Computer-mediated communication in autism

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Abstract

The aim of this thesis was to examine linguistic and social processing in autism and Asperger syndrome (AS), through computer-mediated communication. The first investigation used conversational analysis, on a corpus of computer-mediated dialogue, generated by two adults with AS. The results revealed that one of the two individuals had problems asking questions. Hence, an inability to ask questions may be one aspect of AS communication, though it may be not universal in this population. The second study used a computer program called Bubble Dialogue (Gray, Creighton, McMahon & Cunningham, 1991) to investigate the working understanding of nonliteral language and responses to inappropriate requests in individuals with AS and high-functioning autism (HFA). The AS/HFA group showed poorer understanding of a figure of speech and were more likely to consent to socially inappropriate requests compared to their typically developing peers. In contrast, understanding of sarcasm was predicted neither by verbal ability, executive ability nor clinical diagnosis. The results suggest that having AS/HFA does not, a priori, dispose someone to having problems with communication and socialisation, and that verbal ability protects the individual to a certain extent. Additionally, executive ability also seems important in mediating socialisation and communication ability. The third experiment tested the hypothesis that an autistic preference for internet-based communication may be due to the absence of verbal and non verbal cues, physical distance, and slower rate of information exchange through that medium. To test this, participants worked out predetermined map routes

by asking the experimenter closed questions either via text chat, or through telephone conversations. An initial examination of the results suggested that AS performance may in fact have been better via the telephone. However, a detailed look at the strategies employed by some individuals with AS suggests that their executive problems may have resulted in their use of a less than systematic way to solve the task in both media. The results of this study also indicate a relation between executive and mentalising ability because both are required to solve the task. Interestingly, many of the participants with AS could generate novel closed questions to successfully solve the map task in both media, though they were slower than controls. Using computer mediated communication has therefore given us greater detail into the nature of, and the factors that influence, communication in autism.

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Chapter 1

General background to Autism

"The little mermaid sang more sweetly than any of them and they all applauded her. For a moment she felt glad at heart, for she knew she had the finest voice either in the sea or on land."

(from *The Mermaid* by Hans Christian Anderson)

1.1 History

The above quotation reflects one of the many stereotypes of the autistic child: haunted, fey, gifted and beautiful. Yet the reality of autism is very far from this romantic notion. The term autism (from the Greek 'autos' meaning self) was first coined in 1911 by the eminent psychiatrist Eugen Bleuler. He used the term to describe a symptom of schizophrenia: the egocentric thinking and social withdrawal, the narrowing of relationships with people and the outside so extreme that it left only the person and their self. It was not until the 1940s, however, that descriptions of the disorder now known as autism were first published. Before then individuals with autism evidently existed, but were probably given different diagnostic or cultural labels depending on where and in what period of history they lived. For example, the more intellectually able may have been labelled as 'blessed fools' in Tsarist Russia or 'idiots savants' (Happé, 1994). Houston and Frith (2000) describe a Scottish Laird, Hugh Blair, whom if alive today would probably receive an autism diagnosis. There may even have been some famous figures with autism, for example, McKean (in an article by Lister, 2000) claims that architect and designer, Charles Rennie Mackintosh, had Asperger syndrome due to his irascible nature and unique visual perspective. Early in the last century, children with autism may have received the label of 'Childhood Schizophrenia'. In today's diagnostic classifications, schizophrenia is a label usually given to adults and only rarely does schizophrenia have an onset before late childhood.

Autism was independently and almost simultaneously described by Leo Kanner in the United States of America, in 1943, and by Hans Asperger in Austria in 1944. Kanner and Asperger both believed this disorder was present from birth. They both saw children who seemed unable to form normal emotional relationships with others, but unlike Bleuler's schizophrenic adults, the children's disturbance had an early onset. Kanner called the condition 'early infantile autism' (which is perhaps a misleading term because it implies that autism does not continue into adulthood). Asperger described his eponymous syndrome as a more broadly defined condition which he called 'autistic psychopathy'. Despite the enormous influence of the two men, Kanner and Asperger never actually met.

There is a great deal of overlap between both Kanner's and Asperger's descriptions of autism and some differences. Nowadays, the consensus seems to be that Kanner and Asperger described the same condition but their experience was with individuals at different developmental stages. For example, a child with a Kanner-type diagnosis may develop into an Asperger-type adolescent (Wing, 1991).

1.2 Kanner's cardinal features

Kanner and Eisenberg (1956) selected five features they believed were characteristic of all the children Kanner saw. To this day, these features form the basis of the diagnostic criteria for autism. The disorder was not accepted into official diagnosis until the publication of DSM-III in 1980 (The third edition of the Diagnostic and Statistic Manual of the American Psychiatric Association. Currently, the most up-to-date version is DSM-IV-TR, 2000).

Kanner's own words (taken from Happé, 1994) appear in italics, together with examples from my own experiences.

1. Extreme autistic aloneness: *There is, from the start, an extreme autistic aloneness that, wherever possible, disregards, ignores, shuts out anything that comes to the child from outside*. The parents of these children described them as *self-sufficient, like in a shell, acting as if people weren't there, happiest when alone*. Kanner said the children neither sought nor seemed to want social contact and displayed this from an early age by not opening their arms out when being picked up and not moulding themselves to the body of the person holding them. In contrast to Kanner's descriptions, however, Bauminger and Kasari (2000) concluded that high-functioning children with autism are lonely rather than loners. Ironically, their study supports Hobson's (1986, 1993) and

Kanner's (1943) affective theories (rather than the cognitive theories) of autism because the children reported actual feelings of loneliness.

Kanner's idea that the fundamental problem in autism is relating emotionally to others is alive today in Hobson's theory. Hobson (1990) postulates that making emotional contact with people is innate and it is this inability in autistic individuals which is the source of their social debilitation. He states that there are specific forms of communication between a young child and adult which provide the necessary psychological basis for understanding others' minds. Brown, Hobson, Lee and Stevenson (1997) state that these forms of communication involve 1) patterned intercoordination of feeling between the child and others, 2) an ability to see or otherwise apprehend the directedness of other people's attitudes towards a shared world, and 3) a propensity to identify with these outwardly focused attitudes of others, and to recognise the distinction between others' attitudes and one's own.

2. *An anxiously obsessive desire for the preservation of sameness*: Kanner stated that these children became distressed by even minor changes in routine, for example, taking a different route to school. He said they showed obsessive ritualistic behaviours in their everyday routines, such as taking their clothes off or putting them on in a particular sequence and became extremely challenging if the routine was not precisely adhered to. They engaged in repetitive activities: for example, I knew a young man who listened to the same record over and over again, and another who read the same science-fiction fantasy

books repeatedly.

3. Limitations in the variety of spontaneous activity: These children showed a *fascination for objects* which they *handled with skill in fine motor movements*; for example spinning objects and completing sometimes complex jigsaw puzzles. However, they did not show much in the way of spontaneous activity. Their stereotypy of self-stimulatory behaviours range from low-level typologies (e.g., rocking, spinning, hand flapping), to higher-level typologies (e.g., verbal perseverations, conversational obsessions). They also showed a narrow range of interests (e.g., wanting to listen to one record all the time). Interestingly the fine motor movements required to spin coins contrasts with the idea that autistic individuals, especially those with Asperger syndrome are clumsy (see Ghaziuddin & Butler, 1998; Green et al., 2002; Smith, 2000). Clarity about the nature of the motor features and especially clumsiness in autism will only occur once there is an agreed operationalisation of clumsiness.

4. The *kind of language that does not seem intended to serve interpersonal communication*/ immediate or delayed echolalia: Some children repeated or echoed, with remarkable fidelity, what they had heard another person say either immediately (immediate echolalia) or sometime after (delayed echolalia).

For example:

Parent: What would you like for dinner?

Child: What would you like for dinner?

Additionally the children reversed pronouns using 'You' to refer to themselves and 'I' to refer to the other person. Hence when they said "You want some biscuits?" They in fact meant that they wanted some biscuits.

Some of the children Kanner saw showed irregularities in the pitch and intonation of their spoken language and some were neologistic; that is, not using words and phrases in their usual meaning. These idiosyncratic words or phrases were often associated with a past incident. For example, another young man I knew called birthday cards "jelly" because as a child he made an association between birthday cards and party food. This is an example of the use of words or phrases with private, individualised meaning which any listener, who has not shared the experience, would have difficulty understanding. Kanner (1946) used the term *metaphorical language* to describe such instances.

Autistic children with some language comprehension, were over literal in their interpretations and failed to understand the underlying meaning of utterances. For example, a young woman with autism I met became very distressed whenever she was told that she was going swimming. Until someone said to her "You are going swimming and you are coming back".

5. Good cognitive potentialities: Despite having severe learning disabilities, Kanner believed that the children had islets of superior ability. He believed they could utilise their excellent rote memories in a practical and applied way, if

only they would, instead of memorising isolated and essentially meaningless pieces of information; for example, bus timetables, weather forecasts. Kanner believed the children were being uncooperative rather than being unable to use their abilities. Intriguingly, Happé (1999) states that these savant skills in recognised areas such as art, calculation, memory and music are ten times more common in people with autism than any other mental handicap, occurring in about one in ten individuals with autism. Though, Happé (1999) does not provide any evidence for this.

In his first paper on autism, Kanner wrote about additional features which included:

Odd responses to sensory stimuli: These children may show oversensitivity and become disturbed when exposed to crowd noises, vacuum cleaners, flashing or bright lights, and so on. A shower may feel like fast flowing needles, but paradoxically they may show incredible tolerance to what the rest of us would consider severe pain. Some children may also show strong preferences for certain kinds of clothing materials, especially for items worn nearest the skin.

Destructiveness, aggression and outbursts: Frustration often born from their compulsion for sameness, or desperation to be understood, probably leads these children to destroy objects and injure themselves and others (see Guess & Carr, 1991; Oliver, 1995, for accounts of the functional use of self-injurious behaviour in children with learning disabilities).

Unusual eating habits and problems with feeding: Kanner noticed that some children with autism were extremely selective about what they ate. In contrast others ate almost anything and everything, including non-edible items.

Highly intelligent families: Kanner stated that the parents of the children he saw were highly intellectual. This was probably due to an unrepresentative sample from referral bias. Nevertheless, researchers have recently looked to see if an extension of the autistic phenotype exists in the families of individuals with autism. Bailey et al. (1995), in their review of several studies, stated that, the first-degree relatives of individuals with autism, had an elevated rate of cognitive and social abnormalities. Baron-Cohen and Hammer (1997a) found that the parents of children with autism did better than controls on tests which individuals with autism are usually good at; for example, visuo-spatial tasks such as the embedded figures and block design tests. More recent research has looked at the extended phenotype of autistic symptoms. One such study, conducted by Pickles et al. (2000) found 'milder' aspects of autism in participants' siblings and parents.

1.3 What causes autism?

The exact causes of autism are still not known and it remains a contentious area, especially with regards to recent vaccination controversies (see Charman, 2002). However, most researchers would probably agree that there are a number of risk factors involved, and that autism is likely to be organic in origin. Thirty years ago the situation was very different, when lack of parental affection was thought to cause of autism. Kanner (1949) viewed autism as an unusually early schizophrenia mediated by environmental factors like having cold unaffectionate parents. Bruno Bettelheim (1967) extended this idea and lay the aetiology of autism at the doorstep of the child's parents, especially the mother, and based therapies on the 'refrigerator mother' hypothesis. He stated in his book, The Empty Fortress, *The precipitating factor in infantile autism is the parent's wish that his child should not exist. ... To this the child responds with massive withdrawal* (taken from Silberman, 2001). Bettelheim prescribed 'parentectomy', that is, the removal of the child from the parents, and years of family therapy as the treatment for autism. His hypothesis added a burden of guilt to the already existing sadness of having an autistic child, and made autism a source of shame and secrecy, which in turn probably hampered efforts to obtain clinical data.

In time, theories of parental causation were largely dismissed because of lack of evidence, with researchers finding that parents of children with autism did not differ from parents of children of typically developing children either in personality, marital happiness or family interactions (Koegel, Schreibman, O'Neil & Burke, 1983). It is therefore ironic that parents, these days, may be seen not as the cause of autism, but as the carriers of the gene(s) for autism. Indeed, parents themselves may show some of the milder aspects of the disorders (e.g., Pickles et al., 2000).

1.3a Genetic factors

There does not seem to be one single cause of autism, though there are a number of risk factors associated with the disorder. For example there is strong evidence, from twin and family studies, suggesting that inherited genes play a role in determining who is autistic. The exact mechanism of inheritance remains unknown. Future research detailing family pedigrees might shed light on whether autism is maternally or paternally transmitted, and perhaps reveal why males are more at risk of autism than females (see Section 1.4, p. 14). According to Singer (2000) a unilineal-inherited pattern (genetic contribution from one side of the family) implies a dominant inheritance whereas bilineality (genetic contribution from both sides of the family) implies recessive or polygenic transmission patterns.

Twin studies show that monozygotic (MZ - identical) twins have a higher concordance rate for autism than dizygotic (DZ - fraternal) twins: 36 percent and 0 percent respectively (Folstein & Rutter, 1977). The rate rises to 82 percent and 10 percent when the phenotype was extended to look at concordance rates for autistic features (Bailey et al., 1995). Bailey et al. (1995) found a large difference in the concordance rates for monozygotic and dizygotic pairs (60-90 percent vs. less than 5 percent). These figures translated into the underlying liability of autism of about 90 percent, making it the most genetically influenced of all multifactorial child psychiatric disorders (Rutter, 1999). According to Bailey et al. (1995), the difference in concordance rates between MZ and DZ twins suggests that autism is a complex genetic trait which involves more than one genetic locus. In fact Pickles et al. (1995) conclude that autism is unlikely to be caused by a single gene, but also unlikely to be due to more than 10 genes. This means that many family members are likely to have some of the genes that make a person susceptible to autism, but they will not have them all. Therefore if a combination of genes is needed to develop autism, these relatives will not develop the condition but will be carriers (Rutter, 1999).

It is hardly surprising that siblings of an individual with autism are at greater risk of the syndrome than the general population (Folstein & Rutter, 1977). However, only 2-3 percent and 3 percent of siblings exhibited autism in Folstein and Rutter's (1977) and Bolton et al.'s (1994) studies respectively. In Bolton et al.'s (1994) study this figure rose to 6 percent of siblings, when the phenotype was extended to include more broadly defined pervasive developmental disorders (PDD)[1] and Asperger syndrome. The figure rose to 20 percent of siblings when their broadest definition of *lesser variant* autism (e.g., reading difficulties that just occurred in childhood, or social impairments that first emerged in adolescence/adult life) was included. In contrast 0

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[1]Davison and Neale (1994) state that in part to clarify the distinction between autism and Schizophrenia DSM-III introduced, and DSM-IV retained, the term Pervasive Developmental Disorders. In DSM-IV, autism is one of several PDD; the others being Rett's disorder, Child Disintegrative disorder and Asperger syndrome.

percent, 0 percent and 3 percent exhibited autism, PDD/Asperger syndrome, or *lesser variant* autism respectively in a comparison sample of siblings of individuals with Down syndrome.

