tendency of some individuals with autism to focus on parts of objects (e.g. a child spinning the wheel of a toy car rather than playing with it within the context of a story), their enhanced rote memory ability (in contrast to normal subjects who find information easier to remember when it is meaningful in some way to them), and their restricted repertoire of interests, may all be conceptualised as variations from 'normal' behaviour which reflect a context-free rather than contextualised approach, a focusing on parts and detail rather than the extraction of meaning.

The literature on *field dependent/independent* cognitive style considers these dimensions as occurring throughout the normal population, rather than characterising distinct populations, and therefore provides information about how these styles influence behaviour across the normal population. A wide variety of experiments suggested that individual's cognitive style along this dimension was a strong influence on their social behaviour (Witkin and Goodenough, 1977). *Field independent* individuals were likely to function more autonomously, to show less interest in others, to prefer nonsocial situations and to distance themselves from others both physically and psychologically. *Field dependent* individuals, on the other hand, were likely to use referents within their social context to assist problem solving, were more attentive to social cues, and had a strong interest in others which they showed through seeking proximity and actively

engaging in social situations. *Field independent* individuals showed greater skill in analytic tasks, whereas *field dependent* individuals showed greater facility in interpersonal relating. The descriptions of the social behaviour of people with field independent cognitive styles, is suggestive of some of the social impairments characteristic of autism. However, even within the population of people with autism social behaviours are not universal and there may be subtypes who differ in this dimension (Wing and Gould, 1979; Wing, 1981).

Although, the weak central coherence literature focused initially on explaining the non-triad features of autism, possible interactions with other theories and findings that would give central coherence a more integral role in our understanding of autism have been put forward. Frith and Happe (1994) suggest that an interaction between 'theory of mind' ability and central coherence, may account for the finding that most but not all individuals with autism fail current experimental tasks designed to assess theory of mind. They suggest that those who pass may still 'fail' in everyday social interactions, as they are unable to gain the necessary information from the social context about others' states of mind. Whereas they suggest that theory of mind problems may reflect an organic deficit, they conceptualise weak central coherence, as a possibly genetically inherited trait and speculate that it may be seen in relatives of people with autism in line with the idea of a broader autistic phenotype that extends beyond current diagnostic boundaries. In this respect, some further rapprochement between central coherence and field-relative cognitive styles may be seen in the implication that the non-clinical population may show variations in such a trait.

RELATIONSHIPS AMONG COGNITIVE FINDINGS AND THEORIES

The studies of cognitive functioning outlined above reflect an emerging picture of the cognitive functioning associated with autism, which seems to be characterised by areas of strength as well as weakness. Some of the theories and findings from different areas may be compatible, either by adopting a unitary approach where one deficit is seen to cause the other(s) or by acknowledging that various kinds of broad and narrow deficits exist independently. Thus the theory of mind account may be integrated with the notion of weak central coherence to explain social and non-social characteristics within autism (Frith and Happe, 1994). The picture of impairments and apparent assets in autism would arise from the parallel contributions of a deficit in a modular system dedicated to processing mental state information and a deficit in a more distributed system that determines cognitive style or the manner in which information is processed.

However, although research at other levels such as biology and genetics have opened up the possibility of multiple primary deficits causing autism, (Goodman, 1989), cognitive psychologists have tended to focus on identifying a single, primary deficit and have therefore constructed arguments which set the different theories in competition. Executive functioning accounts seek to understand autism as arising from a much broader area of deficit than suggested by the theory of mind account. Causal links between the two impairments, in either direction, may be considered. Bailey *et al.* 1996 raise the possibility that understanding one's own mind (an important aspect of intact theory of mind) would be necessary for executive function in terms of supporting the ability to monitor one's intentions in order to follow a plan of action towards a goal. However,

arguing that the causal direction runs from the broad deficit in executive functioning to the narrow deficit in theory of mind may be more convincing. Theory of mind failure could be merely artefactual - a function of the inherent executive function demands of the tasks. Alternatively, theory of mind deficits may be real but caused by executive function problems such as working memory, inhibition of prepotent response and inference. Given the real difficulties in social interaction shown by people who fail theory of mind tasks, and even some of those who pass, even those authors who advocate the causal primacy of executive function appear more willing to adopt the latter model (Ozonoff *et al.*, 1991).

The weak central coherence theory is the only one which has been directly related to characteristic findings on intelligence assessments. Indeed, this theory arose out of investigations of the performance of individuals with autism on tasks similar to the Weschler Block Design subtest (Shah and Frith, 1983, 1993). A direct relationship between low verbal ability and weak central coherence has not been raised. The proponents suggest that weak central coherence should be unrelated to content, so that different tasks should be possible where facilitation by weak or normal central coherence is unrelated to task content. An example of a verbal task facilitated by weak central coherence, might be Word Order from the K-ABC where the words to be remembered are randomly rather than meaningfully connected. People with autism have been shown to outperform controls on learning lists of unrelated words, but not on meaningful sentences (Hermelin and O'Connor, 1970). However, it would seem unlikely that high levels of verbal ability would be achievable with severe weaknesses in central coherence.

The relationship between proposed executive function deficits and IQ profiles is unclear. In adult patients with frontal lobe injury, where the model originates, it has been suggested that crystallised intelligence remains intact whereas fluid intelligence is severely affected. This finding would apparently be the opposite to that seen in autism, and might therefore invalidate the executive function metaphor. However, given that this area of research as it relates to autism is still relatively ill-defined, it may be that the different pattern can be accounted for in terms of the timing of assault and its impact on subsequent development. Clearly since autism is a disorder with onset very early in childhood, if not of congenital origin, significant differences from the adult pattern are likely. However, it is important that they are clarified if the metaphor is to remain useful.

Theory of mind deficits may bring a confounding element into the assessment of IQ since non-social cognitive functions are often assessed in ways that draw on understandings of social interaction. This may be either in terms of the interaction with the examiner (e.g. understanding what the examiners reasons are for asking the Comprehension questions), or in terms of the content of tasks such as Picture Arrangement.

RATIONALE FOR THE PRESENT STUDY

The new developments within diagnosis, with the formal recognition of Asperger's disorder and autism in the most widely used clinical and research diagnostic systems, allow for and invite further exploration of their relationship (Rutter and Schopler, 1992). The different areas of research discussed above give rise to distinct predictions in terms of the relationship between Asperger's disorder and autism. Whereas some findings on IQ profiles and theory of mind assessments suggest divergence at a cognitive level, executive findings have not as yet revealed differences between the two. The literature on weak central coherence offers the hypothesis that central coherence will be weak even in theory of mind passers (most frequently individuals with Asperger's disorder), and would account for their pervasive social impairment in real life, despite their success in experimental assessments, as they may be unable to garner the necessary information that is implicit in the social context. However, it may be important to consider the possibility that those with good verbal ability will have more normal central coherence

The present study aims to explore the patterns of strengths and weaknesses shown on the K-ABC by children who have received a differential diagnosis of either Asperger's disorder or autism according to DSM-IV criteria. The study seeks to address the following questions:

- what are the characteristic strengths and weaknesses within each group?
- to what extent does performance on the K-ABC distinguish the two groups?
- do the groups show preference for sequential or simultaneous processing and if so is the preference the same or different across the groups?

- do strengths and weaknesses in performance on the K-ABC suggest specific deficits in autism and/or Asperger's disorder such as weak central coherence or the predominance of a particular cognitive style such as field independence?

In addition, in a smaller study, we shall attempt a preliminary exploration of relationships between IQ profiles and other measures of cognitive functioning that have been important in the theoretical literature about autism: executive functioning, theory of mind and central coherence.

Thus the current study will undertake a broad assessment of cognitive ability. However, distinctions made on the basis of patterns of assets and deficits in cognitive processing and cognitive style preferences will be sought rather than on the basis of global cognitive performance. Thus, whereas some researchers have conceptualised PDDs as a continuum with mainly quantitative differences differentiating individuals, this study attempts to explore whether there may be qualitative as well as quantitative differences at a cognitive level.

METHOD

SUBJECTS

Source

Participants were recruited from two sources: two National Autistic Society (NAS) schools, and a tertiary level child development centre. A few of the participants from the centre had been fully assessed prior to the start of the study and their data was included retrospectively. The rest of the subjects were assessed during the course of the study.

Diagnosis

All children had diagnoses of either Asperger's disorder or autistic disorder as defined by DSM-IV (APA, 1994). The diagnostic protocols for each disorder are set out in Tables 1 and 2. For children attending the NAS schools, diagnosis was established by reviewing the individual's school assessment file with the school psychologist. Diagnoses at the child development centre were reviewed from the case notes in relation to DSM-IV criteria and clarified with the key clinician where necessary. Diagnosis was based on notes of developmental interviews with parents, and of direct observations of the child's interpersonal and play behaviour in the clinic and school settings. Information from cognitive assessments was not reviewed or included in the process of diagnostic assignment in order to avoid a potential source of circularity in the study. Children were assigned a diagnosis consistent with DSM-IV criteria as applied to a reading of the case notes specifically for the purpose of the study and not necessarily in line with the diagnosis originally given by the clinic, for example in cases which were assessed before DSM-IV applied.

Table 1: DSM-IV diagnostic criteria for autism

<p>A. A total of six (or more) items from 1, 2 and 3 with at least two from 1, and one each from 2 and 3.</p> <p>1. Qualitative impairment in social interaction as manifested by at least two of the following:</p> <p>a) marked impairment in the use of multiple <i>nonverbal behaviours</i> such as eye-to-eye gaze, facial expression, body postures, and gestures to regulate social interaction;</p> <p>b) failure to develop <i>peer relationships</i> appropriate to developmental level;</p> <p>c) a lack of spontaneous <i>seeking to share enjoyment, interests, or achievements</i> with other people (e.g. by a lack of showing, bringing or pointing out objects of interest);</p> <p>d) lack of social or emotional <i>reciprocity</i>.</p> <p>2. Qualitative impairments in communication as manifested by at least one of the following:</p> <p>a) delay in, or total lack of, the development of <i>spoken language</i> (not accompanied by an attempt to compensate through alternative modes of communication such as gesture or mime);</p> <p>b) in individuals with adequate speech, marked impairment in the <i>ability to initiate or sustain a conversation</i> with others;</p> <p>c) stereotyped and repetitive use of language or <i>idiosyncratic language</i>;</p> <p>d) lack of varied, spontaneous <i>make-believe play</i> or social imitative play appropriate to developmental level;</p> <p style="text-align: right;">(continued)</p>

3. Restricted repetitive and **stereotyped patterns of behaviour**, interests, and activities, as manifested by at least one of the following:

- a) encompassing preoccupation with one or more stereotyped and *restricted patterns of interest* that is abnormal either in intensity or focus;
- b) apparently inflexible adherence to specific, *nonfunctional routines* or rituals;
- c) stereotyped and repetitive *motor mannerisms* (e.g. hand or finger flapping or twisting, or complex whole-body movements);
- d) persistent *preoccupation with parts of objects*.

B. Delays or abnormal functioning in at least one of the following areas with **onset prior to age 3 years**: (1) social interaction, (2) language as used in social communication, or (3) symbolic or imaginative play.

C. The disturbance is not better accounted for by Rett's Disorder or Childhood Disintegrative Disorder.

Table 2. DSM-IV diagnostic criteria for Asperger's disorder

A. As Category A 1 for autistic disorder
B. As Category A 3 for autistic disorder
C. The disturbance causes clinically significant impairment in social, occupational, or other important areas of functioning.
D. There is no clinically significant general delay in language (e.g. single words by age 2 years, communicative phrases used by age 3 years).
E. There is no clinically significant delay in cognitive development or in the development of age-appropriate self-help skills, adaptive behaviour (other than in social interaction), and curiosity about the environment in childhood.
F. Criteria are not met for another specific Pervasive Developmental Disorder or Schizophrenia.

Inclusion criteria

Children were aged between five and twelve and a half years old, reflecting the age range for which the main cognitive assessment used (the Kaufman - Assessment Battery for Children, K-ABC; Kaufman and Kaufman, 1983) is appropriate. Children with low overall levels of functioning (Mental Processing Composite, MPC < 70, which is considered the best measure of IQ) were excluded in order to enhance the comparability of the two subject groups. Thus the samples should allow comparison of cognitive abilities that might not be accounted for by the presence of severe learning difficulties, in one group. The cut-off has been widely used in research to identify a high-functioning group with autism, and forms part of the diagnostic criteria for Asperger's disorder.

Main study

A total of 46 children were assessed. Eight children were excluded because their MPC fell below 70, placing them within the learning disability population. Of the original 46 children, 23 had Asperger's disorder and 23 had autistic disorder. Of the children who remained in the study once the MPC criterion had been applied, 22 had Asperger's disorder and 16 had autism. The characteristics of the two samples in terms of age, sex and source are presented in Table 3.

Subsidiary study

In an attempt to make a preliminary exploration of whether links could be made between findings on intelligence assessment batteries and performance on tests from areas of theoretical interest in the cognitive study of autism, a number of experimental tasks were administered to a subset of the original participants. Nine subjects from the Asperger's disorder sample were assessed with the experimental battery. Due to practical

considerations, the majority of the autism sample in this section of the study came from the school sample. This was because of the large catchment area of the child development centre precluding further assessment of many who had attended the clinic. In addition, subjects were not approached for further assessment if their original K-ABC assessment could no longer be considered a good measure of their current functioning because of the elapse of time. Six of the children with autism included in the subsidiary study were ultimately excluded from the main study reported above as their MPC fell below the cut-off point of 70. The autism sample for the subsidiary study therefore comprised six children from National Autistic Schools with $MPC < 70$ and four school children and one clinic child with $MPC > 70$ (see Table 4). All the subjects with Asperger's disorder in the subsidiary study were also included in the main study. Sample characteristics for the subsidiary study (age, sex and source) are shown in Table 4.