1.3b Environmental factors

If autism were an entirely genetic disorder, however, then monozygotic twins should have a 100 percent chance of inheritance. Thus environmental factors must interact with the genetic predisposition to the disorder. Several environmental factors are already known to increase the chances that autism will develop, for example in utero exposure to rubella (Rodier, 2000).

The origins of autism

Rodier (2000) suggests that autism occurs very early in the life of the embryo. She looked at studies of thalidomide victims (the morning sickness drug which caused birth defects in the 1960s) which showed that 5 percent of victims had autism, a rate which is about 30 times higher than in the general population. Thalidomide victims with autism had abnormalities in the external parts of their ears, but no malformations of their arms or legs. This suggested that these individuals had been injured very early in gestation: between 20 and 24 days after conception, a time before many women even know they are pregnant. Therefore either through a genetic defect or environmental influence, it may be that autism's origin occurs very early in gestation rather than postnatally as is commonly thought.

This timing of injury gives clues about the kind of structures that might be affected so early on. Rodier states that very few neurons are formed as early as the fourth week of gestation and most are the motor neurons which operate the cranial nerves that control eyes, face, jaw, throat and tongue muscles. The cell bodies of these neurons are located in the brain stem, which is an area associated with basic functions like breathing, eating, balance, motor coordination etc. On the surface this seems paradoxical because problems with language, planning and interpretation of social cues would be expected to be associated with the higher level regions of the brain like the prefrontal cortex. However, other symptoms of autism like hypersensitivity to touch and sound, and lack of facial expression seem more likely to originate in brain regions associated with basic functions.

<u>Exposure to in uteruo testosterone</u>

Another possible pre-birth factor in the aetiology of autism may be exposure to high levels of testosterone. The role of testosterone in autism is not clear, though the 'Extreme male brain theory' of autism (Baron-Cohen & Hammer, 1997b; Baron-Cohen, 2002) suggests that the high male to female ratio is one clue to autism, and notes that the male sex hormone, testosterone is found in the greatest quantities in males.

A phenotypic marker for high exposure to this sex hormone is a low 2nd to 4th digit ratio (the index and ring finger). Manning, Baron-Cohen, Wheelwright and Sanders (2001) measured the ratio of the 2nd and 4th digits in 72 children with autism and their families, and found lower ratios of the 2^{nd} and 4^{th} digits in children with autism, their siblings, fathers and mothers. This suggests that families with low 2^{nd}: 4^{th} digit ratios are at greater risk of autism. Additionally, children with autism had lower 2^{nd}:4^{th} digit ratios than children with Asperger syndrome. This suggests an association between language development and a reduced 2^{nd}:4^{th} digit ratio (Manning et al., 2001).

1.4 How common is Autism?

The recorded occurrence[2] of autism depends heavily on how it is defined and diagnosed (Happé, 1994). Even taking into account variations in diagnostic criteria, autism seemed a relatively rare disorder because epidemiological studies revealed a prevalence of between 4 and 5 per 10 000 births (Lotter, 1966; Wing & Gould, 1979). Though, a meta analysis by Gillberg and Wing (1999) found that epidemiological studies conducted over the last 10 years show a prevalence rate of 10 per 10 000 or higher. Charman and Baird (2002) suggest that the increases may be partly due to more individuals with an average IQ being diagnosed, and an increase in autistic spectrum disorders (ASD) being identified as comorbid with other disorders including, Down

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[2]Incidence measures the development of 'new cases' and is usually studied for disorders with clear onset. This measure is potentially problematic in developmental disorders because age of recognition may be very different from age of onset. Prevalence is the number of individuals with a condition at one in time, over a defined period.

syndrome, cerebral palsy, tuberous sclerosis, Tourette syndrome and Turner syndrome.

Furthermore, a number of recent studies have found a prevalence of between 15 and 40 per 10 000, and up to as much as 40 to 60 per 10 000 for overall rates of ASD (Baird et al., 2000; MRC, 2001). Up to now only four studies have investigated the prevalence rate of Asperger syndrome (see Section 1.7, p. 19). All have been in Nordic countries and show a similar rate of prevalence of 26 to 48 in 10 000, or about 0.3 to 0.5 percent (Gillberg & Coleman, 2000).

Gender differences in autism

These epidemiological studies also show a higher ratio of males to females, with autism occurring in approximately 5 boys to every 2 girls. This ratio increases as one moves along the autistic spectrum, ranging from 5:1 (Lord, Schopler & Revicki, 1982) to as high as 15:1 (Newson, Dawson & Everard, 1984) at the higher-functioning end. Therefore, a more specific genetic cause of autism, without a corresponding learning disability, seems more likely to occur in males than females given the increased ratio of males to females at the higher-functioning end of the autistic spectrum. This difference in sex ratio, and its amplification at the higher-functioning end of the spectrum, seems to be one of the biggest clues to understanding autism. As yet no one has a definitive answer as to why males are at greater risk of autism, Tourette syndrome and other developmental disorders. It may have something to do with the fact that the 'default' foetus sex is female, and it is only the genes on the Y chromosome that stimulate male characteristics to develop; hence change may be equated to risk. After this stage, any brain damage, through foetal haemorrhaging, has a more-or-less equal change of affecting boys and girls.

Skuse et al. (1997) looked at girls with Turner syndrome and used evidence from their study to suggest an account of why males are more vulnerable to developmental disorders, such as autism. Turner syndrome is a genetic disorder affecting only girls. It is a disorder which results from part or all of one X chromosome being deleted. (All 'normal' females have two X chromosomes, one inherited from each parent). About 70 percent of females with Turner syndrome inherit their single X from their mother; the remaining 30 percent inherit it from their father.

Skuse et al. (1997) found evidence that these two groups with Turner's syndrome differ in their social behaviour. The ones who inherited their X chromosome from their mother had significantly more social difficulties than those who inherited their X chromosome from their father. This suggests that social ability is located on the father's X chromosome.

All 'normal' girls inherit one X chromosome from their mother and another from their father, whereas all 'normal' males have an X and a Y chromosome. Crucially males inherit one X chromosome and this can <u>only</u> be inherited from their mother. Therefore, Skuse et al. (1997) argue, boys are at greater risk of socially debilitating genetic disorders and this is perhaps why there is a higher ratio of males to females who are diagnosed as autistic.

1.5 Does Autism really exist?

Unlike Down syndrome, Williams syndrome or Turner syndrome, which can all be diagnosed at a biological or genetic level, autism is defined at the behavioural level; to date there are no genetic markers, or brain structure abnormalities that have been identified as the cause or site of autism. This is despite evidence of a strong inherited genetic component in autism (see Section 1.3, p. 8).

A true syndrome must be composed of a constellation of co-existing symptoms that do not occur by chance. The difficulty with diagnosis at a behavioural level is that behaviours may come together purely by chance. Wing and Gould (1979) undertook a comprehensive study to see if behavioural features of autism appear as a systematic pattern of symptoms which occur together. Their epidemiological study found that children with autism had deficits in i) *socialisation*, ii) *communication* and iii) *imagination* and that these problems had a tendency to occur together. These are a known as Wing's triad of impairments and remain core to the current diagnostic criteria for autism in DSM IV-TR (The current version of the Diagnostic and Statistical Manual of the American Psychiatric Association).

Because autism is a developmental disorder, Wing's triad of impairments may express themselves in different ways at different points along the individual's development.

i. Wing and Gould (1979) defined problems in socialisation as an inability to engage in two-way interactions. They described three types of behaviour which capture this quality of social impairment: aloof, passive or odd. A toddler with autism might show aloofness by rejecting affectionate physical contact with others. The child might be passive by unquestioningly doing whatever s/he is told, even if it gets them into trouble. Walking up to a stranger and showing them a series of photographs, as a social introduction, is an example of autistically odd behaviour.

ii. Problems of communication might be shown in the same individual, at different times. For example, as a three year old the child may not produce any spoken language but as a teenager they may talk incessantly about one topic; for example, the years in which certain pop songs charted.

iii. A child with autism might show an underlying impairment in imagination by lining up toy cars, rather than pretending to drive them and involve them in crashes with appropriate sound effects. A teenager with autism might show no interest in fiction in films, novels or TV dramas, preferring to read road maps or bus timetables.

That is why, when making a diagnosis, clinicians usually take a detailed developmental history because a 'snapshot' of that individual might not show impairments of socialisation, communication and imagination.

1.6 Autistic Continuum or Spectrum

Because autism is a developmental disorder, the clinical picture of an individual varies according to which stage of their development is looked at, in combination with their age and their intellectual ability. Wing (1988) introduced the concept of an autistic continuum, capturing the idea of a range of problems from highly able individuals who have only the slightest social impairments to those who have multiple problems of which social impairments are only one. The continuum overlaps with learning disabilities (Shea & Mesibov, 1985) and arguably shades into normality.

1.7 Asperger (or Asperger's) syndrome

Asperger or Asperger's syndrome is a diagnostic label given to individuals with autism who are at the higher functioning end of the autistic spectrum. Hans Asperger himself did not lay down specific criteria for diagnosis of the syndrome. Rather it was Lorna Wing (1981) who first used the term Asperger's syndrome to describe the very able individuals who did not fit Kanner's description of a socially passive, aloof, silent person with autism. Individuals with Asperger syndrome are now thought to be a sub group of people lying at the more cognitively able end of the autistic continuum.

Nevertheless, there is considerable controversy about the difference between a diagnosis of Asperger syndrome (AS) and those who are high(-er) functioning individuals with autism (HFA). In a cluster analysis of high-functioning children with autistic spectrum disorders, Prior et al. (1998) found that it was possible to statistically differentiate children in three subgroups based on their behaviours, and theory of mind ability (see Chapter 2). The three subgroups did in fact mirror the three clinical subgroups of autistic-like, Asperger-like and mild PDD or PDD-NOS. However 22 percent of those diagnosed with AS were put in the autistic-like cluster and 20 percent in the mild PDD/PDD-NOS cluster. Interestingly, the critical factor when deciding on a diagnosis of AS or HFA, using DSM-IV and ICD-10 (WHO, 1992), is delay in language development. In the Prior et al. (1998) study early language development did not differentiate between cluster groups, and so may not be reliable in diagnosis (Prior et al., 1998). This lack of reliability is supported by Manjiviona and Prior (1999) who found that the presence or absence of early language delay in children with AS and HFA respectively, did not appear to have any relation to the neurocognitive profiles of the children. Furthermore Gilchrist et al. (2001) found that, by adolescence, there were close behavioural similarities between individuals with AS and those with HFA despite differences in speech development. Interestingly, the Asperger-like cluster of participants in Prior et al.'s (1998) study had some awareness of and desire for friendship and social relationships, and were also more likely to have special interests related to high cognitive abilities like computer skills (Prior et al., 1998).

A major part of the problem surrounding diagnosis stems from the hierarchical diagnostic heuristics of the major diagnostic systems. Both DSM IV (see Appendix, p. 248) and ICD-10 (Appendix, p. 250) state that someone cannot be diagnosed with Asperger syndrome if they have at any time met the criteria for autism. This is known as the 'precedence rule'. This means that most people with a diagnosis of Asperger syndrome probably in fact meet the criteria for autism if the diagnostic criteria were strictly adhered to. They would definitely meet the criteria for autism if they showed, before 3 years old, behavioural difficulties in social reciprocity, communication in any form (e.g., nonverbal), difficulties in play, or restricted and repetitive interests. To be diagnosed with Asperger syndrome, their language development must not show any clinically significant delay or disorder and they must have normal cognitive and self-help skills.

However, high-functioning autistic individuals and those with Asperger syndrome both have no associated learning disability, so it is difficult to distinguish between the two groups both diagnostically and experimentally (see Baron Cohen, O'Riordan, Stone, Jones & Plaisted, 1999, for a concise rationale). Additionally, Gilchrist et al. (2001) concluded that adolescents with AS and HFA may show similar communication and social abnormalities, despite differences in onset of speech.

To add to the controversy and confusion, somewhat ironically, none of the four cases Asperger used to illustrate what he thought were the defining features of the syndrome would meet the current DSM and ICD criteria for Asperger syndrome (Miller & Ozonoff, 1997); all of them would first meet the criteria for autism (Miller & Ozonoff, 1997) and therefore preclude a diagnosis of Asperger syndrome. However, they would have met Gillberg's criteria for Asperger syndrome (Gillberg & Gillberg, 1989) which are based on those described by Hans Asperger (see Appendix, p. 252 for Gillberg's original and expanded diagnostic criteria for Asperger syndrome).

Wing (1991) also states there is a debate about whether people with Asperger syndrome are different from or the same as higher-functioning individuals with autism, whether sub groups of autism truly exist and what theoretical use any distinction provides. Schopler (1985) argued that "Since no behavioral distinction between higher-level autism and Asperger Syndrome has yet been demonstrated, diagnostic confusion can be reduced if the Asperger Syndrome label is not used, at least until an empirically based distinction from higher-level autism can be demonstrated for it" (p. 359). Furthermore, Happé (1994) suggested that the Asperger syndrome label has been of clinical if not theoretical value.

Studies trying to discriminate between individuals with Asperger syndrome and high-functioning autism have provided inconsistent and mixed results. Volkmar, Paul and Cohen (1985) argue that the practical distinction between children with Asperger syndrome and high-functioning children with autism is problematic. Ozonoff, Pennington and Rogers (1991b) found that individuals with a diagnosis of higher-functioning autism performed poorly on Theory of Mind tasks and verbal memory (Buschke Selective Reminding Test, Buschke, 1974) compared with individuals with Asperger syndrome and so argued for a distinction between the two labels. However, a significant group difference in VIQ may have influenced the results. When VIQ was controlled for, the group differences remained, but only at marginal statistical significance.

According to Wing (1991) the Asperger syndrome label is a signpost to service provision and help for families whose autistic child is of normal intelligence, but whose condition has remained undiagnosed until adolescence or adulthood[3]. The label of AS has, nevertheless, facilitated thinking about a clinical population for whom there has not been much service provision until recently. It has also enabled autism to be thought of as a disorder which persists into adulthood, rather than the infantilising impression Kanner's 'early infantile autism' term evokes (see Ozonoff & McMahon Griffith, 2000, for an up-to-date and detailed review of the external validity of Asperger syndrome).

1.8 Is Asperger syndrome a less socially debilitating form of Autism?

Asperger syndrome is thought of as a mild form of autism because the individual has autism, but without a severe associated learning disability. This

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[3]In their survey of 770 families, Howlin and Asgharian (1999) found that the mean for the diagnosis of autism was 5.5 years, compared to11 years for Asperger syndrome.

may be misleading if 'mild' implies 'less of a problem'. The very reality of having normal to superior intelligence seems to give greater insight into their own peculiarities and social shortcomings. One study found that autistic children with higher IQs perceived themselves as less socially competent than those with lower IQs (Capps, Sigman & Yirmiya, 1995). According to Wing (1991), individuals with Asperger syndrome are susceptible to mental illness. Thus, the very fact that individuals with Asperger syndrome shade so closely into 'normality' is often the very source of their problems and they can suffer mental illness or maladjustment as a consequence.

Individuals with Asperger syndrome may feel that they are 'different' from others and feel they just cannot comprehend, never mind engage in, the subtleties of relationships. Temple Grandin, an American academic with Asperger syndrome, has spoken and written about her experiences at length. She states in Sachs (1995) that she had never dated anyone, finding "such interactions completely baffling and too complex to deal with" because "she was never sure what was being said, or implied, or asked, or expected" (p. 272). Such feelings of social separation and isolation may be the starting point for mental illness.

Furthermore, individuals with Asperger syndrome have a disability that is essentially 'invisible'. If someone uses a wheel chair then it is reasonable to suspect that they have a disability and may be unable to do some things. Hence, the general public and service providers are more likely to be accommodating, tolerant, and make allowances for them. However, if one looks 'normal' and mostly acts 'normal', then 'unusual' behaviours may be completely misinterpreted and perhaps perceived as psychotic or threatening. An individual with Asperger syndrome may find their well intended actions entirely misinterpreted. For example, shadowing someone in a supermarket because you have noticed they have 12 items in their basket, and the express checkout sign displays 'ten or fewer items' (Dewey, 1991).

1.9 Summary

Autism is currently considered a neurodevelopmental disorder with a large inherited genetic component. Recent epidemiological studies suggest that autism is increasing, however this may be due to more stringent diagnosis, rather than any real increase in numbers. Like many other developmental disorders, autism affects more boys than girls, and this ratio increases at the non-learning disabled end of the autistic spectrum. However, no one has yet definitively explained why males are at greater risk. Asperger syndrome is a relatively recent diagnostic label, given to autistic individuals without early language delays. It has proved difficult though to distinguish between individuals with high-functioning autism and AS, leading to a suggestion that it should be removed from the next incarnation of DSM. However, the AS label has enabled autism to be thought of as a life-long disorder and not just restricted to childhood.

There are many contemporary theories of autism elucidating the diverse range of cognitive, motor and sensory deficits which are seen across the autistic spectrum. The theories detailed in Chapters 2 and 3 not only describe autism, but seek to explain why such a diverse and seemingly disparate range of characteristics are seen in this enigmatic condition.

Chapter 2

Theories of Autism:

Theory of mind and joint attention

"The only thing worth having a theory about is pleasure".

(Oscar Wilde)

2.1 Understanding other minds

Imagine a world in which we could read people's minds as though they were thought bubbles in comic books. What kind of world would it be? There would be no more secrets, no more lies and no more surprise birthday parties. Would it be worth even talking to each other, if we knew what others were thinking? Of course we cannot literally read other peoples' minds, but we can make sense of their actions by attributing mental states to them (Dennett, 1978).

The first researchers to scientifically investigate the understanding of other minds were Premack and Woodruff (1978). In their seminal study, they looked to see if a chimpanzee, Sarah, was sensitive to the mental states of a man in a video, struggling with a variety of problems. Sarah was presented with a series of cards relevant to the man's predicament. In one clip he was trying to leave a locked room and Sarah reliably selected the card with an intact key on it, and not the distracter cards showing pictures of broken or bent keys. Premack and Woodruff (1978) originally coined the term "theory of mind", stating that, "An individual has a theory of mind if he imputes mental states to himself and to others" (p. 515). They argued that chimpanzees could demonstrate possession of a "theory of mind", and their work sparked a whole wave of research into the understanding of other minds in apes, children and individuals with autism (see Call, 2001, for a up-to-date review on Chimpanzee social cognition).

Theory of mind is a catchy if somewhat misleading term because it is not the same as a scientific theory. Rather, having a theory of mind provides the individual with the ability to predict mental states from external events. This ability is also known as mentalising or mindreading (Baron-Cohen, 1995).

The following case illustrates what happens when someone is impaired in reading minds. M. is a young adult with Asperger syndrome who lives in residential care. He was in mainstream education until fourteen years old, but found it increasingly difficult to cope. M. was diagnosed with autism at the relatively late age of sixteen and was given the specific label Asperger syndrome. One of M.'s behaviours is to try and get people into trouble by breaking objects and blaming it on a carer who is with him. Curiously, he still destroys things while a third person is in the same room and yet continues to blame it on the carer. It is as if M. does not realise that the third person is an independent witness to the event who is capable of testifying that M., rather than the carer, had destroyed the object.

The above example shows that one consequence of M.'s mentalising problems is that he cannot effectively deceive others. His difficulties extend to not thanking people for birthday and Christmas presents and staring at anyone who has just hurt themselves. On the surface it looks as though M. is just an ungrateful and tactless person. However, if M. suffers from an inability to apprehend others' minds, then his behaviours can be interpreted very differently. That is he may not be able to mentalise, and therefore not realise how disgruntled the present giver might feel at not being thanked, or how embarrassed the injured person might feel when stared at.

The theory of mind hypothesis of autism seeks to explain deficits in communication, imagination and socialisation as an underlying cognitive problem. The hypothesis states that Wing's triad of impairments (see Section 1.5, p. 17) are secondary to the failure to develop a theory of mind and not primary deficits (Klin, Volkmar & Sparrow, 1992).

M.'s story is an example of mindreading in everyday life, but how do we test for an inability to apprehend others' minds in a scientific, systematic and controlled way?

2.2 The false belief paradigm

An underlying cognitive problem with individuals with autism could be identified in its most specific form as a failure to grasp the substantive quality of a simple factual belief. Yet how do you test someone's understanding of belief? One difficulty is that beliefs and reality are usually congruent with one another. For example, if you believe that your bicycle is outside your house and you look out of a front window, then you fully expect to see your bike. Even when you are not looking at your bicycle, you still believe that it is there. A thief might steal your bike as you watch television, but your belief remains that it is parked outside. In this case you have a false belief about the location of your bicycle, where reality and your mental state become incongruous with one another.

2.3 The unexpected transfer task

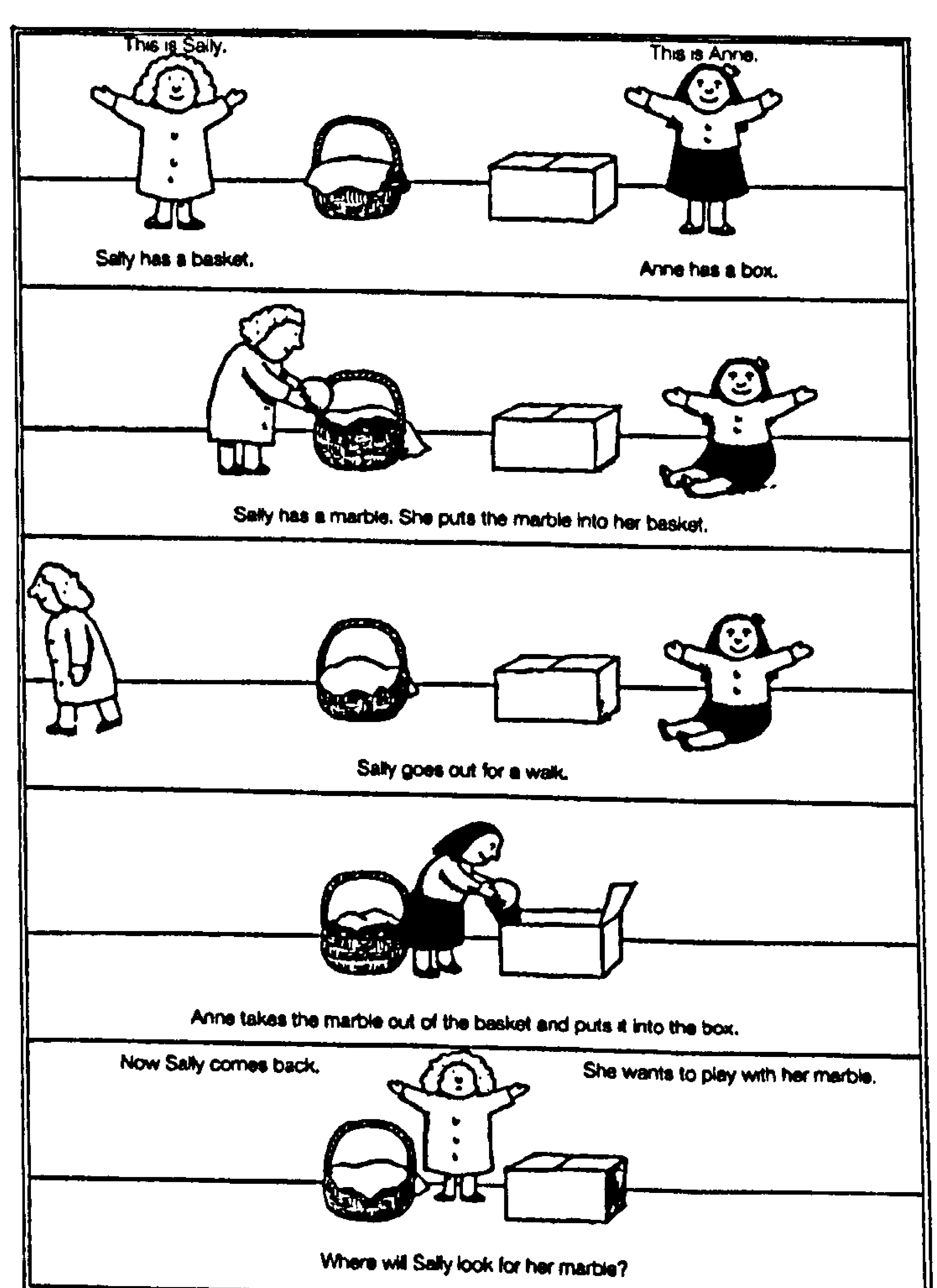
Around the age of four typically developing children show an ability to infer the representational states of themselves and others. Children can display this ability by passing a number of theory of mind tasks; for example, the unexpected transfer task which is a test of false belief, originally devised by Wimmer and Perner (1983). Baron-Cohen, Leslie and Frith (1985) used Wimmer and Perner's design in their 'Sally-Anne' experiment in which they tested children with autism, Down syndrome and typically developing children.

Two dolls were used, Sally and Anne, to act out the scenario (see Figure1). Sally has a basket and Anne has a box. Sally has a marble which she puts into her basket. Sally then goes out. Anne then takes out Sally's marble and puts it into her box while Sally is away. Then Sally comes back and wants her marble. The test question asked is, "Where will Sally look for her marble?"

The correct answer is of course "the basket". This answer is correct because

Anne has taken out the marble unbeknownst to Sally (who has not seen the transfer) and Sally still believes that the marble is where she last saw it. It was argued that to answer the test question correctly, participants needed to represent Sally's mental state in their own minds by making a representation of a representation (or metarepresentation). The crucial point is that someone's knowledge depends on their own informational access. In this example seeing leads to knowing; without having seen the transfer, in this experiment, Sally is unlikely to know the new location of the marble. Sally could have been told about the new location, but that would require informational access of a different kind.

. Figure 1. The Sally-Anne task in pictorial form (taken from Frith, 1989)



Baron-Cohen et al. (1985) asked children a location-based test question: "Where will Sally look for her marble?". Therefore, children's beliefs were tested without them having to understand any mentalistic vocabulary; for example, the kind of understanding that would be required to answer a test question like, " Where does Sally think her marble is?"

Furthermore, Baron Cohen et al. (1985) found that children who failed the false belief task did not fail due to poor recollection/memory of the sequence of events in the unexpected transfer task because they all knew which doll was which (Naming Question) and correctly answered the two control questions: "Where is the marble really?" (Reality Question); "Where was the marble in the beginning?" (Memory Question).

Baron-Cohen et al. (1985) discovered that the children with autism, who had relatively high verbal mental ages (VMA - mean of 5 years, 5 months, as measured by the British Picture Vocabulary Scale, or BPVS, Dunn, Dunn, Whetton & Pintilie, 1982), performed poorly when compared to verbal age matched typically developing children and children with Down syndrome with a mean VMA of 2 years 11 months. The vast majority of the children with autism (16 out of 20) incorrectly judged that Sally would look for the marble in its new location (the box). While the majority of children with Down syndrome said she would look in the basket. It was as if the children with autism did not take into account Sally's belief.

Baron-Cohen et al.'s (1985) use of comparison groups elegantly ruled out i) immaturity in verbal intelligence and ii) any language comprehension deficit as competing explanations for the autistic children's failure. Furthermore, the inclusion of the Down syndrome control group might suggest that having a learning disability per se cannot explain failure on the task. On the other hand, Yirmiya, Erel, Shaked, Solomonica-Levi (1998) question the interpretation of results when children with Down syndrome serve in comparison groups. They argue that individuals with Down syndrome have a unique profile, and have strengths in attentional, social and emotional abilities. Therefore the inclusion of children with Down syndrome may not rule out the possibility that failure on the false belief task is not due to mental retardation. Interestingly Yirmiya et al. (1998) argue that Baron-Cohen et al.'s (1985) study shows the strengths of children with Down syndrome, just as much as it shows the impairments in children with autism.

de Gelder (1987) criticised Baron-Cohen et al.'s (1985) study by stating that children with autism are known to have deficits in their pretend play and their imagination. She argued that children with autism might view the dolls, in the unexpected transfer task, as inanimate and not capable of having beliefs or other mental states. Therefore, the children might resort to a default interpretation of the test question and consider where they themselves would look for the marble and report the marble's current location. Another experiment, however, helped refute de Gelder's criticism, by utilising the deceptive box procedure.