TABLES OF SAMPLE CHARACTERISTICS

Table 3. **Sample characteristics: main study**

	Asperger's disorder n = 22	Autism n = 16
Age: mean (SD)	8.9 (2.3)	8.1 (2.3)
Sex: male / female	22 male 0 female	14 male 2 female
Source: clinic / school	22 clinic 0 school	12 clinic 4 school

Table 4. **Sample characteristics: subsidiary study**

	Asperger's disorder n = 9 (all included in main study also)	Autism n = 11 (6 subjects were not in main study)
Age: mean (SD)	9.8 (2.2)	11.2 (2.0)
Sex: male / female	11 male 0 female	7 male 4 female
Source: clinic / school	11 clinic 0 school	1 clinic 10 school

MEASURES

Instruments were selected to provide the following information: a broad overview of the child's cognitive functioning, a comparison of abilities across tasks requiring distinct processing abilities and styles, tasks which research has suggested discriminate between the performance of subjects with autism and those without autism..

Main Study:

1. Kaufman - Assessment Battery for Children (K-ABC, Kaufman & Kaufman, 1983)

The test provides a broad assessment of children's intellectual functioning suitable for five to 12.5 year olds. The test consists of eight subtests (see Table 4) for this age group which are organised according to a dichotomy between two basic types of information processing. Subtests within the sequential processing scale present problems which must be solved by arranging the input in sequential or serial order. Each idea is linearly or temporally related to the preceding one. Subtests in the simultaneous processing scale are spatial, analogic or organizational in nature. Input has to be integrated and synthesised. Thus, whereas sequential processing takes items one by one, simultaneous processing manipulates many stimuli at once. A non-hierarchical relationship between the two types of processing is assumed. The Mental Processing Composite (MPC) combines performance scores on both the processing scales and is intended as the best measure of total intelligence, reflecting the assumption that intelligent behaviour probably results from the integration of sequential and simultaneous processing. Equally, the individual subtests are constructed as complex tasks, primarily sequential or simultaneous in nature, but drawing on elements of the other processing style as well.

The K-ABC has been standardised on US samples including children with disabilities, and has been suggested to have less of a verbal bias than the Weschler intelligence tests that are more commonly used in the UK, making it particularly suitable for the population of this study. In addition, it has been used as the instrument of choice for assessing general intelligence at the child development centre.

Table 5. Brief descriptions of K-ABC subtests

SEQUENTIAL SUBTESTS

Hand Movements	A motor-visual task. The child copies from memory a short series of hand movements executed by the examiner.
Number Recall	Auditory short term memory. The child repeats a sequence of random numbers spoken by the examiner.
Word Order	A visual memory task with motor response. The child points to pictures in the order in which they were named by the examiner.

SIMULTANEOUS SUBTESTS

Gestalt Closure	An incomplete picture of a familiar subject is presented for naming.
Triangles	Visuo-spatial task with motor response. An abstract design has to be matched using several identical rubber triangles (blue on one side and yellow on the other).
Matrix Analogies	Abstract reasoning. The child has to select the picture or design that best completes a 2-by-2 visual analogy.
Spatial Memory	Randomly arranged pictures are presented, then replaced by a gridded page where the child must indicate the locations of the pictures from memory.
Photo Series	Randomly arranged pictures relating an event have to be organised mentally and placed in temporal sequence.

Measures used in Subsidiary study only:

2. *Luria Hand-Game* (Hughes, 1996; after Luria, Pribram and Homskeya, 1964)

This task is designed to assess problems in *executive functioning*, that are reported in individuals with autism. The relative simplicity of the task's presentation allows assessment of complex cognitive activities in a younger age group (pre-school normal sample, sample with autism aged six - 18 years) than traditional executive function tests (e.g. Tower of Hanoi, Wisconsin Card Sorting Test). The task requires control of action and thinking. A prepotent response is first established by requiring the child to imitate a hand movement. The ability to control action internally is then assessed by requiring the child to provide a specific but different hand movement to that presented.

Procedure:

Tell the child that you want them to play a game with you. Make your hand into a *fist* and ask the child 'Can you show me how you make a fist with your hand?' If the child makes a fist successfully, then *point a finger* and say, 'Good , now show me how you point a finger'. If this action is also correctly performed by the child proceed with the game.

Imitation condition

'Here's how we will play the game. First we both put our hands behind our backs. Now when I show my hand I want you to make the **same** shape as me. So if I make a fist, you make a fist. If I point a finger, you point a finger too.' Allow the child fifteen presentations in the order outlined below, stopping when the child has produced six consecutive correct imitations:

Contrast condition

'That was very good. Now the game gets a bit harder. We both put our hands behind our backs again. But, when I show my hand, I **don't** want you to make the same shape as me. I want you to make the other shape. So if I make a fist, you point a finger. If I point a finger, you make a fist. What do you do if I show a fist? What do you do if I point a finger?' Present trials in the order outlined below, repeating the instructions and giving feedback on performance until four consecutive correct responses are made. A child is rated successful if six consecutive correct responses are made within the fifteen trials.

A second version of the test was also administered to each child whereby the child first has to make a nonmatch and then has to match a gesture signalled on each trial by the experimenter. This variation was designed for the study by the author and supervisor. By reversing the contrast and imitation conditions of the Luria Hand-Game (using separate hand movements), this additional test should allow an inability to inhibit action in the face of strongly directive external stimuli, from cognitive flexibility problems.

3. *Segmented Block Design* (after Shah and Frith, 1993)

This task is included as it provides evidence as to whether subjects show weak central coherence in their approach to processing a visuo-spatial task. Subjects are required to construct two types of design. A condition where a design is presented in an unsegmented form is compared to that where the design is pre-segmented into its constituent parts. The presence of a strong facilitatory effect associated with the

presegmented condition reflects the operation of normal central coherence in task processing.

Design and materials:

The subject was shown a two-dimensional pattern on a card and was required to construct a similar pattern using all four blocks provided. Four designs to be constructed were selected from the Block Design subtest of the Weschler Intelligence Scale for Children (WISC-III-UK) to span an appropriate range of difficulty for the age group of the study. Four identical blocks necessary to complete the designs were provided. The set of designs used are presented in Appendix 5. The effect of segmentation was investigated by presenting the same designs as wholes or as composed of four separate blocks.

Procedure:

The subject was first shown the four blocks and told that they were all the same - two red sides, two white sides and two sides half red and half white (divided on the diagonal). The subject was then shown two demonstration designs in turn, which were first constructed by the experimenter, then the blocks were jumbled and the child asked to construct the same design working as quickly as possible. The time taken in seconds was recorded. The unsegmented designs were all presented first, followed by the segmented versions. In keeping with Shah and Frith's protocol this was done to avoid alerting subjects to the strategy of segmenting the designs into individual blocks. Thus the task should assess the subject's spontaneous ability to solve the problem.

4. *Test for Reception of Grammar* (TROG; Bishop, 1982)

The TROG is an individually administered, multiple choice pictorial test designed to assess receptive understanding of English. The test consists of 80 four-choice items, where the subject is required to select the picture that corresponds to a phrase spoken by the tester. The test has been standardised on British children aged four to twelve years, and has been used in assessment of children with language disorders and learning disabilities. The test takes about 10 to 20 minutes to administer. Its purpose in this battery was to provide a gross measure of language ability as many of the other tests require verbal ability in addition to the specific cognitive abilities they are designed to assess.

5. *WING Subgroups Behavioural Development Questionnaire* (Castelloe and Dawson, 1993)

The WSQ is a questionnaire designed to be completed by a child's parent or teacher. It consists of 13 groups of four different descriptions of behaviour which characterise the aloof, passive, active-but-odd or normally developing subgroups across a number of domains (e.g. social approach, communication, play skills). Two groups of questions are shown in Appendix 4. Questionnaires were completed by parents for those children recruited from the child development centre, and by school staff for the NAS children. It has been used by the developers with children ranging from four to 20 years of age. Comparison of WSQ subgrouping with clinician grouping based on behavioural observation has shown good concordance, $r(35) = .73$, $p < .001$ (O'Brien, 1996).

6. *Theory of Mind Tasks*

First order theory of mind tasks:

- i) The *Sally-Ann task* (Wimmer and Perner, 1983). The child is shown two dolls, one called Sally and one called Ann. The child watches as Sally places her toy in a basket and leaves the scene. While she is away, 'naughty' Ann moves the toy from the basket and puts it into a box. Then Ann leaves the scene. When Sally comes back the child is asked the test question, 'Where will Sally look for her marble?'. Two control questions are used to ensure the child has remembered the important details of the story: first, 'Where did Sally put her toy in the beginning?', and second, 'Where is the toy really?'.
- ii) *Smarties task* (Perner, Frith, Leslie and Leekham, 1989). The child is shown a familiar container, (e.g. smarties tube or matchbox), and is asked what they think is inside. Once the usual contents have been stated by the child, the child is shown the actual contents of the box, e.g. a coin. The contents are then replaced in the container. The test question is asked of the child, 'If we show this box to (friend's name), what will they say is in the box?'. A memory control question is also asked: 'What is really in the box?' .

Second order theory of mind task:

- iii) *Ice-Cream Van story* (Baron-Cohen, 1989)

Children are read a story that is acted out with toys. Two children, John and Mary, are in the park and the ice-cream man tells them he will stay in the park with his van all day. John goes home for money to buy an ice-cream. Once he has gone, the ice-cream man

tells Mary, that he has changed his mind and is going to sell ice-cream outside the church.

A comprehension question is asked: did John hear the ice-cream man tell Mary that?

On the way to the church, the ice-cream man meets John. He tells John about his change of plan. A second comprehension question is asked: did Mary hear the ice-cream man tell John that? Mary goes round to John's house. His mum tells Mary that John has gone to buy an ice-cream. The following set of questions are asked.

Belief question: Where does Mary think that John has gone to buy an ice-cream?

Justification question: Why does Mary think that?

Reality question: Where did John really go to buy his ice-cream?

Memory question: Where was the ice-cream van in the beginning?

PROCEDURE

Main Study

All children between the ages of 5 and 12 who had been assessed on the K-ABC by a clinical psychologist at the Child Development Centre between 1992 and 1997 were examined and diagnoses assigned according to DSM-IV criteria for Pervasive Developmental Delay, (APA, 1994). Cognitive assessments were obtained from retrospective records for a proportion of the Centre sample, and were collected prospectively for the remaining subjects. All assessments were carried out one-to-one in a quiet room with breaks as necessary according to standardised guidelines. The administration of the K-ABC takes between 45 to 95 minutes.

Subsidiary Study

Measures for the subsidiary study were administered to the children from the two NAS schools and those children who were assessed at the child development clinic between January 1996 and March 1997, and lived within an accessible distance from the study base. The smaller sample size available for the subsidiary study, and the lower than expected MPC scores of the school sample, meant that the criteria of $MPC < 70$ was not applied to this part of the study. Clinic children were assessed either at home or at the clinic. NAS school children were assessed individually in a room at school over two sessions. Liaison with class teacher's aimed to minimise disruption to the children's routines for the purpose of testing. The administration of the cognitive tasks took approximately 45 minutes. Questionnaires were completed by school staff in their own time.

RESULTS

MAIN STUDY

Oneway analysis of variance indicated that the two groups did not differ significantly on chronological age. The mean scaled scores for all the subtests and means of Sequential and Simultaneous Processing Scores and of the Mental Composite Score of the study groups are shown in Table 6.

The two groups are significantly different in their Mental Processing Composite(MPC) means, considered the best measure of general intelligence on the K-ABC ($F(1,36) = 15.89, p < .01$). The majority of results on the subtests that contribute towards the MPC, also show a significant difference, with the Asperger's disorder group scoring higher than the autism group. This is consistent with the overall difference in MPC between the two groups. However, despite the overall higher level of the group performance in Asperger's disorder, three subtests do not differentiate the group of subjects with autism from those with Asperger's disorder. On three of the Simultaneous Processing Scale items - Gestalt Closure, Triangles and Spatial Memory - the two groups are not significantly different. A fourth Simultaneous subtest - Matrix Analogies - and the Simultaneous Processing summary score become insignificantly different when the Bonferroni correction is applied to compensate for multiple analyses. The three subtests on which, contrary to expectation, the two groups may clearly be said not to be performing at significantly different levels, are all hypothesised to be affected by a field dependent style (Kaufman and Kaufman, 1983).

Table 6. K-ABC mean scaled scores, sequential and simultaneous processing scores and mental composite score across diagnostic groups

Kaufman item	Asperger's Disorder n=22		Autism n=16		p
	mean	(SD)	mean	(SD)	
Hand Movement	10.5	(1.5)	8.0	(3.3)	p < .01*
Number Recall	12.0	(2.9)	7.7	(2.8)	p < .01**
Word Order	10.8	(2.4)	7.9	(3.3)	p < .01*
Gestalt Closure	9.0	(2.7)	8.3	(2.1)	
Triangles	10.3	(3.5)	8.5	(2.2)	
Matrix Analogies	11.8	(2.8)	8.9	(3.1)	p < .01
Spatial Memory	8.6	(2.9)	6.9	(3.1)	
Photo Series	9.6	(2.4)	6.7	(1.8)	p < .01**
Sequential Processing	107	(11.1)	86.8	(12)	p < .01**
Simultaneous Processing	98.7	(14.5)	87.1	(12.6)	p < .05
Mental Processing Composite	102	(12.9)	85.4	(12.3)	p < .01**

* significant at .05 level with Bonferroni correction for multiple analyses

**significant at .01 level with Bonferroni correction for multiple analyses

The group with Asperger's disorder had significantly higher scores on MPC, Sequential Processing ($F(1,36) = 28.69, p < .01$) and Simultaneous Processing ($F(1,36) = 6.62, p < .05$) than the autism group. It was not possible to construct subsamples from the two groups which were matched for MPC as there was insufficient overlap in the range of scores across groups. Although the total range of scores is similar in each group with the lowest scores 70 and 79 and the highest scores 123 and 127 for autism and Asperger's disorder respectively, the majority of MPCs in children with autism were in the range from 70 - 90, whereas the majority of the Asperger's disorder sample were in the range from 90 - 110. Therefore, further analysis in terms of absolute differences between the two groups was not undertaken. Instead, statistical analyses were used which attempted to capture qualitative differences between the patterns of performance seen in each group.

Sequential versus simultaneous processing preferences

A chi-square analysis was used to compare the two groups on processing preference. All individuals, whose scores on the two processing summary scores differed, were placed in one of two mutually exclusive categories, depending on whether the direction of their preference was towards sequential or simultaneous processing. Absolute differences between groups were therefore disregarded, and instead the relative strength of each subject's scores on the two processing scales determined classification. One child with autism could not be classified, as they had achieved identical scores on the two scales. The results of the categorisation are presented in Table 7.

Table 7. **Cross-classification of children by sequential/ simultaneous processing preference and DSM-IV diagnosis**

	Asperger's disorder (n=22)	Autism (n=15)
Sequential	18	7
Simultaneous	4	8

Two way Pearson chi-square: $\chi^2 = 5.03, p < .05$

Pearson one-sample chi-square for Asperger's disorder: $\chi^2 = 8.82, p < .01$

Seven children with autism and 18 children with Asperger's disorder were categorised as having a preference in the sequential processing direction. Eight children with autism and four children with Asperger's disorder showed a preference in the simultaneous direction. A 2 x 2 Pearson chi-square indicated that there is a significant difference between the two groups based on the proportion of each group falling in the Sequential or Simultaneous 'direction of preference' categories ($\chi^2 = 5.03, df = 1, p < .05$). Whereas no group preference is discernible for children with autism, the group of children with Asperger's disorder show a significant preference in the direction of Sequential Processing (Pearson one-sample chi-square, $\chi^2 = 8.82, df = 1, p < .01$).

Profile Analysis

In order to consider whether each diagnostic group showed significant ratio of variance across the subtests which contribute to the overall assessment of intelligence, each group was analysed with a within subjects repeated measures anova, based on mean group scores for each subtest. This analysis may be conceptualised as treating the subtests as all measuring intelligence, but differing in the task conditions they use to produce a measure of the ability.

The autism group did not show significant differences across the 8 subtests with this analysis, compared to their random variation across subjects. The Asperger's disorder group did show a significant ratio of variance, ($F(7, 18) = 5.09, p < .001$). Figure 1 presents the mean subtest scores for each group. As may be seen, the profile from the autism group is relatively flat consistent with the finding of non-significant ratio of

variance. The Asperger's disorder group profile shows peaks on Number Recall and Matrix Analogies and troughs on Gestalt Closure and Spatial Memory. Further analysis did not reveal significant differences between specific pairs of subtests for the Asperger's sample, despite the overall significant ratio of variance seen across the 8 subtests taken as a whole. This may be because there was insufficient power due to the relatively small sample size.

Comparison of profiles to other studies of children with autism

Figure 2 presents the profiles for each group in this study (as presented in Figure 1) alongside the profiles obtained from the two other studies of children with autism on the K-ABC that were discussed in the Introduction (Allen *et al.*, 1991; Freeman *et al.*, 1985). The most striking observation arising out of these comparisons is the absence of the characteristic peak on the Triangles subtest in either the Asperger's disorder or autism groups in the present study. The Triangles peak seen in the Allen and the Freeman studies may be considered comparable to the well-replicated finding of peak performance on the Block Design subtest of the Weschler scales. In addition, in comparison to the Allen sample, the autism sample have scores on the Sequential subtest which are higher and although not as elevated as those seen within the Freeman sample or the Asperger's disorder sample, nevertheless result in equivalence between the mean Sequential and Simultaneous summary scores.

Figure 3 presents the three summary scores for the two groups in the present study and the Allen and Freeman samples. Figure 3 highlights the similarity in general intelligence (as indicated by the MPC) between the sample of children with autism in the present study and the Allen sample (85 and 81 respectively), and between the Asperger's group and the Freeman sample (102 and 99 respectively).

Figure 1. Mean group profiles across K-ABC subtests for Asperger's disorder and autism

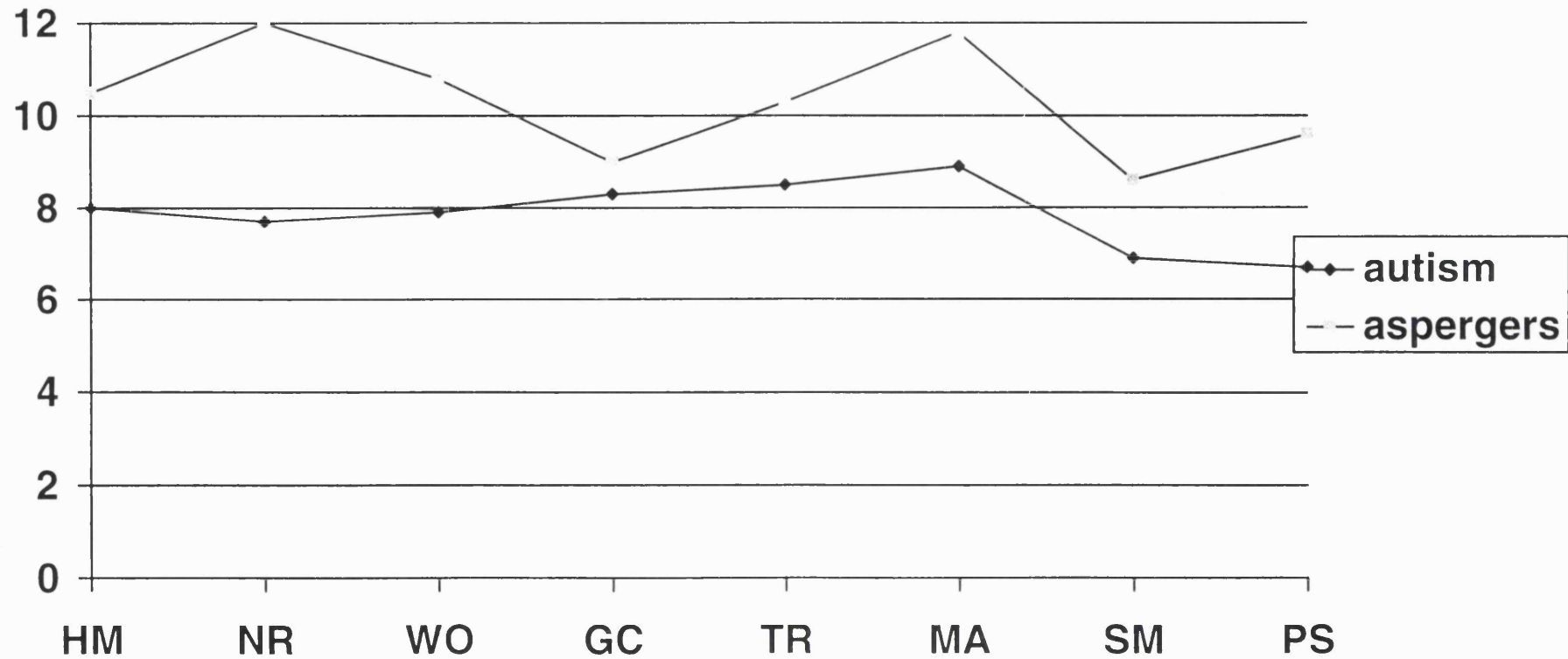


Figure 2. Profiles across K-ABC subtests for Asperger's disorder and three autism samples

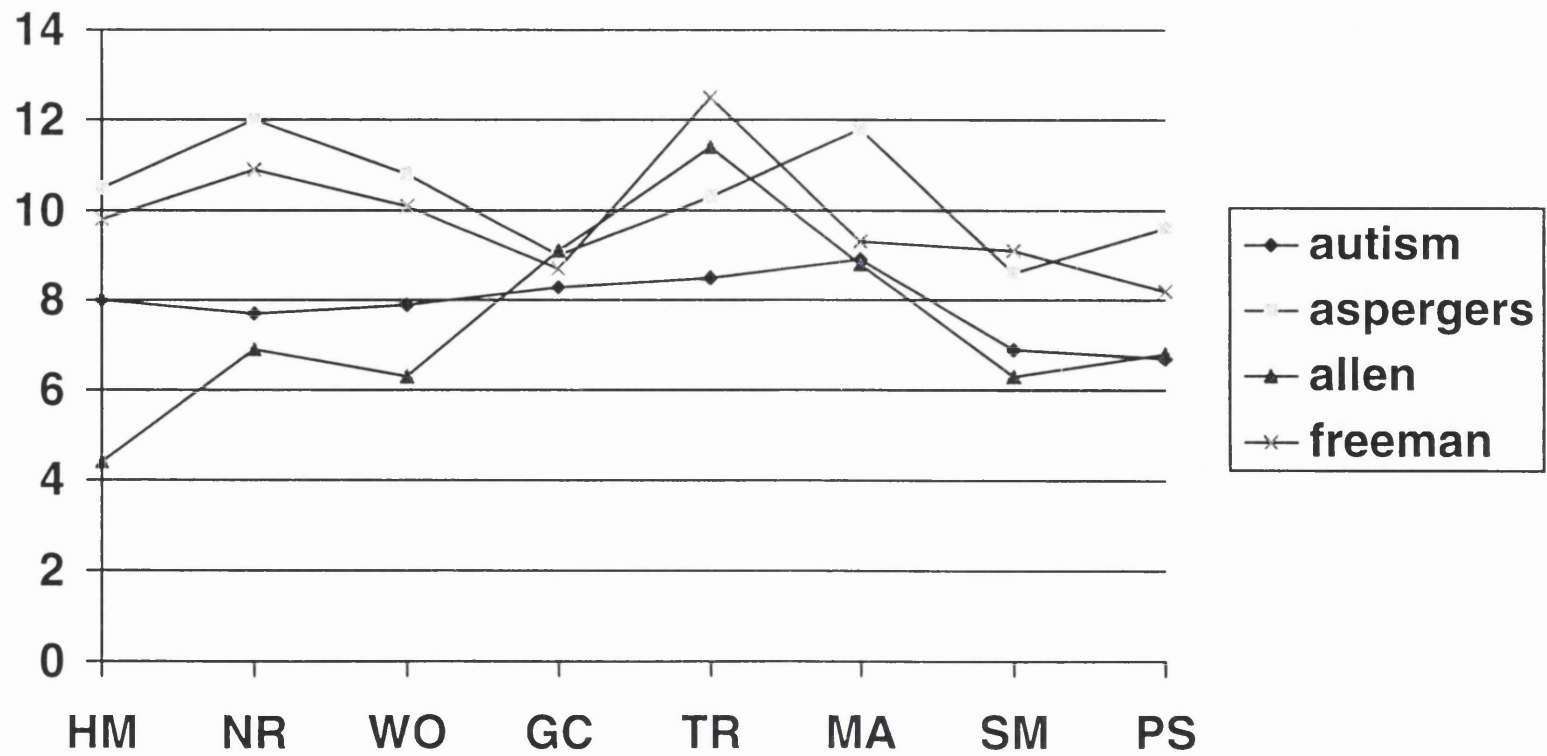
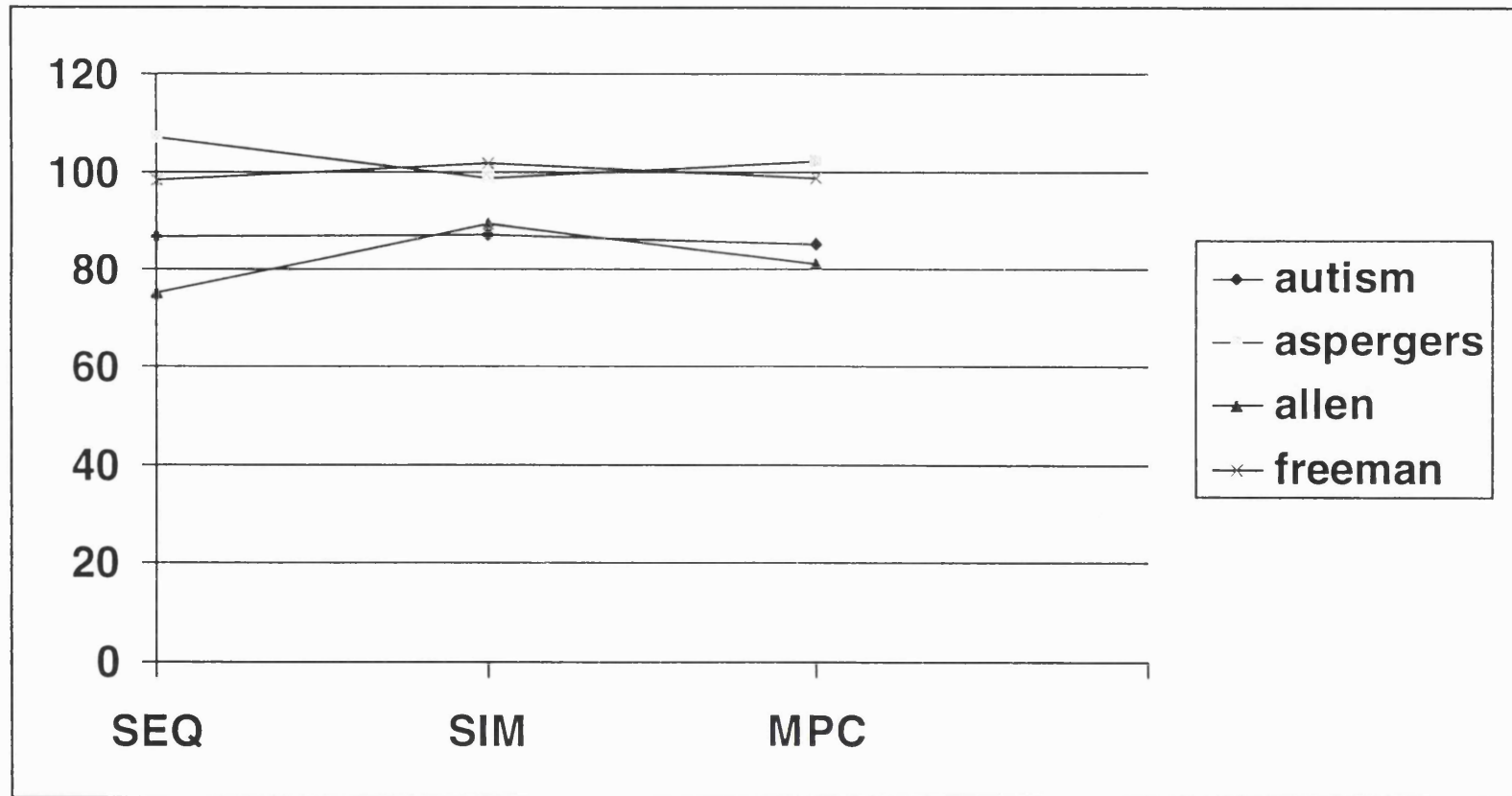


Figure 3. Mean sequential (SEQ), simultaneous (SIM) and mental processing composite (MPC) scores for Asperger's disorder and three autism samples



Ipsative analysis

In order to allow intergroup comparison, while controlling to some extent for absolute differences in IQ level between the two groups, each subject's score on individual subtests was transformed into a score reflecting the difference between their score on that subtest and their overall mean subtest score, referred to as the 'subtest deviation score'. If Asperger's disorder and autism share a similar cognitive profile one would expect few if any differences in terms of strengths and weaknesses in subtest scores relative to the mean. Group means on these transformed scores were compared using oneway anova and are presented in Table 8. The autism and Asperger's disorder groups did not differ in terms of whether their performance on the subtests were strengths or weaknesses relative to their mean scores, except on two subtests. On Number Recall, the Asperger's disorder deviation score was above their mean and significantly different from the autism deviation score which was below their mean ($F(1,36) = 4.85, p < .05$). On Gestalt Closure, the mean-relative score reflected a strength for the autism group and was significantly different from the Asperger's disorder group score which reflected a weakness relative to their mean score ($F(1,36) = 5.58, p < .05$). These two subtests are within the Sequential and Simultaneous processing scales respectively. Whereas the majority of subtests within each scale place some demands on the opposite processing dimension, Number Recall and Gestalt Closure are identified as the only subtests which provide fairly pure measures of the respective processing styles (Kaufman and Kaufman, 1983).