2.4 The deceptive box paradigm

Perner, Frith, Leslie and Leekam (1989) investigated autistic children's understanding of their own and another person's mental state using the deceptive box paradigm. First devised by Hogrefe, Wimmer and Perner (1986) and Perner, Leekam and Wimmer (1987), children are presented with a Smarties tube and asked what they think is inside. (Smarties are small, many coloured, oval-shaped, well-known European confectioneries. A US equivalent is M&Ms. Smarties are packaged in a distinctive tube which displays its contents on the outside). After replying "sweets", the experimenter reveals that the box actually contains a pencil which is then put back in the tube. Finally children are asked to say what another person who had never seen the tube before would think was inside. Perner et al. (1987) found that typically developing 4 year old children correctly judged that another person would think it contained Smarties. Younger children failed to acknowledge another person's false belief and responded with the realist answer of pencil. When this experiment was repeated with children with autism, Perner et al. (1989) found that only 4 out of 24 correctly answered the test question.

Perner et al.'s (1989) results confirmed and strengthened Baron-Cohen, Leslie and Frith's (1985) findings. Their results supported the idea that children with autism have a deficient theory of mind, which could not be attributed to problems handling make-believe, as de Gelder (1987) had argued.

2.5 But what about the talented minority?

There is, however, another problem with the theory of mind hypothesis of autism which is that a small but, nevertheless, significant number of children with autism regularly pass tests of false belief. These data seem anomalous if autism entails a lack of understanding that minds contain beliefs. There are three possible ways of explaining this finding.

i). One extreme position is to say that the children who passed the tasks are wrongly diagnosed and are not in fact autistic. This seems very unlikely, but nevertheless is a possibility given current diagnostic controversies.

ii). The diametrically opposite position is that the theory of mind hypothesis is incorrect because it simply cannot account for the children who pass the task and yet are autistic.

iii). In between the two extremes, it could be argued that the theory of mind hypothesis may explain some of the cognitive impairments seen in individuals with autism but does not fully explain the disorder.

2.6 Second-order belief attribution

Baron-Cohen (1989) attempted to buoy the theory of mind hypothesis of autism by suggesting that although some children with autism could pass first-order theory of mind tasks (showing an ability to think about another person's thoughts about an objective event), they could <u>not</u> pass second-order theory of mind tasks (showing an ability to think about another person's thoughts about a third person's thoughts about an objective event).

Baron-Cohen suggested that autism was a <u>delay</u> in the development of a metarepresentational capacity rather than a substantive deficit. He argued that the 80 percent of children with autism who failed the Sally-Anne task were delayed in their first-order belief attribution unlike the 20 percent who passed.

Baron-Cohen set out to support his hypothesis by again using a paradigm first developed by Perner and Wimmer (1985). The scenario was once more enacted using two toys, John and Mary, who lived in a toy village which contained two houses, a church and a park. The story consisted of four episodes:

Episode1. Mary and John saw the ice-cream van in the park.

Episode2. John went home to get some money and meantime Mary saw the ice-cream van move to the church.

Episode3. John unexpectedly sees the ice-cream van at the church, so his belief about the van's location remains true.

Episode 4. Mary sets out to look for John whom she is told, has gone for an ice-cream.

The participants were 10 typically developing children, 10 children with Down syndrome and 10 children with autism who were all matched for verbal mental age. They were all asked the test question:

" Where does Mary think John has gone to buy his ice-cream? "

The correct answer is "the park" because in the second-order belief attribution task, participants have to make a judgement about Mary's belief about John's belief; that is, a judgement about one person's false belief about another person's true belief.

Baron-Cohen (1989) found that 90 percent of the typically developing children (mean chronological age 7.5) passed the belief question, as did 60 percent of the children with Down syndrome (mean VMA of 7.5), but none of the children with autism (Mean VMA of 12.2). Baron-Cohen concluded that although some individuals with autism may have the means of passing a first-order theory of mind task, they could not pass a second-order theory of mind task and therefore did not have a fully representational theory of mind.

Bowler (1992), however, found that 73 percent of young adults with Asperger syndrome were able to pass second-order belief attribution tasks, again using Perner and Wimmer's (1985) John/Mary design. Therefore, these individuals, who showed an autistic profile yet could pass both first and second-order theory of mind tasks, posed another serious problem for the theory of mind hypothesis of autism.

Additionally, a criticism was made by Russell, Saltmarsh and Hill (1999) who argue that second-order false belief tasks may not even be testing an understanding of mental concepts at a deeper level than first-order tasks. They state that second-order tasks might only tap into the number of embedded representations a person can hold in working memory. Therefore the ability to pass second-order false belief tasks is more likely to be related to executive ability in planning tasks (like the Tower of London and Tower of Hanoi), than to actual mentalising ability (see Chapter 3 for more details of executive function and theory of mind and their relation).

2.7 Problems with the theory of mind hypothesis of autism

The theory of mind deficit hypothesis of autism faced three major problems: specificity, uniqueness and universality. The specificity claim is that autism involves a domain-specific deficit; that is, theory of mind is unrelated to any other domain. The uniqueness, or the 'discriminant validity' problem, is that a deficient theory of mind is unique to autism and autism alone. The universality claim is that all individuals with autism have a deficient theory of mind.

Looking at the specificity claim, some researchers argue that theory of mind is domain-specific, with a dedicated neural system (e.g., Baron-Cohen, 1995). Others argue that mental state information is processed by domain-general cognitive functions, namely executive functions (e.g, Frye, Zelazo & Palfai, 1995). (See Chapter 3 for further discussion of the specificity claim of the theory of mind deficit hypothesis of autism).

Regarding the uniqueness claim, Yirmiya et al.'s (1998) meta-analyses comparing theory of mind abilities of individuals with autism, individuals with mental retardation, and typically developing individuals found that children with learning disabilities also show deficits in theory of mind relative to their mental age, although these deficits are less severe than amongst individuals with autism (Yirmiya et al., 1998).

In terms of universality, studies have consistently found that individuals with autism (typically higher-functioning) pass both first and second-order tests of theory of mind, yet still have autism. Therefore, several researchers developed more advanced theory of mind tasks (including Happé, 1994; Baron-Cohen, Jolliffe, Mortimore & Robertson 1997; Baron-Cohen, O'Riordan, Stone, Jones & Plaisted, 1999). These researchers hypothesised that first and second-order theory of mind tests were not sensitive enough to find deficits in more able autistic individuals, and thus they developed tests specially for this population (The findings and their implications are discussed in more detail in Chapter 4).

2.8 Does autism result from a failure to develop joint attention?

Baron-Cohen (1995) states that joint visual attention between a young child and others may be a precursor to understanding others' mental states. Baron-Cohen (1995) theorises that a failure to develop a theory of mind arises from an early failure of the representational shared-attention mechanism. That is, children with autism cannot represent the psychological relation of seeing or attending that links an adult with an object. The absence of this triadic relationship between the child, adult and object is seen through a lack of pointing to show and gaze-following.

Trepagnier (1996) suggests that the disruption of social gaze interaction in the first few months of life accounts for the triad of impairments. The origins for this gaze disruption are left fairly vague, with Trepaignier stating that it comes from a predisposition to neuropsychiatric symptoms. According to Trepagnier, gaze disruption leads to a failure to develop joint attention which in turn leads to an impairment in language, social and cognitive abilities.

Similarly, Tantam (1992) suggests that the specific condition of Asperger syndrome arises from an abnormality of 'social gaze response'. Tantam (1992) argues that a reduction in social gaze could underlie a failure in development of theory of mind, because any failure to attend to people's faces means that children do not learn about facial expressions (Hobson, 1986) which are signals of psychologically important information (Ellis, Ellis, Fraser & Deb, 1994). Thus, children with visual impairments might be expected to perform poorly on theory of mind tasks.

2.9 Development of theory of mind in blind children

The development of joint visual attention is impaired in congenital blindness, and there are studies suggesting that blind children show problems of understanding others' minds. Evidence for a delayed or deficient theory of mind in congenitally blind children comes from Minter, Hobson and Bishop (1998) who looked at the performance of blind children on tactile versions of the unexpected transfer and the deceptive box tasks. Children's performance on these tasks was significantly poorer than verbally and chronologically matched controls, although the blind children performed better on the unexpected transfer task than the deceptive box task version.

Support for Trepagnier's gaze disruption hypothesis arguably also comes from Brown et al. (1997) who found autistic-like symptoms in congenitally blind children (including those who had light perception only). This suggests that children who are deprived of joint attention for whatever reason (in this case from not having vision), show a shared constellation of problems.

2.10 Development of theory of mind in deaf children

This failure to develop joint attention could allow for socially based explanations for a deficient theory of mind: Without joint attention, it would be difficult to share comments about the world. For example, deaf children may not be able to receive and make comments about their world until they become proficient in a sign based language, and this might not happen until as late as middle childhood.

Peterson and Siegal (1995, 2000) state that lack of early exposure to mental state terms due to hearing impairment results in a failure to develop a theory of mind. They found that 34 percent of deaf children tested failed a standard test of false belief. This is despite the deaf group having a mean age of 10 years and 7 months and a mean IQ of 103.2. Peterson and Siegal argue that the lack of early exposure to mental state terms in conversation contributed to the failure on the false belief task. Since nearly all deaf children are born to hearing parents (more than 90 percent according to Marschark, Green, Hindmarsh and Walker, 2000; no more than 4-10 percent of the deaf population have a deaf parent according to Mogford, 1993) most children are not exposed to mental state commentary until they learn sign based languages, which is usually at school. Interestingly, only two children in Peterson and Siegal's (1995) study were native signers (born to signing deaf parents), and both these children passed both trials of the false belief task. Support for the superiority of native signers comes from Wolfe, Want and Siegal (2002) who found that they outperformed a group of late signers on theory mind tasks. This provides some support for the early conversational exposure account of the development of theory of mind.

Russell et al. (1998) found evidence supporting Peterson and Siegal (1995). They found that British deaf children, raised in a hearing environment, performed considerably worse on tests of false belief than hearing children from other studies. However, unlike Peterson and Siegal (1995), Russell et al. (1998) divided their sample group in three ages ranges: mean ages of 6, 10 and 15. The ability to pass false belief tasks was age dependent, with the oldest group showing a pass rate of 60 percent compared to that of the middle and youngest groups who showed pass rates of 10 percent and 15 percent respectively. This suggests that exposure to sign based language can bring about improvements in passing tests of false belief, but development is tardy (Russell et al., 1998).

Support for early exposure to conversations including mental state commentary in developing a child's mentalistic understanding comes from various studies (Dunn, Brown, Slomkowski, Tesla & Youngblade, 1991; Lewis, Freeman, Kyriakidou, Maridaki-Kassotaki & Berridge, 1996; Perner, Ruffman and Leekam,1994). These researchers found that theory of mind performance was related to the number of older siblings a child has, suggesting that the larger the family the greater the chance a child has of receiving a richer social experience and thereby passing tests of false belief.

2.11 Different bases of a deficient theory of mind?

The underlying root causes of a failure to develop a theory of mind may be different for different disorders and conditions, but the developmental pathway through which eventually they affect the child may converge and be the same. In the case of deaf children, their pathway to understanding mental states, and presumably passing tests of false belief, may be facilitated through learning a manual language which provides them with exposure to and expression of mental state processes. For blind children, it may be their visual problems which result in a failure to develop joint attention, which then in turn delays their social development.

2.12 Does failure on a false belief task mean that deaf children lack a theory of mind?

Marschark, Green and Walker (2000) strongly argue that deaf children should not be considered to lack a theory of mind merely because they give an incorrect judgement on a test of false belief. Marschark et al. (2000) used a narrative method in which deaf and hearing children were videoed while describing stories. According to their criteria, Marschark et al. (2000) found that 87 percent of deaf children demonstrated a theory of mind by using mental state terms and descriptions compared with 80 percent of hearing children. They argue that false belief is too conservative a test, and requires more than the ability to understand their own and/or others' mental states and how those states relate to behaviour.

Marschark et al. (2000) cite work from Courtin and Melot (1998) who state that deaf children might actually have some advantages in development of theory of mind. They state that sign language might foster visual skill perspective taking. In fact in British Sign Language, 'role shift' is a part of its grammar and an essential part of communicating and recounting events to others. Additionally, despite the fact that deaf children fail tests of false belief, they do not show autistic-like features in other aspects of their behaviour. This suggests that the test of false belief might have questionable external validity.

2.13 Summary

The theory of mind deficit hypothesis of autism is one of the most influential contemporary theories of autism. It moved autism research clearly into the cognitive age and spawned a whole wave of studies. The theory, born from philosophy and zoology, was then operationalised by developmental psychologists. It has now been moved on by developmental psychopathologists, and is a testament to the symbiosis between disciplines.

The study of joint attention as a precursor for the development of mind, suggests that blind and deaf children may also have theory of mind deficits. However, a clearer distinction between having a theory of mind and passing a false belief task may be required since a failure on a test of false belief is not necessarily associated with autistic-like deficits.

Moreover, the successful application of this theory is questionable, with studies showing that teaching autistic children how to pass tests of false belief does not improve their everyday social understanding (Hadwin, Baron-Cohen, Howlin & Hill, 1996, 1997). Furthermore, the theory's explanatory power has waned in recent years as it has tried and failed to account for individuals across the autistic spectrum, such as those with Asperger syndrome who pass many false belief tasks. The strength of the theory lies in explaining the socio-communication aspects of autism, although, this leaves the way open for other contemporary theories, described in the next chapter, to explain the sensory-perceptual, motor, restricted interests and repetitive behaviours of the disorder.

Chapter 3

Theories of autism:

Executive dysfunction, Weak central coherence and Multiple deficit accounts

It was six men of Indostan,
To learning much inclined,
Who went to see the elephant,
(Though all of them were blind),
That each by observation
Might satisfy his mind.

(*from* The Blind Men and the Elephant *by* Godfrey Saxe)

3.1 Executive dysfunction hypothesis of autism

The above stanza is from a poem which tells of six blind men sent to inspect a new animal which had arrived in their kingdom. Each of them described a different part of the animal, for example the trunk, an ear, a leg. They argued amongst themselves, stating that their own opinions were correct and the others were wrong. In one sense each man was right, but because they did not piece together their different experiences of the animal, they were all wrong as well. This allegory could perhaps be applied to autism research.

Some symptoms of autism are not so easily explained by the theory of mind deficit account. For example, the autistic individual's need for sameness, their difficulty switching attention, a tendency to perseverate and lack of impulse control. These symptoms are similar to those shown by individuals with frontal lobe lesions in Dysexecutive syndrome (DES, Baddeley & Wilson, 1988) who have problems with executive function. This has led some researchers (Ozonoff, Pennington and Rogers, 1991a) to suggest that autism could be explained by a deficit in Executive Function (EF).

Historically, the notion of EF comes from analysis of the result of damage to the Prefrontal Cortex (PFC). More recently, EF investigation has been undertaken by researchers of typical and atypical cognitive development (Zelazo & Müller, in press). However, despite EF being traditionally related to the PFC, EF is not the same as PFC function. For example, Shallice and Burgess (1991) found that some individuals with PFC damage did not show impairments in EF, while some people with damage outside the PFC do show impairments (e.g., Anderson, Damasio, Jones & Tranel, 1991; Levisohn, Cronin-Golomb & Schmahmann, 2000). Interestingly the PFC is also thought of by some to be a site of theory of mind abilities (Stone, Baron-Cohen & Knight, 1998; Shallice, 2001; Stuss, Gallup & Alexander, 2001).

3.1a Defining executive function

There is no consensus about the components of executive function, though the term is thought to include: initiating, sustaining, shifting and inhibition/stopping

(Denkla, 1996a). Denkla (1996b) suggests that executive function may be considered as metacognitive, but that it ought to remain close to its clinical neurology roots of motor praxis or 'execution' in, for example, motor sequencing tasks (Denkla, 1996b). In line with this, Green et al. (2002) suggested that the EF hypothesis fits their findings of clumsiness in AS, in that motor problems may stem from an inability to form a plan of the required sequence of movements and hold it in working memory until execution. Ozonoff et al. (1991a) provide a more extensive definition:

"Executive function is defined as the ability to maintain an appropriate problem-solving set for attainment of a future goal; it includes behaviors such as planning, impulse control, inhibition of prepotent but irrelevant responses, set maintenance, organized search, and flexibility of thought and action" (p. 1083).

Zelazo and Müller (in press) argue that definitions of executive functions are often lists and after reviewing such lists Tranel, Anderson and Benton (1994) suggested that EF corresponds to: planning, decision-making, judgement and self perception. By contrast, Gillberg and Coleman (2000) define EF as all those faculties needed to work, in a motivated fashion, towards a goal that may not be reached instantly.

Since executive function is so broadly defined, Zelazo, Carter, Reznick and Frye (1997) have used Luria's (1973) idea that EF is a function, an operation, which captures the diversity of executive processes without listing them or locating them in an homunculus. Zelazo et al. (1997) suggest a problem solving framework of EF, stating that EF is a function and neither a mechanism nor a cognitive structure. They argue that functions are behavioural constructs defined by their outcome, that is what they achieve. Therefore the outcome of the use of executive abilities is problem solving.

Zelazo et al.'s (1997) problem solving framework is useful in that many executive function tasks consist of multiple components, so poor performance on the task could be attributable to break downs at one stage of the many processes. Zelazo et al.'s functional approach can therefore identify at which stage, in a task, performance breaks down and therefore at which stage the person has a problem. This is especially useful in understanding perseveration, which is a defining feature of autism (e.g., asking the same question over and over again. See Section 3.1c for an expansion on perseveration).

3.1b Neuropsychological tests of executive function

There are a number of tests of executive function and The Wisconsin Card Sorting Test (WCST, Grant & Berg, 1948; Heaton, 1981) is a very widely used measure that assesses an aspect of inhibitory control (Baddeley, 1990). In this task, four cards are placed in front of the participant, which vary across three dimensions: colour, geometrical shape and number (e.g., a card may have two blue stars). Participants are asked to match a deck of similar cards to the target cards, but are not informed explicitly of the rules for sorting. Feedback regarding each attempted match is given. The initial unstated sorting rule is by colour and after ten consecutive correct responses the rule is changed, but crucially without informing the participant.

For accurate performance, a recently learned response rule has to be inhibited. Individuals with autism show similarities with those who have frontal lobe damage in that they tend to continue sorting the cards using the previous rule (perseverative errors) even when told their responses are incorrect. Ozonoff et al. (1991a) gave individuals with Asperger syndrome and high-functioning autism several tests of emotion perception, theory of mind and two measures of executive function (The Wisconsin Card Sorting Test and Tower of Hannoi). They found that in much the same way as individuals with frontal lobe damage, these higher-functioning autistic participants made more perseverative errors. Even so, there were no group differences of the number categories and total number of errors. Moreover, the clinically normal comparison group made more errors in maintaining a set (that is completing ten correct consecutive responses). This means that high-functioning autistic individuals have selective deficits in EF.

The experimenters also found that the tests of executive function more accurately detected autism than either the emotion perception or the theory of mind tests, and so argue that tests of executive function are better diagnostic discriminators. However, Gillberg and Coleman (2000) state that research is needed to discover if there are specific executive deficits in autism, and that a profile of executive abilities would be useful because different profiles may be associated with different disorders (Ozonoff, Strayer, McMahon & Filloux, 1994).

3.1c Perseveration

The WCST is used as a general test of EF, but more specifically it may test perseverative behaviour which is a defining feature of autism (American Psychiatric Association, 1994). Indeed a diagnosis of autism in the absence of perserverative behaviour cannot be made (Liss et al., 2001). However, according to Liss et al. (2001), executive dysfunction may not be the cause of the perseverative behaviour in autism since it is unclear if the relationship is causal, or whether perseveration merely reflects how autism was defined in the first place. So there might be some circularity in the argument that autistic individuals perseverate on cognitive tasks because autism is caused by perseveration. In other words evidence that individuals with autism perseverate on cognitive tasks may simply reflect a selection bias for individuals who received an autistic diagnosis.

Care must be taken in defining, using and interchanging terms like perseveration and repetitive behaviours (see Turner, 1999, for a review of repetitive behaviour in autism). On the surface they may seem synonymous but perseveration might occur for a number of reasons. Prima facie it might seem that perseveration is due to lack of inhibition. However, by looking at the various components of a task like the Wisconsin Card Sorting Task, we can see that perserverative responses might occur for very different reasons.

Zelazo et al. (2001) divided The Wisconsin Card Sorting Task into problem solving components. They state that in the task you need to first construct a representation of the problem, which includes identifying the relevant dimensions. Next you must select a plan, for example sorting according to number. After choosing a plan, you need to (a) retain the plan long enough to guide your thought or action, (b) carry out the selected behaviour. Zelazo et al. (2001) refer to keeping a plan in mind as *intending* and translating a plan into action as *rule use*. Finally, after acting you need to assess your behaviour, for both detecting and correcting errors.

Using this framework, inflexibility can occur at any point in this process and so there are several possible explanations for perseverative performance on the WCST. For example, perseveration might occur after a rule change because a new plan was not formed, or because the new rule was formed but not carried out. Although the framework does not explain EF, it does allow us to pinpoint where the process of problem solving actually breaks down. Without breaking down the various components of a task in this way, two people scoring identically on the WCST, might be interpreted as showing identical perseverative behaviour, when in fact this might be for different reasons. Perhaps this is why the WCST may not be an ecologically valid test of executive dysfunction since individuals can perform well on the task and yet show executive problems in everyday life (Shallice & Burgess, 1991).

3.1d Ecological validity in executive function tasks

Besides theoretically breaking down EF tests into various components (e.g., Zelazo et al. 2001), it is possible to statistically categorise tests. In their investigation of the ecological validity of EF tasks, Burgess, Alderman, Evans, Emslie and Wilson's (1998) factor analysis revealed that EF tasks assessed either one of three aspects of EF: Inhibition, Intentionality and Executive Memory.

Inhibition tests are those in which the participant has to inhibit a prepotent response; for example, Stroop test (Stroop, 1935). Intentionality tests involve the embedding of rules, which Frye et al. (1995) argue encompasses theory of mind (see below). These tests require the participant to adhere to multiple or layers of rules and include Modified Six Elements, Zoo Map, Key Search and Action Programme tests from the Behavioural Assessment of the Dysexecutive syndrome (BADS - Wilson, Alderman, Burgess, Emslie & Evans, 1996) and the Tower of London (Shallice, 1982).

Intentionality is the ability to create and maintain goal-directed behaviours. For example in the unexpected transfer task, the participant has to firstly suppress a prepotent but incorrect response, and s/he must retain action-relevant information in working memory while doing so. According to Russell (1996) intentionality is the precursor of self-awareness and development of mental state concepts. In tests of executive memory, participants have to shift attention between stimuli/response sets. In most tests, participants must set shift from a dominant response according to an arbitrary rule; for example, Rule Shift (BADS, Wilson et al., 1996), WCST (Heaton, 1981).

3.1e Universality of executive problems?

In much the same way that the theory of mind hypothesis of autism has been criticised because some individuals pass tests of false belief, yet still remain autistic, the executive dysfunction hypothesis of autism also faces the same criticism because not every autistic individual shows executive deficits. One problem in determining how widespread executive deficits are in autism, is that most studies focus on group differences, without reporting individual variations. One study (Ozonoff et al., 1991a) which does give proportions of groups with executive problems, showed that 96 percent of the autistic group performed more poorly than the control group mean. More reporting like this is necessary to gauge the scale of the problem.

3.1f Uniqueness of executive problems or the 'discriminant validity' problem.

The executive dysfunction hypothesis of autism has contended with the same criticisms as the theory of mind hypothesis of autism, that is, it cannot accurately discriminate between individuals with and without autism (Liss et al., 2001). There are several reasons why it is difficult to differentiate individuals based on their executive abilities. Firstly, tests of executive function usually investigate only one component of executive function and therefore may be not be comprehensive enough.

Secondly, and related to the first point, executive function is very broadly defined (arguably too broadly) and investigators often use tests which are poor at differentiating executive skills and abilities the tests tap into. For example, the frequently used Wisconsin Card Sorting Task examines cognitive flexibility through set shifting, which is only one component of EF.

Thirdly, there are individuals with Attention Deficit Hyperactivity Disorder (ADHD), Schizophrenia, Obsessive Compulsive Disorder (OCD) and Tourette syndrome (TS) who perform much the same as autistic individuals on tests of executive function. Therefore executive deficits in themselves cannot specifically explain autism. However, Ozonoff (1997) concluded that unlike the disorders listed above, autism involves a specific deficit in cognitive flexibility, while inhibition remains intact. Ozonoff and Jensen (1999) found, in a study of children with autism, Tourette syndrome and ADHD, that the autistic children had problems in task flexibility whereas the ADHD children had inhibition problems. However, Nyden, Gillberg, Hjelmquist and Heiman (1999) failed to discriminate between boys with attention deficit disorder, writing disorder and Asperger syndrome in terms of their executive profiles. Additionally there are no studies showing that individuals with frontal lobe injuries develop the identical profile of strengths and deficits seen in autism. Moreover, Yeates (2001) states that individuals with frontal lobe lesions usually do not develop the social problems associated with autism.

Overall, it seems that the executive dysfunction hypothesis can explain many of the features of autism. However, its limitations are that not all autistic individuals show executive problems, and those that do may not share a similar profile of executive problems. Moreover, executive problems are not unique to autism and are seen in other disorders. A further problem for the executive dysfunction account is that executive abilities may not be domain-specific, but may be related to theory of mind. The relation between these two domains is discussed below.

3.2 How might executive function deficits relate to deficits in theory of mind? Evidence for executive components in theory of mind tests

3.2a The Windows Task

Russell, Mauthner, Sharpe and Tidswell (1991) refer to tasks like the unexpected transfer task and the Sally-Anne task as 'ignorance tasks', because one of the dolls is in a state of ignorance about the new location of an item. Russell et al. (1991) also state that an understanding of deception is another criterion for whether children understand the role of false beliefs and mental life. To test the hypothesis that ignorance and deception tasks are tapping into the same basic ability, Russell et al. (1991) devised the 'Windows Task'.

The ability to deceive others and therefore understand when we are being deceived is something we need for survival as social creatures. Imagine what it would be like if we had no defence against other people's deceptive intentions. Individuals with autism are viewed as socially naive, but it is important to ask where that naivety comes from. Perhaps this naivety stems from an inability to understand others' mental states, as put forward by the theory of mind hypothesis of autism. According to Russell et al. (1991) a person has the conception of false belief if they tell someone else the opposite of what they know to be the truth, with the intention of making that person believe it. In order to show this, the actions of the person need to be interpreted as intending deception rather than a learned strategy for guiding another's behaviour. The Windows Task was devised to do exactly this.

In this task a child played a game against an experimenter for chocolate. In the first phase, neither competitor knew the location of chocolate hidden in one of two boxes because both were closed. The child was told to point randomly to one of the two boxes into which the experimenter then had to look. If the chocolate was in the indicated box, the experimenter got to keep the chocolate. If the box was empty, the child got the chocolate which was in the other box. Thus the child had the opportunity to learn that it was in his or her best interest to make the experimenter go to the empty box.

In the second phase, similar boxes were used. This time however the boxes had windows in them, which faced towards the child and away from the experimenter, so that only the child could see the location of the chocolates. Would the child point to the box s/he knew to be empty, despite not having been told or reinforced to do so?

Russell et al. (1991) found that children with autism and typically developing 3 year olds behaved in much the same way, that is they seemed unable to resist pointing to the box that contained the treat, so their opponent won the treat by default. In contrast, typically developing 4 year olds and children with Down syndrome were able to resist the urge to respond impulsively and so were able to point to the empty box and win the chocolate.

Russell et al. (1991) argue that 3 year olds and children with autism fail the unexpected transfer task, not because they fail to take into account Sally's mental state, but rather they act impulsively about the location of the marble. The Windows Task cleverly links executive function with theory of mind based tasks because the participants must i) curb the impulse (executive control) to point directly at what they want and ii) be deceptive because the other player acts on the participant's gesture (if the other player does not find the chocolate, it remains in the other location for the participant to collect). Samuels, Brooks and Frye (1996) failed to replicate Russell et al.'s (1991) results when typically developing 3 year olds showed no evidence of perseverative behaviour. However, Moore, Barresi and Thompson (1998) managed to replicate Russell et al.'s (1991) findings. Unfortunately, neither Samuels et al. or Moore et al. included an autistic sample in their studies. Despite much research, however, it still remains an open question whether theory of mind and EF abilities are linked.

3.3 Context specific executive performance: Boysen's chimp study

Executive performance might also depend on the specific context and a study by Boysen (1993) illustrates this. Boysen (1993) taught a pair of chimpanzees to play a competitive game. One of the chimps was presented with two plates of food. One plate had a large quantity of food and while the other had a smaller amount of food. Since both chimps were hungry they wanted the plate with the largest amount of food. However, the plate which one chimp received depended on where the chimp playing the role of communicator pointed to. Whichever plate the chimp pointed to was offered to the chimp playing the role of receiver.

The chimps continued to frustrate themselves, when in the role of communicator, by persisting in pointing to the plate with the larger amount of food, which meant the largest amount of food would go to their opponent. It seems that the saliency of the food affected the executive control of the chimps and they could not control their impulses to gesture to the full plate.