Table 8. Mean group scores on each subtest expressed as deviation from overall mean subtest score.

	Asperger's disorder n=22	Autism n=16	p
Hand Movement	-3.8	-3.5	
Number Recall	+1.6	-0.2	p <.05
Word Order	+0.4	-0.1	
Gestalt Closure	-1.3	+0.4	p <.05
Triangles	-0.1	+0.6	
Matrix Analogies	+1.5	+1.0	
Spatial Memory	-1.7	-0.9	
Photo Series	-0.6	-1.15	

SUBSIDIARY STUDY

Sampling limitations detailed in the Method section, led to the samples in the subsidiary study representing significantly different populations in respect of both IQ and verbal mental age, as shown in Table 9. The samples were comparable in terms of chronological age. They were significantly different in terms of overall intelligence ($F(1, 18) = 24.51, p < .01$) and verbal mental age ($F(1, 18) = 35.75, p < .01$). The differences between the two groups severely limits the interpretations that may be drawn from the data for the experimental tasks which are generally scored in a categorical (pass versus fail) manner.

Table 9. Subsidiary study: mental processing scores and verbal mental age of samples

	Asperger's Disorder n = 9	Autism n = 11	p
MPC (SD)	99 (11.6)	71 (13.7)	<.01
range	86 - 114	56 - 99	
Verbal Mental Age (SD)	9.6 (2.2)	4.9 (1.0)	<.01
range	5.25 - 11.0	4.0 - 7.0	

Theory of mind

All subjects were assessed on two tasks of first order theory of mind. Results were analysed using chi-square. On the Smarties task (see Table 10), 6 children with autism failed and five passed. All the children with Asperger's disorder passed the task. The groups' performances were significantly different on the Smarties task ($\chi^2 = 7.01, p < .01$). The strength of the association is seen in phi value of .59. On the Sally-Ann task (see Table 11), 10 children with autism failed and only one passed. The reverse pattern was seen in the Asperger's disorder group with 8 children passing and only one failing ($\chi^2 = 12.7, p < .01$). The strength of the association is demonstrated by phi value of .79. Performance across the two tasks was summed to produce a strict pass category which required success on both of the contributing tasks (see Table 12). Whereas all but one child with Asperger's disorder passed, all children with autism failed theory of mind according to the strict criterion. Pearson two-way chi-square confirmed the significance of the pattern of theory of mind performance across the two groups ($\chi^2 = 16.5, p < .01$).

A second order theory of mind task was too demanding in terms of basic information processing for the majority of the children with autism. Seven children were unable to answer the comprehension control questions, relating to what the story characters have heard. The remaining four children with autism who were able to answer control questions, went on to fail the test questions. Within the Asperger's disorder group, four children failed and five children passed the task (see Table 13).

TABLES DESCRIBING THEORY OF MIND PERFORMANCE

Table 10. **Smarties task** - first order theory of mind

	Asperger's (n=9)	Autism (n=11)
Pass	9	5
Fail	0	6

Pearson two-way chi-square $\chi^2 = 7.01, p < .01$.

Table 11. **Sally-Ann task** - first order theory of mind

	Asperger's (n=9)	Autism (n=11)
Pass	8	1
Fail	1	10

Pearson two-way chi-square $\chi^2 = 12.7, p < .01$.

Table 12. **Theory of mind success according to strict criteria**

	Asperger's (n=9)	Autism (n=11)
Pass	8	0
Fail	1	11

Pearson two-way chi-square $\chi^2 = 16.5, p < .01$.

Table 13. **Ice-cream van story** - second order theory of mind

	Asperger's (n=9)	Autism (n=4*)
Pass	5	0
Fail	4	4

* Seven children with autism were excluded because they failed to answer control questions correctly.

Relationship of theory of mind performance to verbal mental age

On both the Smarties and Sally-Ann task all subjects who had a verbal mental age of 8 years or above passed the tasks (one subject with VMA = 8, 6 subjects with VMA >11), with the youngest verbal age at which both tasks were passed being 7 years. At all other verbal mental ages (4 - 7 years), some children passed at least one task; at age six or below all subjects failed at least one task. The significant differences in verbal mental ages between the two samples means that verbal mental age and diagnosis are confounded. As expected, chronological age was not systematically related to pass rates on the theory of mind tasks for either group of subjects.

Executive Function

Subject's performance across the two variations of hand-game were summed to produce a dichotomous classification of pass / fail. All the children with Asperger's disorder passed both versions of the hand game. Over half of the children with autism failed at least one hand-game (see Table 14). The version of the task in which the contrast condition is presented before the imitation condition, produced lower pass rates than the original Luria Hand Game devised by Hughes (1996). Children with autism who passed generally needed near the maximum number of trials to do so suggesting they experienced considerable difficulty in providing the correct response rather than imitating the experimenter's action. In contrast, children with Asperger's disorder generally passed within the first eight trials. A 2-by-2 Pearson chi-square indicates that there is a significant difference between the two groups based on the proportion of each group who pass or fail the tasks ($\chi^2 = 7.01, p < .01$).

In relation to verbal ability as measured by the TROG, Hughes' findings would predict a positive relationship between verbal ability and executive function task success. Hughes divided her subjects into three verbal levels and provides percentage task success at each level. Success rates within this study (pooled across diagnostic groups) and rates found in Hughes' study are presented in Table 15. Both studies appear to show a minimal level of executive function task achievement for subjects with a verbal mental age below five and a ceiling being achieved for those above eight.

TABLES DESCRIBING EXECUTIVE FUNCTION PERFORMANCE

Table 14. Executive function performance

	Asperger's n = 9	Autism n = 11
Fail	0	6
Pass	9	5

Two-by-two Pearson chi-square, ($\chi^2 = 7.01, p < .01$).

Table 15. Executive function pass rates at different levels of verbal ability

Verbal Level	Asperger's and autism (present study)	Autism (Hughes 1996)
1. (4 - 5 years)	10 %	20 %
2. (5 - 7.7 years)	50 %	50 %
3. (7.8 and above)	100 %	80 %

Central Coherence

The time taken by a subject to complete each set of four unsegmented and segmented block designs were used to produce a mean score for each group of designs. Independent sample t-tests revealed no significant differences between the groups in mean time taken to produce either unsegmented or segmented designs (Table 16 shows group means on the two types of block design task). Moreover each group mean showed an identical lowering of five seconds between the unsegmented and segmented designs, suggesting that the facilitative effect of segmentation was equivalent across the two groups.

In terms of individual performance, subjects were classified as showing weak central coherence, where the improvement in their scores with segmented block designs was less than 20%. This cut-off was chosen as some facilitatory effect would be expected in the majority of subjects, not least because of possible practice effects for the second presentation of each design in the pre-segmented form. Moreover, examination of individual performances showed a tendency for either no or small amounts of facilitation (e.g. under 25 %) or large amounts of facilitation (e.g. over 50 %). Under this criterion, six out of ten subjects with autism and six out of nine with Asperger's disorder were classified as showing minimal facilitatory effect as might be associated with weak central coherence.

Table 16. Central coherence: mean, standard deviation and range of average time in seconds to complete unsegmented and segmented block design tasks.

	Asperger's disorder (n=9)			Autism (n=10)		
	mean	(SD)	range	mean	(SD)	range
unsegmented designs	14.0	(8.3)	5 -28	16.8	(8.5)	7 - 32
segmented designs	9.0	(2.8)	4 - 13	11.8	(3.4)	8 - 18

Performance across the two block design tasks was compared to performance on the Triangles task from the K-ABC in relation to the subject's mean subtest score. Those subjects whose score on Triangles was above their mean were classified as 'strong' and those who scored at or below their mean were classified as 'weak', reflecting their relative skill on this task. Classifications of performance across the two types of block designs were as above. A chi-square analysis did not reveal a significant association between performance on the two tasks (see Table 17).

Table 17. Comparison of Triangle-mean deviation score against performance on block designs

		TRIANGLES	
		Strength	Weakness
BLOCK DESIGN	Strength	7	4
	Weakness	3	5

The above descriptions of performance of the autism and Asperger's disorder samples on the experimental tasks (theory of mind, executive function and visuo-spatial/ central coherence) must be considered in the light of the significantly different overall IQ level and verbal mental age of the two groups. The findings that the Asperger's disorder group out performs the autism group on theory of mind and executive function tasks, may be a function of their higher IQ and higher verbal mental age. In contrast, the finding of similarity of performance on the block design tasks, despite overall difference in IQ is of note.

Associations between experimental tasks

Performance on the experimental tasks in terms of executive function, and central coherence status was compared using chi-square, see Table 18. Significant associations were found between executive function and central coherence status as derived from hand-game and block design performance, ($\chi^2 = 5.43, p < .05$). Subjects who failed at least one hand-game (40 % of the autism sample), were more likely to show considerable improvement with segmented block designs. Subjects who passed both hand-games (all subjects with Asperger's disorder and the remaining subjects with autism) were more likely to show minimal if any facilitatory effect with segmentation. This effect was strongest for the autism sample, since the three subjects who were classified as executive function passers, and showed normal central coherence were from the Asperger's disorder group. Comparisons were not made directly between theory of mind and the two other tasks, as theory of mind success was so strongly split according to diagnostic status.

Table 18. Performance on executive function and central coherence status

	Executive Function	
	Fail	Pass
Normal central coherence	4	3
Weak central coherence	1	11

Wing social behaviour subgroups

No significant differences were found between the two diagnostic groups on a questionnaire relating to social behaviour when group means on each of four subscales were compared. Actual mean group scores are presented in Table 19. Subjects were also classified by the subscale on which they scored highest. Two children with Asperger's disorder and three children with autism could not be allocated a single classification from the questionnaire results. Of those subjects who were classifiable, all subjects with Asperger's disorder were designated 'active but odd'. Subjects with autism were equally split between the 'active but odd' and 'passive' categories.

In an attempt to control for verbal ability and to explore possible patterns between experimental task performance and performance on subtests of the K-ABC, a partial correlation analysis was carried out using the TROG score as covariate. No correlations of possible theoretical validity were seen.

Table 19. Mean group scores on Wing subgroupings

WSQ scale	Asperger's disorder n = 8	Autism n = 10
Active but Odd (range)	43.9 (35-60)	39.4 (10 - 61)
Aloof	23.6 (5-47)	25.6 (12-44)
Passive	36.0 (27-53)	44.4 (31-62)
Typically Developing	21.0 (2-39)	27.5 (9-52)

DISCUSSION

Asperger's disorder is a term that has gained increasing currency over recent years. Clinicians, parents and researchers have used the term to convey the sense of a group who have both commonalities with and differences from autism. A vital question which will determine the future of such a distinction is whether differences between autism and Asperger's disorder are merely a reflection of quantitative variation or whether the two groups can be validly distinguished in qualitative terms? In asking this question in the context of group performance on tests of general intelligence, the content becomes whether group differences, if apparent, merely reflect the higher intelligence of one group over the other or whether specific strengths and weaknesses differentiate the groups which may stand apart to some extent from consideration of overall intelligence. Studies of people with autism have suggested a characteristic 'spiky profile' with peaks on tasks of visuo-spatial ability and troughs on verbal tasks and those requiring the integration of context-relevant information. Fewer findings assessing samples of individuals with Asperger's disorder are available but preliminary studies point to enhanced verbal and crystallised abilities in contrast to the visuo-spatial and fluid strengths seen in autism.

The main study contrasted the cognitive performance of children with Asperger's disorder to children with autism. The findings will be discussed in terms of relative patterns of strengths and weaknesses. Findings on a subsidiary study will be considered in terms of the information they provide about a subsample from each group, although considerable limitations apply to this part of the data. The limitations of both the main and subsidiary study will be discussed, especially in relation to the main problems of conducting research within autism and other pervasive

developmental disorders. Different solutions to the common problems, such as obtaining matched samples and assigning diagnoses will be introduced and compared. Avenues for future research that arise out of both the findings and limitations of the present study will be highlighted. Finally, implications the clinician in the field may draw from the research will be considered.

MAIN STUDY: PERFORMANCE ON THE K-ABC

Sequential / Simultaneous Processing

A significant difference was seen between Asperger's disorder and autism in processing preference, a non-hierarchical descriptive dichotomy. The Asperger's disorder group showed a strong tendency to do relatively better on tests relying on sequential processing, where information is processed serially, than on simultaneous processing tasks. No systematic tendency to perform preferentially across either of the processing scales was seen in the autism group. The finding in both the Asperger's disorder and the autism group adds to, rather than resolves the inconsistency in findings in this aspect of cognitive abilities in autism. Experimental (Allen *et al.*, 1991) and theoretical work (Tanguay, 1984) have supported the prediction that a sample with autism will show relative simultaneous processing preference. However, Freeman *et al.* (1985) found no preference in autism, and even a slight tendency towards sequential preference in a small number of the sample. The Asperger's group in the present study showed the opposite pattern to that found by Allen *et al.* (1991), and suggested by them to be characteristic of the autism spectrum.