Previously, the chimps who took part in the study had been taught to recognise numbers in connection with their corresponding quantities. So for example if they were shown three objects then they would respond by selecting the card with the number three on it. Hence, it seems that these chimps had acquired a simple concept of number.

Boysen then substituted the quantities of food on the plates for numbers. Since the gesturing chimps were no longer constrained by the attentional pull of the food, they successfully pointed to the plate which had the card with the smallest number. Thus they were given the plate with the larger amount of food, and their opponent was given the plate with the smallest amount of food.

Boysen's study suggests that inhibiting a response is related to saliency, and that prepotent responding may be stopped if a less salient 'higher-order' representation of what is desired is used instead. A similar study has not been conducted with individuals with autism, although Russell et al.'s (1991) Windows Task could be replicated, with a slight modification. Numbers could be used to represent quantities of chocolate and we might find that individuals with autism would succeed in much the same way as Boysen's chimps. This remains to be tested empirically.

The success or failure of autistic participants on this task would say something important about the executive dysfunction hypothesis of autism. If individuals with autism succeeded on this task, then it would suggest that even tasks which tap into aspects of executive function are context specific, and it may not be executive ability per se that is dysfunctional in autism. Rather the problem may lie on the more basic level of how potent the desire to respond is. This is perhaps related to Thelen's dynamic systems approach. Thelen and Smith (1994) argue that different behaviours have different levels of attractional pull. It may be that individuals with autism are predisposed to have deeper 'attractor wells' (see Thelen & Smith, 1994), so that saliency is more likely to draw them into perseverative behaviour than for typically developing individuals.

3.4 Is theory of mind required for executive control?

Perner (1997) uses Ozonoff et al.'s (1991a) term Executive Function as a generic term for both Baddeley's (1990) Central Executive and Norman and Shallice's (1986) Supervisory Attentional System. Perner (1997) argues that actions are based on intention and therefore some higher order desire/want/need antecedes the planning and organisation required for that goal to be attained. Consequently, Perner (1997) states that a theory of mind is a prerequisite to executive function and a necessary ingredient for executive control (Perner & Lang, 2000). Therefore Perner predicts there would be no evidence of individuals showing executive control but failing theory of mind tests, whereas there can be cases of theory of mind competence but in the absence of executive control (Perner & Lang, 2000).

3.5 The neuropsychology of the relationship between theory of mind and executive function

Recent neuropsychological evidence suggests that theory of mind and executive function may not be related. Fine, Lumsden and Blair (2001) describe a patient, B.M. who had early or congenital damage to his left amygdala. B.M. showed an inability to represent mental states when tested with a battery of theory of mind tests, including first and second-order tests and Happé's (1994) Strange Stories (see Section 4.2, p.74).

Despite this B.M. showed no indication of executive deficits given that he passed several tests assessing a broad range of executive abilities (including the WCST and BADS). Furthermore there might be a double dissociation between executive function and theory of mind because Blair and Cipolotti (2000) report the case of J.S. who failed tests of EF, but performed well on an advanced test of theory of mind (the Strange Stories). Fine et al. (2001) conclude that dissociating between B.M.'s executive function and theory of mind ability shows that the systems are independent of each other which lends support to the position that theory of mind abilities are domain-specific with a dedicated neural system (Baron-Cohen, 1995).

These case studies, therefore, provide evidence against Perner and Lang's (2000) argument that there should be no instance of individuals showing executive control but failing theory of mind tests. Thus it may be that theory of mind is not required to make executive decisions.

3.6 The third way? Cognitive Complexity and Control Theory

An alternative to the theory of mind and executive function theories is the Cognitive Complexity and Control theory (CCC, Frye, Zelazo & Palfai, 1995; Zelazo & Frye, 1997). CCC is a hybrid theory which states that theory of mind is related to executive function in both typical and atypical individuals because both ToM and measures of executive ability involve rule use. For example a correct answer in the Sally-Anne task requires the use of higher order rules in order to make a correct judgement about where Sally will look:

one might say, "I know that the marble is in the box, but if I am asked about Sally, then if the question is where will she look for the marble, then the answer is basket".

CCC theory offers an alternative to the 'either-or' argument, that is whether executive abilities are required for theory of mind tasks or vice versa. Additionally Zelazo, Burack, Boseovski, Jacques and Frye (2001) argue three points for why the CCC framework is useful for understanding developmental disorders. Firstly, they argue that any kind of developmental disorder may impact on consciousness, rule complexity and behavioural control. Zelazo et al. (2001) state that theories of autism have largely ignored that about 75 percent of individuals with autism have IQs below 70 (and so are intellectually impaired, DSM-IV, 1994). They argue that although intellectual impairment is not specific to autism, its prevalence in autism still requires explanation. It may be that intellectual impairment is not intrinsic to autism, but might interact with other aspects of autism, and therefore the vast majority of individuals with autism who are learning disabled cannot be ignored (Zelazo et al., 2001).

Secondly CCC theory also allows us to work out what makes different disorders unique. For example, using the problem solving framework for executive function, EF tasks can be broken down into their constituent components enabling success or failure to be explained more specifically. Therefore, rather than saying that autism is a disorder of executive function, one may be able to specify the deficits of executive function that are associated with autism (if any).

Thirdly, CCC allows performance on different tasks to be equated. Zelazo, Burack, Benedetto and Frye (1996) found that children with Down syndrome failed theory of mind tasks and performed poorly on a task they created called the dimensional change card sort (DCCS). In the DCCS task children are asked to sort target cards into a tray according to one dimension (e.g., for colour, they are told to "Put the blue ones here and put the red ones there"). After sorting several cards the rules are changed and children are asked to switch to sorting by shape ("Put the flowers in there and put the boats in there"). Irrespective of what dimension is presented first, typically developing 3 year olds and children with Down syndrome (mean MA 5.1 years) continued to sort by the previous dimension, despite being told the new rules on every trial and having sorted cards by the new dimensions at another time. Zelazo et al. (2001) argue that the failure of children with Down syndrome on theory of mind tasks called into question the claim that theory of mind deficits are unique to autism. Furthermore, Zelazo et al. (2001) argue that because performance on theory of mind tasks and DCCS was correlated, theory of mind tasks are not domain-independent and are therefore not specific.

3.7 Central Coherence Theory

Some individuals with autism notice small details which individuals without autism do not, like coins or small pieces of thread strewn over a carpet. These items may not be noticed by most people because they are inconspicuous, but some autistic individuals spot them seemingly without having to scan the floor. It is as if the item just 'pops out' to them. Autism is nearly always thought of as an impairment, but in this instance autistic individuals may be superior to those without autism.

The theoretical starting point for research in this area was Frith's (1989) weak central coherence hypothesis. Frith stated that typically developing individuals have a drive to process things in context, to see things as part of a whole (perhaps small items on a carpet are not noticed because we attend to the whole scene). Frith suggested that in autism there is weak or absent drive for global coherence, that individuals with autism process things in a piecemeal way: processing the individual or constituent parts, rather than the global whole. The initial work on central coherence looked at perceptual processes.

3.7a Visuospatial constructional coherence

Shah and Frith (1983) found that children with autism scored above average on the Children's Embedded Figures Test (CEFT, Witkin, Oltman, Raskin, & Karp, 1971), for their own mental age, and were better than chronologically and mental age matched typically developing children. Jolliffe and Baron-Cohen (1997) found that high-functioning autistic individuals and individuals with Asperger syndrome also excelled at this test. In the CEFT participants were asked to locate a small target shape in a drawing of a larger everyday shape made up of confusing lines (e.g., finding a triangle shape in a picture of a pram). When looking at the figures it seems as if the larger shapes created by the criss-crossing lines are so compelling that the small embedded shape is simply not seen.

Shah and Frith (1993) also found that participants with autism were faster at reproducing 40 different block designs than learning disabled and normal controls. The Block Design is a subtest of the Wechsler Intelligence Scales (e.g, WASI, Wechsler,1999) in which the participant is asked to assemble an identical image of a 2-D picture, as fast as possible, using painted cubic (3-D) blocks of red and white.

The key features of both the Block Design Test and the Embedded Figures Test is that a figure can be segmented or include smaller constituent components. Due to the drive for central coherence, the saliency of these smaller components is not as great as the figure. Frith (1989) argues that individuals with autism show better performance on these tasks because they have a cognitive drive to attend to local rather than global details, that is they have weak central coherence.

Another source of evidence for this theory comes from idiosyncratic peaks in visuospatial and perceptual functioning. For example Happé (1996) found that participants with autism were less likely to succumb to two-dimensional visual illusions than other groups. Happé (1996) argued that geometrical (e.g., Ponzo, Titchner) visual illusions 'work' because people typically see the entire picture as a global whole and that individuals with autism are better at processing local rather than global information and therefore they are less likely to 'fall' for those types of illusions.

However, there is a growing body of evidence which does not support the weak central coherence hypothesis. Brian and Bryson (1996) found that there was no significant difference in response times or accuracy between high-functioning individuals with autism and developmentally matched controls in reaction times to meaningful (e.g., birthday cake), abstract and fragmented disembedded stimuli. They also found that both the autistic and normal groups had more difficulty (as shown by slower reaction times) in finding a simple shape in a meaningful rather than non-meaningful drawing. Brian and Bryson (1996) argue that Shah and Frith's (1983, 1993) findings may have been due to developmental differences rather than differences in cognitive styles between the normal and autistic populations.

Furthermore, Ropar and Mitchell (1999, 2001) discovered, in contrast to Happé (1996), that participants with autism were just as susceptible to two-dimensional visual illusions as controls. Ropar and Mitchell (1999) presented a variety of visual illusions to individuals with autism on a computer screen, and rather than asking them if the illusion were same size or different they asked participants to use computer keys to adjust stimuli to match target shapes. The experimenters concluded that individuals with autism were susceptible to visual illusions because when adjusting lines or circles, the participants systematically underestimated the stimuli's size in comparison to the control condition. Milne et al. (2002) argue that findings like those of Ropar and Mitchell (1999, 2001) suggest that global processing seems to be under attentional control in autism. Therefore care needs to be taken before concluding that autistic individuals have a low-level perceptual deficit (Milne et al., 2002), as in Happé's account.

3.7b Reduced generalization

As an alternative to weak central coherence, Plaisted (2001) argues that perceptual processes in autism are better explained in terms of reduced generalization. Plaisted states that superior autistic performance, on the Block Design and Embedded Figures Task, can be explained in terms of reduced processing of the similarities that are held between stimuli and situations. In the Embedded Figures Task, the target contains some elements in common with the overall pictures and unique features that define it. This is analogous to the piece of thread in the carpet. The thread is difficult to discriminate from the carpet, for the non autistic, because it shares features in common with a carpet, for example colour and texture. However, if the unique features of the stimuli are processed better than the shared features, then the thread will be easier to 'see'.

The hypothesis that autistic individuals process the unique features of stimuli relatively well and common features poorly, give rises to two complementary predictions. Firstly, they should be better at difficult discrimination tasks in which the stimuli to be discriminated hold many elements in common and very few unique elements. Secondly, they should be poorer at a task which requires categorization of two sets of stimuli because they are better at processing the difference between categories rather than shared category features.

Support for the first prediction comes from a perceptual learning task (Plaisted, O'Riordan, & Baron-Cohen, 1998). In this experiment, a normal adult group showed the perceptual learning effect of solving the discrimination of two preexposed stimuli better than discrimination between the two novel, non-preexposed stimuli. The autistic adult group, however, performed significantly better on the novel discrimination problem compared with the normal adults.

In support of the second prediction, Plaisted, O'Riordan, Aitken and Killcross (submitted) found that autistic individuals showed a deficit in initial category learning and a reduced effect of categorizing according to the prototypes, even though they had never seen them before.

<u>3.7c</u> <u>Verbal semantic coherence</u>

Another virtue of central coherence theory is that it may not only explain lower level perceptual processes, but also higher level abilities like language use. For example, Frith and Snowling (1983) used homographs (words with one spelling, but two pronunciations and two meanings, e.g., the metal lead and a dog's lead) to see if children with autism would use the preceding sentence to work out the meaning and use the correct pronunciation. Frith and Snowling (1983), Snowling and Frith (1986), Happé (1997) and Jolliffe and Baron-Cohen (1999b) found that individuals with autism failed to use the preceding sentence to determine pronunciation. This suggests that they might be reading prose as a series of unconnected lists and therefore fail to make associations and 'read between-the-lines'. These skills are needed for understanding communicational intention beyond the surface structure of language.

3.8 Multiple deficit accounts

Baron-Cohen and Swettenham (1997) argue for the creation of subgroups in autism, proposing that autism is in fact a complex of cognitive disorders: impaired theory of mind, weak central coherence and executive dysfunction. They argue that any autistic individual can be affected differently in these three, possibly independent, domains. Such a multiple deficit theory does not, therefore, assume a direct hierarchical association between these cognitive characteristics. Moreover, multiple deficit accounts are intrinsically alluring given the heterogeneity of brain damage associated with the disorder (Bishop, 1993), and so perhaps no single explanation at the psychological level is possible. Additionally, these theories have implications for treatment, in that what may be effective in people affected in one domain, may be ineffective for people who have a deficit in another domain (Teunisse et al., 2001).

Given the 'à la carte' menu style diagnostic system which results in the within-category heterogeneity of autism (Charman & Swettenham, 2001) multiple deficit accounts may be the most comprehensive way to think of the disorder. By moving to this position, however, Baron-Cohen has effectively conceded defeat in defending the modular, domain-specific theory of mind account of autism.

Apart from theoretical arguments, there are also inherent clinical reasons for not sub-classifying autism. The inclusion of Asperger syndrome as a diagnostic category has arguably confused matters. Any further sub-classification increases the risk of having categories such as low-functioning Asperger, medium-functioning Asperger, high-functioning Asperger and so on. This would make a nonsense of a disorder in which people lie some way along its spectrum. One way to get around this, at least experimentally, is to devise methodologies and use statistical techniques which allow the heterogeneity of autistic individuals to be taken into account in group studies. Another approach would be to focus on single case studies as in savant research or cognitive neuropsychology.

3.9 Summary

The theory of mind and the executive dysfunction accounts of autism are not the only theories which try to explain the disorder. Nor are the two theories necessarily competing against each other; Perner (1997), Russell (1996) and Frye et al. (1995) all suggest that theory of mind and executive function are linked. The strength of weak central coherence and reduced generalization theories is that they offer insights into the perceptual as well as the socio-linguistic aspects of autism. Additionally, they highlight that people with autism may be better at some skills than those without the disorder. These strengths may result in these two theories driving investigation into autism over the next decade. Multiple deficit accounts suggest that autistic individuals can have a mixture of the above three cognitive problems/styles which may reflect the reality of autism. Perhaps this is why programmes for teaching mental state understanding do not result in autistic individuals empathising with others in everyday life.