The relationship of verbal ability and processing types may be important in interpreting the range of findings in studies of autism and Asperger's disorder. It is of note that Allen *et al.* (1991) found a similar pattern of simultaneous preference in children with developmental receptive language disorder, although their absolute level of functioning was higher than that seen in the autism sample. Moreover, Lincoln *et al.* (1995) report that increases in verbal ability are associated with increases in sequential processing scores. Thus, the finding of a sequential processing preference in the Asperger's disorder group but not in the autism group may reflect the likely disparity in verbal ability. Absence of language delay is a necessary criterion for diagnosis of Asperger's disorder and no symptoms of deviant communication are required, whereas at least one is required for a diagnosis of autism (APA, 1994). Allen *et al.* (1991) suggested that the failure of the Freeman *et al.* (1985) study to find the predicted simultaneous preference, may have been due to the unusual characteristics of their sample, who had higher verbal IQ than would be expected in an autism sample. Although a direct measure of verbal ability was not taken for our study, the sequential scores of the sample with autism here, are not as high as in the Freeman *et al.* (1991) study, although they are equal to their own simultaneous scores. It is possible that the sample may have been biased in terms of including children with relatively even language skills compared to their overall level of cognitive ability. The sample were taken from a tertiary child development clinic where they had been referred by Consultant Paediatricians or Psychiatrists for differential diagnosis. It may be that differential diagnosis is most problematic and therefore requires specialist opinion in children with features of autism and yet mental age appropriate language skills.

However, it is important to consider that although children with Asperger's disorder are likely to have superior verbal abilities to children with autism, the finding that their sequential abilities are raised relative to their own simultaneous abilities requires explanation. It has been proposed that sequential processing is more associated with the left hemisphere, and if this is so, the present findings would support the proposed association of Asperger's disorder and Nonverbal Learning Difficulties (Klin *et al.*, 1995). Although, motor clumsiness was not required for diagnosis of Asperger's disorder in the present study, in contrast to the Klin *et al.* study, a number of children had concomitant diagnoses of dyspraxia. Although differences in verbal ability may to some extent determine the range of findings in this area, the findings for both autism and Asperger's disorder in the present study and for autism in Freeman's study, suggest that sequential processing deficits are not pervasive within the Pervasive Developmental Disorder's population. This conclusion may be supported by findings from experimental psychology. Baron-Cohen *et al.* (1986) in a study which compared the performance of children with autism and Down's syndrome and normal controls on a picture-sequencing test found the group with autism was only outperformed on stories where an understanding of mental states as opposed to physical causality was required. He therefore ruled out a general sequencing deficit in autism although acknowledging earlier reports of such a finding (Rutter, 1978).

Performance on individual subtests relative to mean subtest score

The results of the ipsative analysis, whereby deviation scores were compared across the two groups provides further evidence of distinct processing preferences. The two groups differed significantly on only two out of a possible eight subtest deviation scores, Number Recall and Gestalt Closure. Moreover, both of these subtests may be seen to stand out from the others as

providing the only relatively pure measures of each type of processing. In comparison to the group with autism, the group with Asperger's disorder showed relatively strong performance on Number Recall (reflecting sequential skills). The opposite pattern was seen on the subtest most strongly associated with simultaneous skills, Gestalt Closure, with autism showing a strength that was significantly different to the deviation from mean performance in Asperger's disorder. The findings from this analysis are consistent with the findings for Asperger's disorder in terms of overall sequential processing preference. However, although here, the findings for the autism group suggest strengths in simultaneous processing, the pattern suggested by performance on Gestalt Closure does not appear consistently across all simultaneous subtests for the autism sample. Although Allen *et al.* (1991) had strongly advocated the simultaneous preference as characteristic of autism, the same research group in a later review of the assessment of intellectual ability in autism, emphasised the intersubtest variability shown by samples with autism within both the simultaneous subscale of the K-ABC and the performance subscale of the WISC-R (Lincoln *et al.*, 1995). Thus discrepancies may be seen between subtests such as Gestalt Closure and Triangles on the one hand and Spatial Memory and Photo Series on the other.

Profile analysis: extent of intersubtest variability within each group

Significant variation across all eight subtests that contribute to the overall estimate of intelligence was only found in the Asperger's sample. Although further pairwise comparisons between subtests did not reveal significant differences, a visual examination of the profile shows peaks on Number Recall and Matrix Analogies and troughs on Gestalt Closure and Spatial Memory.

Field dependence/ independence and central coherence

In terms of absolute performance, despite large overall IQ differences between the two groups (mean MPC of 85 for autism versus 102 for Asperger's disorder) they did not differ significantly on three subtests that may be grouped together in terms of being adversely affected by a *field dependent cognitive style* - Gestalt Closure, Triangles and Spatial Memory (Kaufman and Kaufman, 1983). Although some non-significant differences might be expected by chance, even given significant overall differences between two groups, the fact that these subtests form a theoretically coherent and distinct group at the level of cognitive style supports the validity of the finding. As discussed in the Introduction there are many parallels between the cognitive style dimension labelled field dependent / field independent and the characteristic of cognitive processing identified as central coherence / weak central coherence. Indeed, for the purposes of the present study they may be considered synonymous. A number of studies have suggested that autism is characterised by weak central coherence (Shah and Frith, 1983, 1993; see Frith and Happe, 1994 for review). Kaufman and Kaufman (1983) discuss the impact of a field dependent style (arguably equivalent to normal central coherence) on the three subtests as likely to impair performance to some extent. Thus, in subjects with a field independent style (as hypothesised to be the case in autism) one would not expect to see significant impairment on these tasks.

A perplexing issue in the study of intelligence in general and the pattern of abilities and deficits in autism in particular is what to take as the baseline for 'intelligence' against which various deviations are seen as assets, deficits or spared functions. Thus Shah and Frith (1983) highlight the dilemma that performance in a given area may be spoken of as an 'islet of ability' or an area in which development is less retarded relative to verbal IQ, or merely unimpaired in line with

performance IQ. The problem of interpretation becomes arguably more complex and potentially confusing when abilities are compared across two samples with different overall IQ. Indeed, Happe (1994b) warns that assumptions about the equality of subtests and comparability of IQ estimates, must be questioned when measuring IQ in subjects with autism.

With these caveats born in mind, it may nevertheless be possible to speculate as to why the Asperger's disorder and autism samples should meet in their performance on these three subtests.

To a large extent the interpretation of the finding depends on whether it is considered to result from a strength in autism meeting a weakness in Asperger's disorder or, more parsimoniously, from either a strength or a weakness in one population. The Matrix Analogies subtest may be the best candidate available for providing an estimate of overall intelligence (the MPC although clearly the best overall indicator of intelligence is influenced by the subtests of interest). Matrix Analogies is a task similar to Raven's (1956, 1960) *Progressive Matrices* test, and it has often been suggested that the ability to solve analogies is an extremely good indicator of general intelligence (Sternberg, 1979, cited in Kaufman and Kaufman, 1983). Whereas the subjects with autism is very close to their performance on Gestalt Closure and Triangles (although Spatial Memory is relatively depressed), for the subjects with Asperger's disorder performance on all three of these subtests is clearly below their Matrix Analogies mean. This would suggest therefore, that the similarity of performance across these three subtests is a result of a weakness in the Asperger's disorder group. According to Kaufman and Kaufman (1983), impairment across performance on these three subtests may reflect a field dependent cognitive style. Thus the Asperger's group may not be characterised by the same level of weak central coherence as has been strongly suggested for autism in general. Support for this difference between Asperger's

disorder and autism may also be drawn from the findings of Ehlers *et al.* (1997). As discussed, in the Introduction, the performance of the Asperger's disorder group seemed to fall in the opposite pattern to that of the autism group if one considers the subtests in relation to the factor analysis performed by Lincoln *et al.* (1995). The ability to integrate contextual information, may be seen as relying on normal central coherence.

Characteristic peak on the Triangles task

Despite the above findings of similarity between the performance of subjects with Asperger's disorder and autism on three subtests including Triangles, the characteristic peak on Triangles was not seen for either of the groups in our sample. This was a particularly unexpected result in relation to the sample with autism. However, although Triangles did not represent a peak for the group with autism, it was the second highest mean score, separated from the top score on Matrix Analogies by less than half an IQ point. The lack of a peak on Triangles must be read in the context of a generally flat profile for autism seen in this sample. However, even given relatively good sequential ability 'flattening' the profile (as discussed above in relation to the possible bias in the sample as having been problematic to diagnose), a loss of the peak on Triangles does not necessarily follow. Indeed, the sample in the Freeman *et al.* (1985) study who had much higher sequential scores, still showed the peak on Triangles. One possible explanation relates to the known heterogeneity of autism. The notion of a characteristic peak on visuo-spatial tasks is derived from mean group performances. Many studies do not report the number of individuals who show this pattern. This is a significant omission, given that whilst providing information as to assets or deficits that may be *specific* to autism, it fails to address the extent to which they are *pervasive* within the population of people with autism. Ehlers *et al.* (1997) who

did find that performance on the WISC-R could discriminate between autism and Asperger's disorder, nevertheless report that only a minority, albeit a large one, showed the highly characteristic profile. Happe (1994b) found the characteristic peak on Block Design for both theory of mind passers and failers, but points out that it is possible that some subjects will show impaired Block Design performance, and suggests that this may be due to superimposed spatial processing deficits, masking the advantage that a weak central coherence would normally confer. This is a possible explanation for the present findings.

SUBSIDIARY STUDY: Performance on experimental tasks and WSQ

The findings from the subsidiary study must be interpreted with extreme caution. Differences between IQ and verbal ability were more extreme than those seen in the main study. As the majority of the experimental tasks are scored dichotomously, suggesting a pass or fail on the relevant cognitive ability, the more qualitative and relativist approach to analysis used for the K-ABC results was not possible. Theory of mind and executive function performance will be discussed first, as findings on these tasks is in line with that expected given the IQ differences between the two groups. In contrast the findings on central coherence/ field dependence do not appear to be influenced by the absolute IQ and verbal difficulties. Finally the social characteristics of the two groups will be discussed.

Theory of mind

As found in earlier studies, the Asperger's disorder sample showed high pass rates on first order theory of mind (Bowler, 1992) and were significantly different from the autism sample (Ozonoff and Pennington, 1991). There has been considerable debate in the literature as to what this finding means for both the 'theory of mind' hypothesis of autism and for the relationship of autism and Asperger's disorder (Ozonoff and Pennington 1991; see Happe 1994a for review). Although the second order theory of mind task was too demanding for the majority of those with autism, the finding that only 50 % of the Asperger's disorder sample passed supports interpretations that individuals with Asperger's disorder do have 'theory of mind' deficits but at a higher level or showing less delay than individuals with core autism. Moreover, the failure of the majority of subjects with autism to pass the comprehension control question may itself be understood as arising from a theory of mind deficit. Thus subjects were asked whether a story character who was absent when a particular conversation took place, had heard what was said. Subjects failed by answering yes to this question, which may be suggestive of the identified deficit in autism of appreciating the relationship between perception and knowledge (Perter *et al.*, 1989).

Given the finding of a strong positive relationship between first order 'theory of mind' task performance and verbal mental age, it is likely that verbal ability and theory of mind success at first order level go hand in hand in individuals with Asperger's disorder. Both autism and Asperger's disorder are developmental disorders and diagnostic manuals now highlight the commonality that may underlie different behaviours according to the influence of age and intellectual level. In parallel, theoretical explanations for autism may be moving away from

deficit hypotheses towards delay (e.g. theory of mind), and the findings within Asperger's disorder replicated here support this frame. However, the delay in itself may be damaging in a permanent sense if critical periods of development (e.g. for language or social development) are missed. To what extent verbal mental age is necessary for achieving theory of mind, or alternatively, theory of mind is necessary for achieving a certain mental age awaits the testing of a causal model. This question may go to the heart of possible distinctions between Asperger's disorder and autism.

Executive function

Significant differences were seen between the performance of the two groups with all subjects with Asperger's disorder passing, compared to approximately half of the subjects with autism. This is contrary to the finding by Ozonoff and Pennington (1991) which found that across a range of tasks the only deficit that was present in both Asperger's disorder and high-functioning autism relative to controls, was in the executive function domain. There may be a number of reasons for this discrepancy, in particular relating to verbal ability and IQ. A relationship to verbal mental age similar to that seen within Hughes' (1996) autism sample was found across our two groups. In terms of differences across the diagnostic groups these were not independent of verbal ability. Given that similar effects of verbal mental age were not seen in a moderate learning difficulty population assessed on the Hughes' task (who were already performing near ceiling at the youngest verbal mental age), it is not clear from our results whether Asperger's individuals with lower verbal mental ages would show a pattern of performance in line with the autism group or not. However, it is likely that some progression with verbal mental age is the norm across different samples.

Problems of measurement in executive function tasks are relevant to the findings in the present study. Pennington and Ozonoff (1996) highlight the methodological problem of both floor and ceiling effects. In the present study, the Asperger's disorder sample appears to be performing at ceiling. However, it may have been very difficult to find a task that could capture any deficits within the executive functioning of individuals with Asperger's disorder, while at the same time being straightforward enough to assess the individuals with autism, without producing floor effects. Even the verbal instructions which accompany the hand game, were too complex for some of the individuals with autism assessed for the study, who seemed to be understanding the task from the examiner's miming. This problem in finding a task suitable for comparing the two populations may be considered similar to the difficulties in assessing theory of mind outlined above. A similar solution may be necessary, whereby different tests are available for different ability levels, with the relationships between the different abilities carefully stipulated according to sound and verifiable theoretical criteria (as with first order and second order tasks in theory of mind). This is not yet possible within the domain of executive functioning where reliability has been shown to differ across different ability samples with some tasks appearing not to be sensitive to the same underlying process across the range of performance (Pennington & Ozonoff, 1996).