Each theory of autism, considered above, seems to be able to explain certain aspects of the disorder, but as yet there is no fully integrated account which manages to both describe and explain all the different characteristics of the disorder. An ideal theory would trace it from infancy through to adulthood and apply to both autistic individuals with severe learning disabilities and those who are higher-functioning.

The next chapter describes experiments which have tried to address some of the criticisms of the theory of mind hypothesis of autism, and suggests that information technology may be ideally suited as a tool for investigation.

Chapter 4

Advanced theory of mind and nonliteral language comprehension in autism

And so these men of Indostan
Disputed loud and long,
Each in his own opinion
Exceeding stiff and strong.
Though each was partly right,
All were in the wrong.

(*from* The Blind Men and the Elephant *by* Godfrey Saxe)

4.1 Advanced tests of theory of mind: the Strange Stories, The Eyes Task, The Faux Pas Detection Test, The Awkward Moments Test and Stories from Everyday Life

Ozonoff, Pennington and Rogers (1991a) interpreted the passing of first and second-order belief attribution tasks as evidence that theory of mind deficits are not universal in autism. Happé (1994) stated that because approximately 20 percent of autistic individuals who are given a first-order theory of mind task actually pass, this has been viewed by some researchers as seriously damaging to the theory of mind hypothesis of autism. This has prompted some researchers to seek further evidence of the universality of theory of mind deficits in autism, by developing tests specially designed to be sensitive to the mentalising ability of higher-functioning autistic individuals.

4.2 Strange Stories

The first of these tests was developed by Happé (1994) who created 24 stories to provide a more naturalistic challenge to individuals with autism than traditional theory of mind tests. She designed the stories to be simple accounts of everyday events about different motivations which lie behind utterances that are not literally true. The example that Happé gives is lying to someone when they ask you about their new dress. It may look awful, but you might say it looks good either to spare their feelings or to mislead them into wearing it.

Happé presented autistic participants with 24 short vignettes, about everyday situations, in which people say things they do not mean literally. The stories were each accompanied by a picture and usually two test questions: a comprehension question " Was it true, what X said?," and a justification question, " Why did X say that?" A test like this may be thought of as a 'paper and pencil' test because it is given in the form of a written passage followed by test questions.

Happé (1994) asked for mental state justifications given in response to the why question (e.g., " because Emma is pretending the banana is a telephone") and these where rated as either correct or incorrect. She found that varying degrees of success on the Strange Stories could discriminate between autistic failers of theory of mind tasks, autistic passes of 1st order theory of mind tasks and those autistic participants who passed 2nd order theory of mind tasks. However, even autistic passers of 2nd order theory of mind tests gave incorrect mental state justifications for some of the stories, unlike the normal adult group who made no such errors. The mean verbal IQ of the autistic group who passed 2nd order theory of mind was 95.8 (range 90-101) which is presumably much lower than the normal controls who were university students. Therefore, conclusions based on groups comparison are rather limited (Roeyers, Buysse, Ponnet & Pichal, 2001). However, Jolliffe and Baron-Cohen (1999a) conducted a replication of Happé's (1994) study with two adult autistic groups: one comprised individuals with Asperger syndrome, the other high-functioning autistic individuals. Jolliffe and Baron-Cohen (1999a) found that both clinical groups failed to use context-appropriate mental state terms to explain the strange stories, and in this respect, they differed from closely matched normal adult comparison participants. Thus, verbal ability does not appear to explain difficulties in comprehending the Strange Stories.

In its current paper and pencil form, however, the Strange Stories test could be criticised because participants' comprehension is based on their reflective rather than working understanding of nonliteral language.

<u>4.2a</u> <u>Figurative language in autism</u>

Happé (1993, 1995) suggests that investigating figurative language comprehension, in autism, can be used as a test for Sperber and Wilson's

(1986) relevance theory. According to relevance theory, people communicate the intended meaning, that is the speaker will attempt to make utterances relevant to the listener. Sperber and Wilson (1986) essentially suggested that Grice's (1975) four maxims of quantity, quality, manner and relation (be relevant) could be reduced to just one principle of relevance (Leinonen & Kerbel, 1999).

Happé makes testable predictions about what levels of theory of mind are required to understand different types of figurative language. That is, understanding similes can be understood without being able to pass a first order theory of mind task, because similes can be understood on a purely literal level (Happé, 1993). For example *He was like a tiger* is no different from saying he was like his brother.

However, to understand metaphors like *He really was a tiger* requires a first-order theory of mind understanding because decoding the words literally will not provide the intended meaning. Happé argues that in order to understand a metaphor one has to understand the speaker's intention (or mental state) in a similar way to understanding Sally's current representation of reality (that the marble is in the basket). By simply changing the 'is' to a 'really was' resulted in autistic individuals, without first order mentalising ability, failing to comprehend the sentence (Happé, 1993).

According to Sperber and Wilson (1981) understanding irony[4] is more difficult still and Happé (1993) states that understanding irony requires second-order belief attribution. This is because, according to Sperber and Wilson, an ironic utterance (*Well that's very intelligent isn't it!*) refers to a thought about which we are expressing an attitude of mockery. So in theory of mind terms, an ironic statement is analogous to a thought about a thought - second order belief attribution.

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[4]A point about terminology is perhaps needed to clarify sarcasm and irony. The Oxford English Dictionary says that ironic utterances are thought to include "the use of words to express something other than and especially opposite of the literal meaning of a sentence," whereas sarcasm depends for its effect on " bitter, caustic, and other ironic language that is usually directed against an individual." According to Davidson (1996) sarcasm is intended to be hurtful or scornful. A common way of being sarcastic is through the use of irony, which involves this use of words to convey the opposite of literal meaning of the words. *That was a pretty stupid thing to do!* is sarcastic; *that was intelligent of you*! is both ironic and sarcastic. However, something that is ironic need not be sarcastic such as saying, " They tell me you're a slow runner" to someone who has just won the 100 metres sprint. Kreuz and Glucksberg (1989) use the term sarcastic irony and define it as "the use of counterfactual statements to express disapproval, usually with intent to hurt or wound" (p. 374).

Happé's (1993) study yielded results supporting her prediction of the relation between degree of theory of mind and understanding simile, metaphor and irony.

4.2b Is there a relation between theory of mind and language usage: "Are children with autism deaf to Gricean Maxims?"

Surian, Baron-Cohen and Van der Lely (1996) asked children with autism, Specific language impairment (SLI) and normal controls to identify utterances that violated Grice's (1975) conversational maxims of Quantity, Quality, Relation and Manner.

Maxims of Quantity:

1. Make your contribution as informative as is required.
2. Do not make your contribution more informative than is required.

Maxims of Quality:

1. Do not say what you believe to be false.
2. Do not say that for which you lack adequate evidence.

Maxims of Relation:

Be relevant.

Maxims of Manner:

1. Avoid obscurity of expression.
2. Avoid ambiguity.
3. Be brief (avoid unnecessary prolixity).
4. Be orderly.

Surian et al. (1996) argue that a theory of mind is required to utilise the maxims as both an effective communicator and interpreter. This is because specifically they predicated a close relation between autistic children's performance on the Sally-Anne task and their identification of utterances that did not conform to Gricean maxims. The experimenters argued that this relation would be independent of language delay, or language ability and to test this prediction they included SLI and typically developing comparison groups.

The participants were presented with three dolls, and told that one of them would say something funny or silly. The children were first familiarised with the names of the dolls and their voices, before hearing 25 short pre-recorded conversational exchanges in which a speaker/'doll' violated a conversational maxim. The participants were then simply asked to'point to the doll that said something silly'.

For example:

Violations of the First Maxim of Quality consisted of utterances that were obviously false:

Question (Doll Lucy):	'Where do you live?'
Answer (Doll Tom):	'I live in London.'
Answer (Doll Jane):	'I live on the moon.'

In the control task, the questions and the correct answers were the same as in the Pragmatics task, but the utterances violating a maxim were replaced by a word string in reverse order.

Question (Doll Lucy):	'Where do you live?'
Answer (Doll Tom):	'I live in London.'
Answer (Doll Jane):	'London in live I.'

Surian et al. (1996) found that all the normal controls, all the SLI children and three (out of eight) of the autistic children passed the Pragmatics task, by performing significantly above chance (i.e., scoring at least 17/25 correct, Binominal test, $p = 0.05$). The three autistic children who passed the pragmatics test also passed the Sally-Anne task, but the others failed both tasks. Thus, the association between passing the two tests was significant. The researchers also found that the autistic children did not differ from chance on any of the violation types suggesting that they had problems with all the Maxims. Surian et al. (1996) concluded that the inability to detect pragmatic violations in autistic children stems from their theory of mind deficit.

However, the fact that some autistic individuals can attribute mental states, yet have problems in everyday communication, suggests that more than just mental state understanding is required for conversational competence (Surian et al., 1996). This suggests that social ability and language ability should perhaps be investigated together, to ascertain if poor language comprehension and problems of socialisation are associated.

Additionally, Surian et al. (1996) argue that their results support modularity theory: stating that children with autism have problems with pragmatics because of mindreading difficulties, whereas children with SLI have a domain-specific impairment in their grammar module.

4.3 The Eyes Task

Baron-Cohen, Jolliffe, Mortimore and Robertson (1997) developed an "Advanced test of Theory of Mind" which they called "Reading the Mind in the Eyes" task, or the Eyes Task for short. They argued that first and second-order theory of mind tasks produce ceiling effects when the child has a mental age of between 6 and 7 and therefore such tasks were inappropriate for testing theory of mind in adults with Asperger syndrome.

This time the experimenters moved away from tasks involving belief attribution. Instead, Baron-Cohen et al. (1997) showed participants photographs of the eye region of people's faces (from midway along the nose to just above the eyebrow). Before the main study, Baron-Cohen et al. (1997) asked normal adult judges to generate words to describe the mental states of the people in the photographs just from their eyes. The experimenters found that blind raters unanimously agreed with one another about the words selected by the judges. Baron-Cohen et al. (1997) then asked an adult group with high-functioning autism and/or Asperger syndrome, an adult group with Tourette syndrome and a normal adult group if they could infer the mental states of the people from their eye region photographs.

Baron-Cohen et al. (1997) found that the autistic group were significantly impaired on the Eyes Task when compared with the comparison groups. Note that the adults with autism did not fail the task, but performed significantly less well in comparison to the control groups (i.e., gave fewer accurate responses). In the control Emotion Task, all the participants had to judge photographs of whole faces displaying basic emotions (happy, sad, angry, afraid, disgusted, and surprised). The autism group performed at ceiling and so the experimenters ruled out any deficits in basic emotional expression understanding as an explanation for deficits on the Eyes Task.

Baron-Cohen et al. (1997) argue that the Eyes task provides a 'pure' test of theory of mind (requiring no executive function or central coherence components (see Chapter 3)). Baron-Cohen, Wheelwright, Hill, Raste and Plumb (2001) updated the original Eyes task by increasing the test items from 25 to 36 (in addition to other changes), and also increased the number of response options from 2 to 4, in order to reduce ceiling effects and increase its discriminatory power. Baron-Cohen at al. (2001) replicated their previous finding that adults with AS or HFA were significantly impaired on the test. Furthermore, Baron-Cohen et al. (2002) stated they have developed a version for children, though do not include a reference for it.

Additionally, Rutherford, Baron-Cohen and Wheelwright (2002) have recently extended mind reading tests into the auditory domain, by asking autistic participants to extract mental state information from vocalizations. In the

Reading the Mind in the Voice test, participants heard a two second sample of audio dialogue and have to choose between two adjectives to best describe the mental state of the speaker. Rutherford et al. (2002) found that the participants with AS/HFA gave fewer correct answers than two adult control groups, suggesting that they have difficulties drawing theory of mind inferences from speech. Thus these results appear consistent with Baron-Cohen and colleagues' previous 'Reading the mind in eyes' findings.

4.4 The Faux Pas Detection Test

As well as the 'Reading the Mind in' tasks, Baron-Cohen and his colleagues have also developed a socio-linguistic task with a similar protocol to Happé's (1994) Strange Stories. Baron-Cohen, O'Riordan, Stone, Jones and Plaisted (1999) created a theory of mind task aimed at typically developing 7-11 years olds. They argued that first and second-order theory of mind tests were designed for participants with mental ages of 4-6 years old, and that these tests risk producing ceiling effects if used with children with a mental age higher than six. Baron-Cohen et al. (1999) argue that passing first and second- order tests of theory of mind should be seen as an early point in acquiring a theory of mind and not an end point. More specifically in autism, they argue that theory of mind deficits are "masked" in higher-functioning autistic individuals by only using first and second-order theory of mind tests.

However, Baron-Cohen et al. (1999) do not state what "masked" means. It seems to suggests that advanced tests of theory of mind require more of an 'amount' of theory of mind to be passed, as if theory of mind is a measurable quantity. It is as if theory of mind has moved away from being either absent or present to being a quantifiable resource.

Nevertheless, Baron-Cohen et al. (1999) devised a task aimed to test subtle differences in theory of mind understanding which they stated develops beyond 6 years of age. Their starting point was to provide a working definition of a faux pas as being when a speaker says something that the listener might not want to know, and which usually has negative consequences. Baron-Cohen et al. (1999) created 10 faux pas stories based on that definition, for example:

Sally has short blonde hair. She was at her Aunt Carol's house. The doorbell rang. It was Mary, a neighbour. Mary said " Hello," then looked at Sally and said "Oh, I don't think I've met this little boy. What's your name?" Aunt Carol said, "Who'd like a cup of tea?"

After listening to this narrative from audio tape, the child was asked four questions:

Faux pas detection question:	In the story did someone say something they should not have said?
Identification question:	What did they say that they should not have said?
Comprehension question:	Whose house was Sally at?

False belief question: Did Mary know that Sally was a little girl?

Children had to correctly answer all four questions to be credited with an understanding of faux pas. The experimenters found that children with AS/HFA, who despite being able to pass first and second-order theory of mind tests, answered significantly fewer number of faux pas questions correctly than the comparison groups of typically developing children. They concluded that despite passing the false belief tasks, the AS/HFA individuals had a deficient theory of mind.