Hughes (1996) provides an interesting hypothesis as to the role of verbal ability in executive function tasks. She suggests that subjects with autism and low levels of verbal ability may fail to use language for the pragmatic purpose of self-regulation and that via failure in this mechanism, poor verbal ability leads to planning deficits. One of Hughes' aims in designing a simpler task of executive function was that it should be more comparable in demands to standard

theory of mind tasks. Many authors have presented the theory of mind and executive function hypotheses of autism as competing explanations (Bishop, 1993; Ozonoff and Pennington 1991; Happe 1994a). In the present study all those who passed both theory of mind tasks went on to pass the executive function measures. Of those who failed theory of mind, half passed and half failed the executive function task. These findings are not independent of diagnosis since theory of mind success and failure characterised Asperger's disorder and autism respectively. However, within the autism sample, it is suggestive of some executive function ability being present even in the absence of theory of mind and may argue against the explanation of theory of mind as being caused by executive function deficits. However, executive function is a composite ability and findings on one task cannot be considered conclusive.

Weak central coherence and field independence

The Block Design task within the experimental battery (designed after Shah & Frith, 1993) was included as a measure of field independence that might offer comparisons to the three subtests on the K-ABC that may be expected to be impaired in individuals with a field dependent cognitive style. The finding that the two groups did not differ significantly on their performance on this task, despite overall differences in IQ may support the findings on the K-ABC subtests as a true rather than chance finding. Given hypothesised weak central coherence within autism, the mean difference between their scores on the unsegmented and segmented versions of the task would be expected to be smaller than that of an IQ matched control sample. Higher IQ should have a general effect of decreasing difference times not least because cognitive flexibility should prompt individuals to adapt their predominant style to the task demands. Thus the Asperger's disorder group might have been expected to outperform the autism group both in actual time

taken and in difference between the two conditions, and indeed significant differences were seen on the other experimental tasks. The inclusion of a normal control sample would have been particularly useful on this task. The K-ABC standardisation and the clear findings from developmental psychology on theory of mind development within the normal population (Perter *et al.*, 1987) allow more direct comparison of Asperger's disorder and autism group performances. However, on the Block Design task originally used with a sample of adults with autism, some improvement with segmentation is seen in all subjects' performance, however it is relative to controls that the performance of subjects with autism is clearly superior on the unsegmented presentation. Taken together, the performance on the three K-ABC subtests and the experimental Block Design task, may point to a possible divergence between children with core autism and those with Asperger's disorder that is not explicable merely in terms of IQ or other diagnostic criteria such as language ability.

Within the autism and Asperger's disorder samples in the present study approximately half appeared to be processing with weak and half with normal central coherence. This finding may be compared to a study which looked at central coherence using a test of counting speed where items were arranged randomly or in familiar canonical form which was predicted to enhance speed in subjects with normal central coherence (Jarrod & Russel, 1997). Slightly under half of the sample with autism appeared to show what the authors defined as 'global counting' (i.e. they benefited significantly when the numbers were grouped in a recognisable form). However, this level of central coherence within the sample was still significantly lower than that seen within either a group with moderate learning difficulties or normal children, where 15 out of 22 and 21 out of 22 respectively were defined as 'global counters'. Clearly, it would be necessary

to replicate such findings in other populations for the block design task used in the present study, however this comparison suggests that the rates seen in our study may be typical of the autism population and likely to be different from both normal and other learning disabled populations.

Social Behaviour

In quantitative terms, the two groups did not differ on the measures of social behaviour, being equivalent on all four dimensions: passive, active but odd, aloof and typical development. This may suggest that the groups are equally 'autistic' in the quality of their social interactions. However, the small sample size means that the results should be considered cautiously. Larger numbers would increase power and the likelihood that any actual differences would be detected. The WSQ may be used to categorise individuals in terms of the most frequent type of social behaviour they show. Within this sample it was not possible to assign a single category to a quarter of those assessed. This finding supports the idea that individuals with autism show a range of different social behaviours. For those it was possible to categorise, all the Asperger's disorder group were predominantly 'active but odd', whereas the autism group was split between the 'active but odd' and 'passive' categories. The absence of clear aloof cases within either group may be a function of the IQ level of the sample. Studies that have looked specifically at the Wing subtypes as a means of identifying subgroups within the autistic continuum, have found that the 'active but odd' and 'aloof' styles were seen in association with high and low intelligence respectively (Volkmar, Cohen, Bregman, Hooks and Stevenson, 1989). In addition with increasing age and exposure to school settings, developing tolerance of social interaction may occur as a result of teachers' interventions.

The tendency for children with Asperger's disorder to have an 'active but odd' style, when it is possible to classify them into a single subgroup, is interesting in the information it conveys about their relationship to the world. One of the necessary criteria for Asperger's disorder in DSM-IV (APA, 1994) is that there should be normal curiosity about the environment in early development. It is possible to speculate that both this criterion, and the tendency to show an 'active but odd' style may be connected to the preserved crystallised intelligence that a recent study has drawn attention to in autism (Ehlers *et al.*, 1997). Crystallised intelligence reflects the ability to gain knowledge through social contexts and to be able to apply it appropriately. It is contrasted with fluid intelligence which is considered to be relatively uninfluenced by tutoring, and hypothesised to be measured by tasks such as Block Design from the Weschler scales and Triangles on the K-ABC (Sattler, 1974).

LIMITATIONS OF THE PRESENT STUDY

Significant differences in overall intelligence precluded to some extent direct comparison of the two groups. Although a strict criterion of MPC > 70 was applied to enhance the likelihood of studying matched groups, the two groups largely spanned the 70 - 90 and 90 -110+ range respectively, with insufficient overlap to allow comparison of a subset with equivalent intelligence quotients.

The literature comparing high-functioning children with autism, and children with Asperger's disorder is relatively sparse. Issues of how to match the samples have not been decisively answered and a number of different options have been used. Different matching procedures are likely to have differential effects on results and determine how findings may be interpreted. For

example, Szatmari, Tuff, Finlayson and Bartolucci (1990) compared the cognitive profiles of children with Asperger's disorder and children with high-functioning autism, matched on Verbal, Performance and Full-Scale IQ, across a comprehensive battery. Having found few differences between the two groups, they concluded that the two groups could be combined into a single category. However, although matched for IQ, the study has been criticised for the significantly different ages of the two groups; the subjects with high-functioning autism were significantly older than the Asperger's disorder group. It has been argued that this discrepancy between the two groups, despite the overall similarities in IQ, may be responsible for the failure to find significant differences (Ozonoff & Pennington, 1991).

Matching across a high-functioning autism and an Asperger's disorder sample is not a simple matter, even when some comparability of overall IQ is seen. Given the general finding of significant performance- verbal discrepancies in high-functioning autism, if subjects are matched for full-scale IQ, significant differences are nevertheless often seen between subscale summary scores. Thus Ozonoff & Pennington (1990) studied 13 children with high-functioning autism and 10 with Asperger's disorder who were matched for full scale IQ, but significantly different in Verbal IQ. A similar pattern is seen in Klin *et al.*'s study (1995) where comparability of Full Scale IQ is seen along with significant differences between both Performance IQ and Verbal IQ. A recent study with larger numbers (40 in each group), found significant differences between a sample with autism and an Asperger's disorder sample on Full Scale, Performance and Verbal IQ (Ehlers *et al.*, 1997). The researchers were able to construct a smaller subgroup that were matched for full scale IQ, by discarding approximately half the subjects. Once this operation had been performed the effect discussed above emerged with Asperger's disorder exceeding autism

on Verbal IQ at the .05 level. Despite performing part of the analysis on the matched subgroup, Ehlers *et al.* (1997) conclude that their results show that Asperger's disorder and autism differ on IQ level and verbal ability. They argue that the higher IQ of the Asperger's disorder group does not invalidate their findings, since it is largely a function of characteristic good verbal ability and similar patterns of strengths and weaknesses across the two groups were seen in both the full and sub-samples.

Thus in the present study, despite the overall differences, the groups may be compared in terms of the group profiles, that is, the dispersal of mean subtest scores across the different subtests and subscales. Moreover, if quantitative differences in IQ are the main differentiator, then it may not be clinically meaningful to artificially select matched samples. Generalisation of findings to the rest of the population may be severely hindered. An important standard in selecting subgroups is the extent to which the internal validity of the study may be increased at the expense of the external validity. The majority of studies of cognitive ability in autism, have focused on a high-functioning sample, whether or not a comparison with Asperger's disorder is required (Charman, 1994). The extent to which findings in samples with high functioning autism may be generalisable to the majority of the population who have IQ s below 70, has rarely been discussed within the cognitive psychology literature. The selective ignoring of the majority population has been criticised by authors who wish to see theories attempting to explain all aspects of autism (Bailey *et al.*, 1996). Even though learning difficulties are not specific to autism they are clearly highly associated and require explanation.

An alternative solution has been to match in a pairwise fashion to controls from other learning disabled populations (Ozonoff *et al.* 1991). This is an interesting technique, which may provide leverage in terms of specifying the external relationships of autism spectrum disorders to the wider population in addition to the more internal analysis that is gained from comparing subpopulations within the spectrum. However, the relative youth of the discipline of developmental psychopathology, and the infancy of research into the majority of disorders which might be taken as controls (e.g. attention disorders, dyspraxia, specific language disorders) may prove to complicate rather than facilitate interpretation.

The present study did not provide a match for IQ across the groups, but did apply DSM-IV criteria accurately by close readings of the case notes, and this may be seen as an important strength. Diverse approaches to diagnostic assignment have hindered comparison across studies in the field of autism. Even where studies purport to use standardised criteria, some adjustment specific to the study is regularly seen. For example, researchers have not adopted the hierarchical relationship between Asperger's disorder and autism that is assigned by DSM-IV (APA, 1994). Additional criteria are frequently seen (e.g. motor clumsiness to the diagnostic criteria for Asperger's disorder) which are not necessary criteria in DSM-IV and ICD-10 (1992). Moreover, changes in diagnostic criteria from DSM-III-R to DSM-IV are difficult to operationalise in terms of the different sample characteristics they are likely to generate. Happe (1994a) is particularly critical of what she sees as the arbitrariness of many attempts to separate the two disorders, and questions whether some descriptions of Asperger's disorder would not cover individuals with high-functioning autism and vice versa. For the diagnoses in the present study, clinical biases may effect what is included in the case notes, and for some individuals who

were classified as Asperger's disorder for the study, it is possible they displayed enough symptoms to be eligible for a diagnosis of autism. For example, in relation to the criteria for language and communication ability, where an individual has good language ability and minimal delay in early language, the range of pragmatic difficulties in communication may be given less weight. One possibility is that at the high end of the IQ range, the notion of assessing deviance against expected development for mental age, may be less strictly applied, with a ceiling effect operating in terms of language and communication abilities in similar ways to the ceiling effects shown on experimental tasks measuring 'theory of mind' and 'executive function'. That is, clinicians may be relatively insensitive to high level impairments or unsure where the cut-off between clinical and subclinical difficulties should be drawn.

The relatively small sample size in the study necessarily limits the power of statistical analyses. In the subsidiary study, for example, some chi-squares were performed with a proportion of cells having expected frequencies below five. Howell (1992) suggests that with low expected frequencies power deficiencies are more likely than Type 1 errors (false positive results) so that if anything the differences detected will be an underestimate. The sample sizes in the main study (and even in the much smaller subsidiary study) are in line with sample sizes in other studies in autism. The low prevalence of the disorder across the entire spectrum is one important downward influence on the availability of subjects. The importance of understanding the disorder means that some work with less than optimal power may nevertheless make an important contribution. The population is further reduced for studies that wish to investigate those individuals with autism whose IQ lies within the normal range (approximately a quarter of the autism population).

AREAS FOR FUTURE RESEARCH

The differences and similarities suggested in this comparison of cognitive profiles in Asperger's disorder and autism, might usefully be developed by examining additionally a sample who show the behavioural phenotype of autism, but in a subclinical form. Such a group might be particularly useful in light of the potentially intractable differences in absolute IQ level between the two clinical groups, and could therefore provide a particularly useful comparison group for subjects with Asperger's disorder.

However, although standardised intelligence tests clearly have been developed to allow comparisons across the vast majority of the skill range, the same is not yet true of many of the experimental tasks which attempt to assess the various cognitive deficit theories of autism. Even within the present sample, the need is highlighted for tests to be developed that eliminate the floor and ceiling effects currently hindering executive function, theory of mind and central coherence assessments. At the very least, test development should aim to broaden the window in terms of the range of abilities tests can be used to detect. Efforts could usefully be focused at both ends. More sensitive measures would allow detection of the hypothesised deficits in the laboratory, that might be responsible for observed deficits in real-life situations. Less demanding measures would allow understanding to be expanded to the majority of the autism population whose intelligence lies outside the normal range.

The weak central coherence hypothesis has been put forward as a candidate for broadening the coverage of cognitive theories of autism to include explanation of non-triad features. Given the possible suggestion in this study, that Asperger's disorder and autism may be divergent in the

relationship they show between overall intelligence and central coherence, it would be useful for future research to map more explicitly the relationships between aspects of cognitive profiles relating to central coherence and non-triad features, so bringing together cognitive and behavioural levels of analysis.

Finally, the stringent diagnostic criteria used in this study should allow for comparability with future research based on DSM-IV (1994) categories. However, equally, some of the circular findings evident in the present study and other studies (especially in relation to the role of IQ and verbal ability), and the weakness still apparent in the theoretical basis for the differential diagnoses, mean that an alternative useful approach may be found in more explorative studies to identify subgroups within the autistic spectrum.

The role of verbal abilities in the relationship between Asperger's disorder, autism and the broader phenotype seems a particularly vital area for future research to address. Evidently there are significant differences throughout the population in quantitative terms where an individual's output may range from mutism to loquaciousness. However, aspects of language are still impaired even in very verbal people with Asperger's disorder and yet the exclusion of this category from current diagnostic criteria may mean that research loses sight of subtle yet significant impairments. The interaction of verbal ability and development of social, fluid and crystallised intelligence within the autistic spectrum requires considerable clarification.

SUMMARY AND CLINICAL IMPLICATIONS

The majority of findings in the present study did not suggest any significant differences between children with autism and those with Asperger's disorder, diagnosed by DSM-IV (1994) criteria, that would not be predicted from consideration of the diagnostic criteria alone. Absolute differences where found may be attributed to higher IQ and verbal ability in the Asperger's sample (sequential processing preference, theory of mind success, tendency to show 'active but odd' social style). The two groups studied, showed minimal if any overlap in IQ range, which might be taken to support the idea that Asperger's disorder is no more than a label for children with autism at the highest end of the ability continuum. However, this finding may be a sampling artefact, as overlap has been seen in other studies, and is not precluded by DSM-IV criteria. Indeed the cut-off of $MPC > 70$ was applied to both groups in the study.

Despite the findings of significantly higher intelligence in the Asperger's disorder group, the possibility of a qualitative distinction between the groups is raised in relation to the cognitive style dimension of field dependence / independence, with the former more characteristic of Asperger's disorder and the latter of autism. Additionally, relative preference for sequential processing within Asperger's disorder and simultaneous processing in autism may go beyond that expected from differences in verbal ability. If these findings prove robust, then it may be that the validity of Asperger's disorder is supported. For clinicians in the field, it is important to remain clear about the status of diagnoses they apply and what their reasons for giving particular diagnoses are. Even if research finally concludes that there is no valid qualitative reason for distinguishing Asperger's disorder from autism, clinician's may still find the term useful. However, they should not reify, either a putative or a purely pragmatic diagnosis.

Some well-replicated findings in terms of cognitive profiles in autism were not unequivocally found in the present study. In particular the peak on Block Design or Triangles was not clear either for the group as a whole or as a predominant characteristic of individual profiles. Clinicians should therefore beware of generalising research findings which report averaged group results, to assessments of individuals with autism. Although the presence of a peak on Block Design and similar tasks may be a ‘marker for autism’ that would be useful clinically (Shah and Frith, 1993), its absence should not discount a diagnosis. A similar point needs to be made in relation to the lack of sensitivity seen in some of the experimental tasks, whereby presence of a deficit may provide more useful information than absence.

The present study in many ways raises more questions than it answers. However, one aspect that it highlights is the fertility of links between different domains within psychology. Findings from clinicians, experimental psychologists, neuropsychology and developmental psychopathology have all contributed to understanding in this area and it is important that they should continue to do so.

REFERENCES

Allen, M., Lincoln, A. & Kaufman A. S. (1991) Sequential and simultaneous processing capabilities of high-functioning autistic children and language-impaired children. *Journal of Autism and Developmental Disorders*, **21**, 483-502.

American Psychiatric Association (1980) *Diagnostic and Statistical Manual of Mental Disorders*, 3rd edn. Washington DC: American Psychiatric Association.

American Psychiatric Association (1987) *Diagnostic and Statistical Manual of Mental Disorders*, 3rd revised edn. Washington DC: American Psychiatric Association.

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

Asperger, H. (1944) Die "autistischen Psychopathen" in Kinderslater. *Archiv fur Psychiatrie und Nervenkrakheiten*, **117**, 76-136.

Attwood, A.H., Frith, U., & Hermelin, B. (1988) The understanding and use of interpersonal gestures by autistic and Down's syndrome children. *Journal of Autism and Developmental Disorders*, **18**, 241-257

Bailey, A., Phillips, W. & Rutter, M. (1996) Autism: towards an intergration of clinical, genetic, neuropsychological and neurobiological perspectives. *Journal of Child Psychology and Psychiatry*, **37**, 1, 89-126.

Baron-Cohen, S. (1989) The autistic child's theory of mind: a case of specific developmental delay. *Journal of Child Psychology and Psychiatry*, **30**, 285-297.

Baron-Cohen, S. (1994) How to build a baby that can read minds: cognitive mechanisms in mindreading. *Current Psychology of Cognition (Cahiers de Psychologie Cognitive)*, **13**, 513-552.

Baron-Cohen, S., Leslie, A.M. & Frith, U. (1985) Does the autistic child have a theory of mind? *Cognition*, **21**, 37-46.

Baron-Cohen, S., Leslie, A.M. & Frith, U. (1986) Mechanical, behavioural and intentional understanding of picture stories in autistic children. *British Journal of Developmental Psychology*, **4**, 113-125.

Baron-Cohen, S., Allen, J. & Gillberg, C. (1992) Can autism be detected at eighteen months? The needle, the haystack and the CHAT. *British Journal of Psychiatry*, **161**, 839-843.

Bartlett, F.C. (1932) *Remembering: a study in experimental and social psychology*. Cambridge: Cambridge University Press.

Bishop, D.V.M. (1982) Test for Reception of Grammar. Age and Cognitive Performance Research Centre: University of Manchester.

Bishop, D.V.M. (1993) Annotation: autism, executive function and theory of mind: a neuropsychological perspective. *Journal of Child Psychology and Psychiatry*, **34**, 279-293.

Bolton, P., Macdonald, H., Pickles, A., Rios, P., Goode, S., Crowson, M., Bailey, A. & Rutter, M. (1994) A case-control family history study of autism. *Journal of Child Psychology and Psychiatry*, **35**, 877-900.

Bowler, D.M. (1992) The theory of mind hypothesis of autism: explanation, evidence and assessment. *British Journal of Psychiatry*, **152**, 377-382.

Bryson, S.E., Clark, B.S. & Smith, T.M. (1988) First report of a Canadian epidemiological study of autistic syndromes. *Journal of Child Psychology and Psychiatry*, **29**, 433-445.

Castelloe, P. and 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.

Cattell, R.B. (1971) *Abilities: the structure, growth and action*. New York: Houghton Mifflin.

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

Dawson, G. (1983) Lateralised brain dysfunction in autism: evidence from the Halstead-Reitan Neuropsychological Battery. *Journal of Autism and Developmental Disorders*, **13**, 269-286.

Dennet, D.C. (1978) Beliefs about beliefs. *Behavioural and Brain Sciences*, **4**, 568-570.

Ehlers, S., Nyden, A., Gillberg, C., Sandberg, A.D., Dahlgren, S., Hjelmquist, E. & Oden A. (1997) Asperger syndrome, autism and attention disorders: a comparative study of the cognitive profiles of 120 children. *Journal of Child Psychology and Psychiatry*, **38**, 207-217.

Fein, D., Waterhouse, L., Lucci, D. & Snyder, D. (1985) Cognitive subtypes in developmentally disabled children: a pilot study. *Journal of Autism and Developmental Disorders*, **15**, 77-95.

Freeman, B.J., Lucas, J.C., Forness, S.R. & Ritvo, E.R. (1985) Cognitive processing of high-functioning autistic children: comparing the K-ABC and the WISC-R. *Journal of Psychoeducational Assessment*, **4**, 357-362.

Frith, U. (1991) *Autism and Asperger syndrome*. Cambridge: Cambridge University Press.

Frith, U. & Happe, F. (1994) Autism: beyond "theory of mind". *Cognition*, **30**, 115-132.

Ghaziuddin, M., Tsai, L.Y. & Ghaziuddin N. (1992) Brief report: a comparison of the diagnostic criteria for Asperger syndrome. *Journal of Autism and Developmental Disorders*, **22**, 643-649.

Gillberg, C. (1990) Autism and pervasive developmental disorders. *Journal of Child Psychology and Psychiatry*, **31**, 99-119.

Gillberg, C. and Gillberg, I.C. (1989) Asperger syndrome: some epidemiological considerations: a research note. *Journal of Child Psychology and Psychiatry*, **30**, 631-638.

Globerson, T. (1989) What is the relationship between cognitive style and cognitive development? In Globerson, T. & Zelniker, T. (Eds.) *Cognitive Style and Cognitive Development* (pp. 71-85). New Jersey: Ablex Publishing.

Goodman, R. (1989) Infantile autism: a syndrome of multiple primary deficits? *Journal of Autism and Developmental Disorders*, **19**, 409-424.

Happe, F.G.E. (1994a) *Autism: an introduction to psychological theory*. London: UCL Press.

Happe, F.G.E. (1994b) Weschler IQ profile and theory of mind in autism: a research note. *Journal of Child Psychology and Psychiatry*, **35**, 1461-1471.

Happe, F.G.E. (1995) The role of verbal ability in the theory of mind task performance of subjects with autism. *Child Development*, **66**, 843-855.

Harris, P.L. (1993) Pretending and planning. In S. Baron-Cohen, H. Tager-Flusberg & D.J. Cohen (Eds.) *Understanding other minds: perspectives from autism* (pp.228-246). Oxford: Oxford University Press.

Hermelin, B. & O'Connor, N. (1970) *Psychological experiments with autistic children*. Oxford: Pergamon Press.

Hertzig, M.E., Snow, M.E., New, E. & Shapiro, T. (1990) DSM-III and DSM-III-R diagnosis of autism and pervasive developmental disorder in nursery school children. *Journal of the American Academy of Child and Adolescent Psychiatry*, **29**, 123-126.

Hobson, R.P. (1989) Beyond cognition: a theory of autism. In G. Dawson (Ed.) *Autism: nature, diagnosis and treatment* (pp.22-48). New York: Guildford Press.

Howell, D.C. (1992) *Statistical methods for psychology* (3rd ed.) Boston: PWL-Kent.

Hughes, C. (1996) Control of action and thought: normal development and dysfunction in autism: a research note. *Journal of Child Psychology and Psychiatry*, **37**, 229-236.

Kanner, L. (1943) Autistic disturbances of affective contact. *Nervous Child* **2**, 217-50.

Kaufman A.S. (1979) *Intelligent testing with the WISC-R*. New York: Wiley.

Kaufman, A.S & Kaufman, N.L. (1983) Kaufman Assessment Battery for Children: 1. Administration and scoring manual; 2. Interpretive manual. Circle Pines, MN: American Guidance Service.

Klin, A., Volkmar, F.R., Sparow, S.S., Cicchetti, D.V. & Rourke, B.P. (1995) Validity and neuropsychological characterisation of Asperger syndrome: convergence with nonverbal learning disabilities syndrome. *Journal of Child Psychology and Psychiatry*, **36**, 1127-1140.

Kohs, S.C. (1923) *Intelligence Assessment*. New York: Macmillan.

Lezak, M.D. (1976) *Neuropsychological Assessment*. New York: Oxford University Press.

Lincoln, A.J., Couchesne, E., Kilman, B.A., Elmasian R. & Allen, M. (1988) A study of intellectual abilities in high-functioning people with autism. *Journal of Autism and Developmental Disorders*, **18**, 505-522.

Lincoln, A.J., Allen, M.H. & Kilman, A. (1995) The assessment and interpretation of intellectual abilities in people with autism. In E. Schopler & G.B. Mesibov (Eds.) *Learning and cognition in autism* (pp.89-117). New York: Plenum Press.

Lockyer, L.M. & Rutter, M. (1970) A five to fifteen year follow-up study of infantile psychosis: IV. Patterns of cognitive ability. *British Journal of Social and Clinical Psychology*, **9**, 152-163.

Lord, C. & Rutter, M. (1994) Autism and pervasive developmental disorders. In M. Rutter, E. Taylor & L. Hersov (Eds.) *Child and adolescent psychiatry: modern approaches* (3rd edition, pp. 569-593). London: Blackwell Scientific.

Luria, A.R., Pribram, K.H. & Homskaya, E.D. (1964) An experimental analysis of the behavioural disturbance produced by a left frontal arachnoidal endothelioma (meningioma). *Neuropsychologia*, **2**, 257-280.

Meltzoff, A.N. & Gopnik, A. (1993) The role of imitation in understanding persons and developing a theory of mind. In S. Baron-Cohen, H. Tager-Flusberg & D.J. Cohen (Eds.) *Understanding other's minds: perspectives from autism* (pp.335-366). Oxford: Oxford University Press .

Miller, J.N. & Ozonoff, S. (1997) Did Asperger's cases have Asperger's disorder? A research note. *Journal of Child Psychology and Psychiatry*, **38**, 247-251.

O'Brien, S.K. (1996) The validity and reliability of the Wing subgroups questionnaire. *Journal of Autism and Developmental Disorders*, **26**, 321-335.

Ozonoff, S., Rogers, S. & Pennington, B.F. (1991) Asperger syndrome: evidence of an empirical distinction from high-functioning autism. *Journal of Child Psychology and Psychiatry*, **32**, 1107-1122.

Pennington, B.F. & Ozonoff, S. (1996) Executive functions and developmental psychopathology. *Journal of Child Psychology and Psychiatry*, **37**, 51-87.

Pennington B.F. (1991) *Diagnosing Learning Disorders*. New York: Guildford Press.

Perner, J., Leekham, S., & Wimmer, H. (1987) Three-year olds' difficulty with false belief. The case for a conceptual deficit. *British Journal of Developmental Psychology*, **5**, 125-137.

Perner, J., Frith U., Leslie, A.M. & Leekham, S.R. (1989) Exploration of the autistic child's theory of mind: knowledge, belief and communication. *Child Development*, **60**, 689-700.

Premack, D. & Woodruff, G. (1978) Does the chimpanzee have a theory of mind? *Behavioural and Brain Sciences*, **4**, 515-526.

Rourke, B. (1989) *Nonverbal learning disabilities: the syndrome and the model*. New York: Guildford Press.

Rumsey, J.M. (1992) Neuropsychological studies of high-level autism. In E. Schopler & G.B. Mesibov (Eds.) *High-functioning individuals with autism*. New York: Plenum Press.

Rutter, M. (1978) Language disorder and infantile autism. In M. Rutter & E. Schopler (Eds.) *Autism: a reappraisal of concepts and treatment* (pp.85-104). New York: Plenum Press.

Rutter, M. (1979) Language, cognition and autism. In R. Katzman (Ed.), *Congenital and acquired cognitive disorders* (pp.247-264). New York: Raven Press.

Rutter, M. (1985) The treatment of autistic children. *Journal of Child Psychology and Psychiatry*, **26**, 193-214.

Rutter, M. & Schopler, E. (1992) Classification of pervasive developmental disorders: some concepts and practical considerations. *Journal of Autism and Developmental Disorders*, **22**, 4, 459-481.

Rutter, M., Bailey, A., Bolton, P. & Le Couteur, A. (1993) Autism: syndrome definition and possible genetic mechanisms. In R. Plomin & G.E. McClearn (Eds.) *Nature, nurture and psychology* (pp.269-284). Washington, DC: APA Books.

Sattler, J.M. (1974) *Assessment of children's intelligence*. Philadelphia: Saunders.

Shah, A. & Frith, U. (1983) An islet of ability in autistic children: a research note. *Journal of Child Psychology and Psychiatry*, **24**, 613-620.

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

Sodian, B. & Frith, U. (1992) Deception and sabotage in autistic, retarded and normal children.

Journal of Child Psychology and Psychiatry, **33**, 591-605.

Szatmari, P., Bartolucci, G. & Bremner, R. (1989) Asperger's syndrome and autism: comparisons of early history and outcome. *Developmental Medicine and Child Neurology*, **31**, 709-720.

Szmatari, P., Tuff, L., Finlayson, M.A. & Bartolucci, G. (1990) Asperger's syndrome and autism: neurocognitive aspects. *Journal of the American Academy of Child and Adolescent Psychiatry*, **29**, 130-136.

Tanguay, P.E. (1984) Toward a new classification of serious psychopathology in children.

Journal of the American Academy of Child Psychiatry, **23**, 373-384.

Temple, C.M. (1997) Cognitive neuropsychology and its application to children. *Journal of Child Psychology and Psychiatry*, **38**, 1, 27-52.

Ventner, A., Lord, C. & Schopler, E. (1992) A follow-up study of high-functioning autistic children. *Journal of Child Psychology and Psychiatry*, **33**, 489-507.

Volkmar, F.R., & Nelson, I. (1990) Seizure disorders in autism. *Journal of the American Academy of Child and Adolescent Psychiatry*, **29**, 127-129.

Volkmar, F.R., Cohen, D.J., Bregman, J.D., Hooks, M.Y. & Stevenson, J.M. (1989) An examination of social typologies in autism. *Journal of the American Academy of Child and Adolescent Psychiatry*, **28**, 82-86.

Waterhouse, L., Morris, R., Allen, D., Dunn, M., Fein, D., Feinstein, C., Rapin, I. & Wing, L. (1996) Diagnosis and classification in autism, *Journal of Autism and Developmental Disorders*, **26**, 59-86.

Welsh, M.C. & Pennington, B.F. (1988) Assessing frontal lobe functioning in children: views from developmental psychology. *Developmental Neuropsychology*, **4**, 199-230.

Weschler, D. (1958) *The measurement and appraisal of adult intelligence*. Baltimore: Williams and Wilkins.

Weschler, D. (1974) *Weschler Intelligence Scale for Children - Revised*. New York: The Psychological Corporation.

Wimmer, H. & Perner, J. (1983) Beliefs about beliefs: representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition*, **13**, 103-128.

Wing, L. (1981) Asperger's Syndrome: a clinical account. *Psychological Medicine*, **11**, 115-29.

Wing, L. (1988) The continuum of autistic characteristics. In E. Schopler & G.B. Mesibov (Eds.)

Diagnosis and assessment in autism (pp.91-110). New York: Plenum Press.

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.

Witkin, H.A. & Goodenough, D.R. (1977) Field dependence and interpersonal style.

Psychological Bulletin, **84**, 661-689.

World Health Organisation (1992) *International Classification of diseases and disorders.*

Clinical descriptions and guidelines (ICD-10). Geneva: WHO.

APPENDIX 1. ETHICAL APPROVAL

Our ref:NG/gb
Date: 10 December, 1996



Dr Tony Charman
Lecturer in Psychology, UCL
University College London
Gower Street
London
WC1E 6BT

Dear Dr Charman,

RESEARCH PROPOSAL - ROLE OF KAUFMAN - ABC

Further to my letter of 25 October 1996, I write to confirm that the NAS Board has approved your research proposal.

A number of minor points were made:

- * is there any way in which sample size might be increased within available resources in order to seek to ensure consistency in findings?
- * care will as always need to be taken in explaining IQ figures to parents, but in this case researchers are experienced Clinicians - presumably the direct lines provided are to those Clinicians?
- * the letter for parents is not particularly user-friendly; it might be better for words like "cognitive" not to appear in the Information Sheet, but a statement to the effect that withdrawal will have no effect on services provided to their children ought to be included
- * No doubt you will ensure that participating children have not had the Kaufman assessment recently, and that their participation is recorded in their notes to ensure the tests are not repeated in the near future

I hope that these comments are useful.

Patron: HRH The Princess Royal
Chief Executive: Geraldine Peacock

**BUILDING A BRIGHTER FUTURE
FOR PEOPLE WITH AUTISM.**

APPENDIX LETTER TO PARTICIPANTS

Tucker

I have copied this letter to Linda ~~Fitzgerald~~ at Radlett Lodge School (Cindy being absent sick) and to Chloe Phillips at Sybil Elgar School. Please correspond with them direct, or through Pilar Martin, as you wish.

I wish you every success with this interesting and potentially useful piece of research.

Yours sincerely

Norman Green
DIRECTOR - LEGAL & ADMINISTRATIVE SERVICES

cc. Linda Tucker (Radlett School)
Chloe Phillips

APPENDIX 2. LETTER TO PARTICIPANTS



Sub-Department of Clinical Health Psychology

UNIVERSITY COLLEGE LONDON

GOWER STREET LONDON WC1E 6BT

Direct Line: 0171-380 7897
UCL: 0171-387 7050
Code from overseas: +44 171
Fax: 0171-916 1989

Dear Parent,

We are psychologists conducting research into aspects of how children and adolescents with autism spectrum disorders tackle a variety of thinking tasks. In particular we are interested in whether some standardised assessments can be useful when assessing children with a range of developmental disabilities, including autism.

We are asking you and your child to be involved, in the following ways:

We would like to visit your child at school to complete a formal assessment, the Kaufman-Assessment Battery for Children and some brief comparable tests. The Kaufman is used for clinical assessment at Harper House Children's Service, and other diagnostic centres. The research aims to broaden our knowledge of how different subgroups within the autism spectrum perform on these tests, in order to illuminate our use of them clinically. The tasks are presented as game-playing and puzzles, and most children enjoy taking part. The whole test takes about 1 hour to complete, with breaks given as needed by the child. We would naturally liaise with your child and the school staff so as not to disrupt routine. We would also like your permission for a questionnaire on your child's behaviour to be completed by the school psychologist.

All information collected in the sessions is anonymous and confidential to the research team and no details of any individual who took part in the study would be released.

Ethical approval for the study has been given by the National Autistic Society and the school psychologist, Pilar Martin, is fully aware of the study.

Attached you will find a consent form for your own participation, and that of your child. Please read this form carefully. Complete it if you are willing to take part in the study and return to us via your child's classteacher. We will be pleased to clarify any points or queries that you have so do not hesitate to ring me (Tony Charman) on 0171-380-7897. If you do not wish to take part in the study, or if after initially agreeing you decide to withdraw from the study, you may do so without adversely effecting any services provided to your child now or in the future.

Please retain this information sheet for your future reference.

Thank you in anticipation of your cooperation.

Yours sincerely,

Dr. Tony Charman
Ms. Rosie Hurlston

Lecturer in Psychology, UCL
Clinical Psychologist in training, UCL

APPENDIX 3. CONSENT FORM

STUDY: ASSESSMENT OF CHILDREN WITH AUTISTIC SPECTRUM DISORDERS

Dr. Tony Charman
Rosie Hurlston

Lecturer in Psychology, UCL
Clinical Psychologist in Training, UCL

1. I have read the letter/ information sheet about this study and I understand what will be required of me and my child if we agree to take part.
2. My questions concerning this study have been answered by.....
3. I understand that at any time I may withdraw myself and my child from the study without giving a reason. All materials collected would then be returned to me or destroyed. Withdrawing or choosing not to take part in the study will not affect provision of services to my child.
4. I understand that any records which are made will be kept confidential, and that any reports arising from the work will be anonymous, and that my family will not be identified.
5. I give my permission for myself and my child to take part in the study.

Name of Parent.....

Parent's signature.....

Name of Child.....

Home address.....

.....

Date.....

APPENDIX 4. SAMPLE QUESTIONS FROM WING SUBGROUP QUESTIONNAIRE

This child shows this behavior:

<i>Never</i>	Very Rarely	Rarely	Sometimes	Frequently	Very Frequently	Always
0	1	2	3	4	5	6

Group #2.

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

Which of the items in the group above best describes your child?

Please circle: 1 2 3 4

This child shows this behavior:

Never	Very Rarely	Rarely	Sometimes	Frequently	Very Frequently	Always
0	1	2	3	4	5	6

Group #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 child.

1. When my child is with unfamiliar adults or children she does not start interactions, but she will interact with others if they pull her into activities. 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 the other people.

Rating: _____

2. When my child is with unfamiliar adults or children she readily approaches others to interact and responds easily to others. Her manner of interacting is generally appropriate (not awkward or unusual).

Rating: 0

3. When my child is with unfamiliar adults or children she either fails to respond when others approach or turns or walks away from others. She only approaches other people to obtain something that she needs or to play physical games (for example, roughhousing or tickling); otherwise, she does not approach others to interact.

Rating: 4

4. When my child is with unfamiliar adults or children she does approach others to interact but is awkward or unusual in her manner of doing so. She is not able to change her speech or behavior to adapt to others and continues to pursue her own topics or favorite activities, even in the face of active discouragement.

Rating: _____

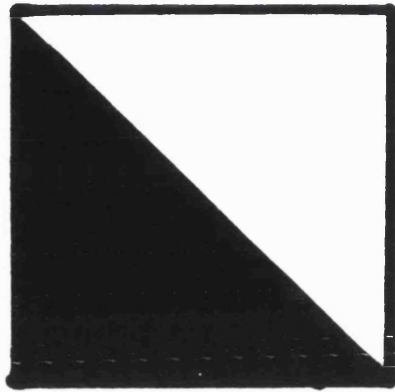
Which of the items in the group above best describes your child?

Please circle: 1 2 3 4

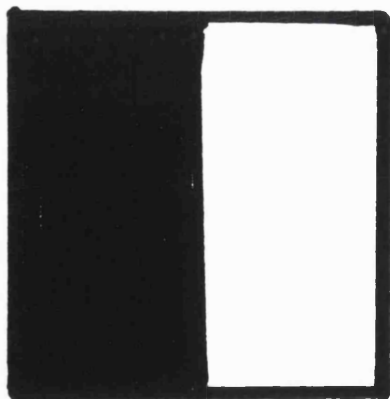
APPENDIX 5. STIMULI FOR BLOCK DESIGNS

BLOCK DESIGN - DEMONSTRATIONS

A.

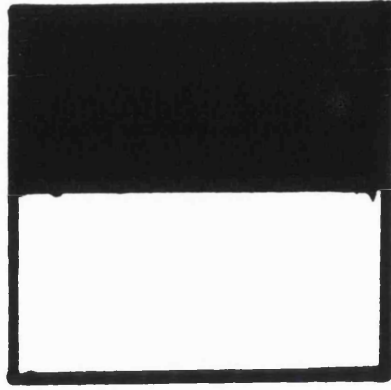


B.

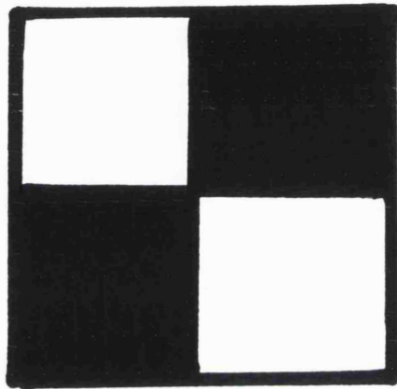


BLOCK DESIGN - UNSEGMENTED

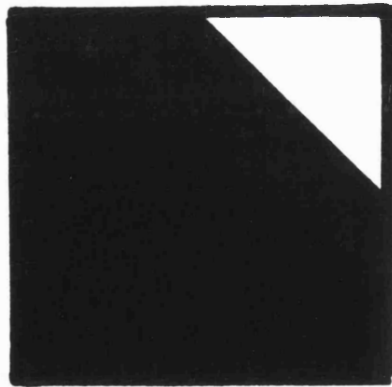
1.



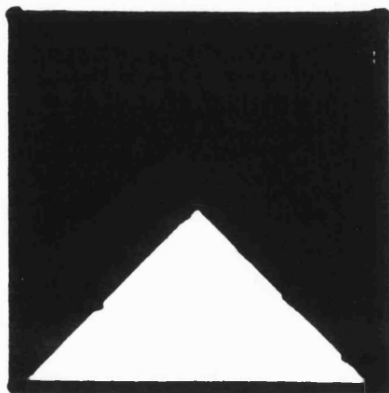
2.



3.

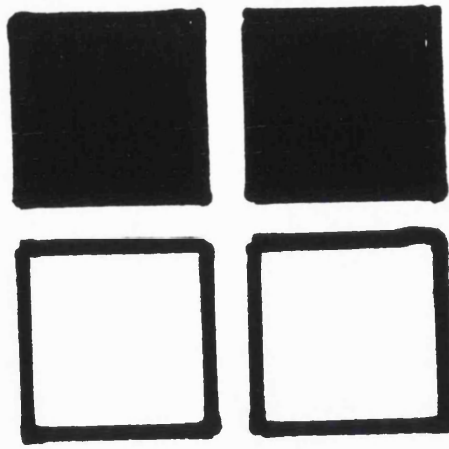


4.

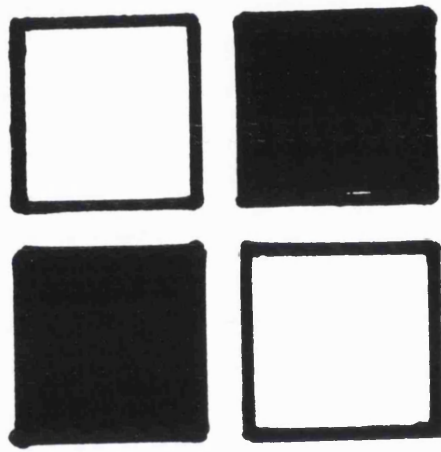


BLOCK DESIGN - SEGMENTED

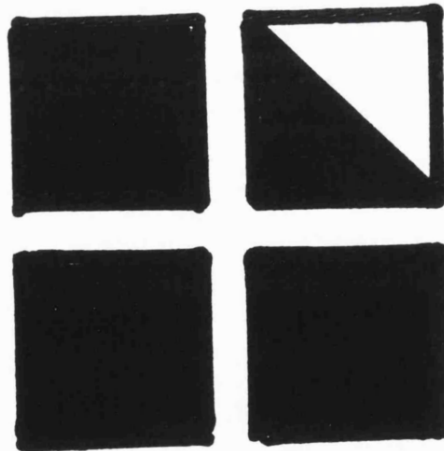
1.



2.



3.



4.