4.5 The Awkward Moments Test

Devised by Heavey, Phillips, Baron-Cohen and Rutter (2000), the Awkward Moments Test uses video scenes (mostly from UK television advertisements) in which characters experience socially uncomfortable or 'awkward moments'. An example was a film set in a high-rise apartment:

A man knocks on the door of his new neighbour. The door is opened by an attractive woman. He asks to borrow some tea. She invites him inside and introduces her pet dog. After she has left the room, the man throws a ball for the dog to fetch, but accidentally throws the ball out of the window. The dog jumps out of the window to chase the ball. The film ends by showing that the dog is unhurt.

After viewing the clips, adult participants answered a mental state question which tapped into their understanding of the social nuances of the scenes, and control questions which did not have a theory of mind or social aspect. Heavey et al. (2000) found that the AS/HFA group gave fewer correct answers than typically developing male adults. The authors concluded that although the test could reveal groups differences, it may not be a 'pure' test of theory of mind because it made both executive and central coherence demands. As with the Strange Stories, the Awkward Moments Test is based on participants making reflective judgements about a third party.

4.6 Stories from Everyday Life

Kaland et al. (2002) developed a vignette-based advanced theory of mind test similar to Happé's Strange Stories: participants read a passage and were asked a series of questions which were then rated. Unlike the Strange Stories, however, these vignettes were longer and required both social and linguistic comprehension, with themes such as Jealousy, Empathy, Social Blunders, Contrary (mixed) emotions and so on. The test questions tapped into understanding the physical and mentalistic aspects of the story. For example in the 'Castles in the air' story the participant read the following vignette:

> "The architect Ken Peterson is known as a person rich in ideas. He works with Solnes, a master builder who has his new office in town. He goes to Solnes almost daily with new ideas about how to build bigger and better buildings.
>
> The idea-rich architect uses steel and glass as construction materials,

because they are the materials that can give the most protection against storms and bad weather. With these materials it is possible to build fine, big buildings. Wooden material and roof tiles are well suited for the construction of normal single-floored dwellings, he says.

Many of the people who hear Peterson's many building plans regard them as quite unrealistic. Solnes, the master builder, is also normally sceptical of the architect's ideas. One day Peterson arrives and says that he has begun drawing plans for the town's new city hall. He will build it high, he says, 35 floors - because this will save on land area. Solnes, the master builder, thinks that this and a number of Peterson's other recent ideas are totally unrealistic. Solnes says: 'Peterson, now I think you are building castles in the air."

After reading the passage, the participant was asked several questions. Some questions tried to tap into their comprehension of the physical aspects of the story, for example:

"How many floors does Peterson intend the new Town Hall to have?"

While other questions aimed to gain insight into their understanding of the mentalistic aspects of the story, for example:

"Does Solnes really mean that Peterson is planning to build a castle made only of air?"

Kaland et al. (2002) state that their major finding was that participants with AS had significantly less success in inferring mental as compared with physical states on the Stories from Everyday Life. In addition to the correctness or otherwise of participants' judgements, Kaland et al. (2002) used the time taken to answer the questions as an index of processing ability. They found that the AS group took longer than the normal comparison group answering the physical inference questions, and that this time difference was even more pronounced for the mental inference questions. Furthermore, the AS group also took longer answering the mental than physical questions. Kaland et al. (2002) interpreted their findings as evidence of Hermelin and O'Conner's (1985) 'logico-affective' states because the AS individuals may be using cognitive rather than affective processes to work out the correct mentalistic answers, and hence take longer.

Kaland et al. (2002) argue that this view of social impairment fits Bruner and Feldman's (1993) description of interactions with people with autism as like waiting for someone to make a next move, or solving a maths problem. This temporal processing view is congruent with Kaland et al.'s (2002) findings that the AS group answered fewer mental state questions correctly than the comparison group, and supports Happé's (1994) and Jolliffe and Baron-Cohen's (1999a) Strange Story findings. Additionally, Kaland et al. (2002) stated that they found 'relatively high relations' (p. 524) between their participants' scores for the Stories from Everyday life and their scores on the Strange Stories test, though no statistical values are given.

4.7 Social attribution tasks (SATs)

Klin (2000) states that there is too much discrepancy between theory of mind task performance and everyday social functioning in autism. He argues that theory of mind tasks are too easily facilitated by verbal ability, too explicit (as opposed to subtle and implicit) and insensitive because they tend to be 'all-or-nothing' dichotomous tests, like the false belief task. Klin (2000) argues that, in contrast, real life social ability is on more of a continuum, and that people have degrees of competence. Hence, the pass/fail nature of the false belief task is insensitive to the subtleties of social ability. Therefore, he developed a task designed to test the capacity for making social attributions.

Klin's Social Attribution Task (SAT) was based on a famous study by Heider and Simmel (1944) in which college students were shown geometric objects interacting with each other. The researchers found that participants interpreted the object movements in a predictable way, describing the geometric interactions consistently, using descriptions like 'friendly' and 'aggressive'. Klin (2000) states that social attribution of geometric shapes draws on a cognitive process because mental state terms are used to describe the shapes as social agents.

Klin (2000) showed a group of higher-functioning adolescents and adults with autism, a group with Asperger syndrome and "normal controls" (his quotation marks) Heider and Simmel's original (1944) silent animation. Klin asked participants to describe the animation and analysed the generated narratives.

The HFA and AS participants tended to describe the animation in mainly geometric terms, whereas the normal control group searched for social meaning in the visual stimuli. Klin's (2000) results suggest that typically developing people look for social meaning whenever they can, even in objects, provided there is some relation between them. Klin (2000) suggests that fundamental to being human is looking for social meaning, perhaps as a default, and maybe this is why children (Carey, 1985) and adults (Kahneman & Tversky,1973) anthropomorphise their reasoning about the world.

However, Bowler and Thommen (2000) found that children with Asperger syndrome/autism were able to distinguish intentional action from mechanical motion at the same level as CA and VMA comparison groups, when shown Heider and Simmel's animation. Nevertheless, these autistic children were less likely to comment on the interaction between the 'characters' when they did not physically touch. This requirement of physical contact does hint at a subtle difference in generating social cognitive explanations in the autistic children and normal controls.

Abell, Happé and Frith (2000) extended this social attribution paradigm, but with their own specially developed animated sequences, generated and displayed on computer. In this study, children with autism, moderate learning disability (MLD), of typical development, and normal adults were shown random movement, goal-directed interactions and 'theory of mind' interactions of triangles. The researchers found that although the autism group used mental state terms to describe the 'theory of mind' interactions, these were inappropriate and so echoed the Strange Stories (Happé, 1994) results in which autistic passers of second-order belief attribution used mental states terms as frequently as control participants, but used them inappropriately.

The results from these studies suggest that individuals with autism may not have the same propensity to impose social meaning as the rest of society. However, these studies may be criticised because they tell us very little beyond what is already known about belief attribution in autism.

4.8 Theoretical problems with advanced theory of mind tests

Baron-Cohen et al. (1999) argue that theory of mind develops beyond 4-6 years. The problem with Baron-Cohen et al.'s (1999) argument, however, is that the unexpected transfer task was devised as a test capable of generating evidence for a representational theory of mind. It was an open question, then, about what age children develop a theory of mind. Therefore, the test was never developed *a priori* for a specific age group. It is only with the discovery that some individuals with autism pass both first and second-order theory of mind tasks, that the post hoc development of advanced theory of mind tests began, and the subsequent suggestion that understanding the mind continues beyond the fourth year in typical development.

Baron-Cohen et al. (1999) have therefore had to extend the age range of theory of mind development to include higher-functioning autistic individuals. Despite being arguably more ecologically valid, these experimenters have, firstly, moved a long way from the neat conceptual rigour of the unexpected transfer task. Secondly, there are still individuals with autism who perform well on these more advanced tasks. These group-based studies merely show that groups of autistic individuals do less well relative to comparison groups, they do not show outright failure (e.g., Baron-Cohen et al., 1997)

Baron-Cohen, and other researchers', arguments to support the theory of mind hypothesis of autism are arguably flawed in that it is possible to claim that advanced theories of mind require <u>more</u> theory of mind. However, this is post hoc and sounds as if theory of mind is an amount of something. One could also question the scientific merits of constantly looking for failure, or relative poor performance. Additionally some researchers (e.g., Tager-Flusberg, 2001) write about theory of mind as if it had always been conceived of as being more than just about the false belief task. It does sound like history is being changed to suit the data. It may well be that passing the false belief task is evidence only of the very early emergence of mentalistic understanding, and that newer tests are more age-appropriate. However, the sequence in which these experiments were conceived and carried out reveals the reasoning behind their development and therefore needs to be clearly stated. For instance, it seems unlikely that advanced theory of mind tests would even have been developed if people with Asperger syndrome were found to have failed tests of second-order belief attribution.

4.9 How else could you pass a theory of mind task?

Frith, Happé and Siddons (1994) suggested that autistic passers of both first and second-order theory of mind tasks may have used non-theory of mind and non-mentalistic methods to solve the tasks by "hacking" out solutions. I interpret hacking to mean a logical method of processing the stories and coming out with the correct answer (note that Frith et al. (1994) do not explicitly state what it is). Supposedly, the autistic passers do not infer the mental states of the protagonists in a false belief story. Instead they use this method of hacking to achieve the correct answer[5].

Perner and colleagues' paradigms were well conceived and controlled and, in their view, passing tasks could only be done if someone could understand mental states. Therefore, according to them, there is no reason to think that a correct answer can be hacked out. If it were true that someone could hack out a correct answer, then passing or failing a false belief task would not necessarily tell us anything about the mentalising ability of the individual. In consequence, failing to acknowledge false belief would not be informative about the status of an individual's theory of mind. Hence, an argument trying to account for autistic belief attribution success, via a non-mentalistic route, would undermine the core phenomenon supporting the theory of mind

[5]The use of a non-mentalistic algorithm has been computer modelled by Wahl and Spada (2000). Modelling 1st and 2nd order belief attribution tasks allowed them to accurately predict children's performance on these tasks.

hypothesis of autism. This would mean that failing to acknowledge a false belief would not necessarily imply lack of theory of mind. Thus, a test of false belief would have dubious credentials as an operationalisation of theory of mind.

A clearer distinction needs to be made between theory of mind and the 'litmus-test' of theory of mind: the false belief task. Using the terms synonymously causes confusion because it is not clear how individuals with a triad of impairments (which perhaps come from a more primary cognitive deficit) are able to pass such a 'pure' test of theory of mind. Recently, the wide-spread use of the false belief task on its own, without other measures, has been called into question (Marschark et al., 2000; Russell et al. 1998), and some authors (Bloom & German, 2000) have gone as far as arguing that it should be abandoned as a test of theory of mind. Additionally, if it is argued that autistic individuals can pass the task through either a verbal means or by hacking, then that risks undermining the test of false belief entirely because typically developing individuals might find solutions to the false belief task in different ways.

4.10 Problems with our current vision of autism

The current vision of autism stems from the results of experiments like the Strange Stories test. By focusing on these studies, we would conclude that individuals with autism cannot understand nonliteral language. Moreover, there is little or no consideration that lack of understanding could be linked with impaired verbal and executive abilities. Rather, lack of understanding is simply presented as being related to their poor performance on a test of belief attribution. Furthermore, even autistic individuals who pass second-order theory of mind tasks are argued to have problems with nonliteral language comprehension. Additionally, this problem is presented as being unique to autism and is thought to stem from a domain-specific problem in mentalising.

This picture is flawed, however, not only because of the studies' methodological limitations, but also on principled grounds. These tests were not designed to investigate the nature of, and influences upon, autistic communication. They were, by contrast, created to sustain the theory of mind hypothesis of autism. By narrowly focusing attention on finding evidence to support this theory, Happé and Jolliffe and Baron-Cohen missed the opportunity to further our understanding of autistic communication. Hence, we are still left with numerous gaps in our current vision of autism. For example, we still do not know what makes autistic communication uniquely autistic. We do not know if there is something inherent in the structure of autistic language which is the source of the social problems seen in the disorder. We do not know what factors influence nonliteral language comprehension, nor do we know if these problems are unique to autism. We do not even know if individuals with autism have communicative problems which are universal in all forms of media. The assumption, which has never been questioned, never mind tested empirically, is that autistic individuals have communicative problems across all types of media. This is despite both real-life evidence, and theory suggesting that people with autism may be better at communicating via some media than others. Based on all these reasons, therefore, our current understanding of autism neither reflects the complexity nor the reality of the condition.

4.11 Problems with the current methodology and ways to solve them

In their current form, advanced tests of theory of mind may be criticised for a number of different reasons. Tests like the Strange Stories, based on participants answering questions after reading a passage, tap into their reflective rather than their working understanding. Therefore their performance on such tasks may not be a true reflection of their competence. Furthermore, the example of Kaland et al's (2002) vignette, shows that the stories themselves can be relatively long. Hence, the participants have to process a lot of text before they are tested, by a series of questions, on their understanding of the story. Thus, the task demands of story-based tests are arguably high, and so the poor performance of autistic individuals may be attributable to their poor comprehension of the vignettes, rather than their poor understanding of nonliteral language.

Studies of social understanding, like The Awkward Moments Test (Heavey et al., 2000), can be criticised on similar grounds as language-based tests, essentially because they used the same methodology as the Strange Stories test, and were created from the researchers with the same theoretical mind set. The only fundamental difference between the two methodologies is that participants watched a film clip instead of reading a vignette.

A different approach is needed, one which allows participants to demonstrate 'on-line' competence (e.g., Heider & Simmel, 1944). A test in which participants could demonstrate their working understanding would arguably provide better evidence of their mentalising ability. One method of doing this would be via computer-mediated role-play. If participants computer role-played characters, in a situation contrived to test their working understanding of nonliteral language, then this would give a more ecologically valid indication of their nonliteral language comprehension. The added bonus of role-play is that no test questions need be asked because participants' responses could be rated. The absence of test questions avoids any interpretation that participants are answering test questions based on what they believe the experimenter wants to hear, rather than what they think is correct.

The same criticism, that some tests tap into reflective rather than working understanding, may be directed at those designed to measure social comprehension, like the Awkward Moments Test. A computer role-play situation would arguably be only one level of abstraction from a real life situation. By contrast watching someone else on film and answering questions may be too far removed to tap into the kind of responses participants would make in everyday life. Furthermore, Klin (2000) suggests that in real life settings there is a continuum of social dysfunction and that 'all or nothing' tests may not be sensitive to theory of mind delays in autistic individuals.

Linguistically-based advanced tests of theory may also be criticised because they are pass of fail, or 'all-or-nothing' tests. For example, in the Strange Stories test, understanding of nonliteral language was based on the judgements of only two raters, one of whom was the experimenter and so not blind to the experimental hypothesis. Despite showing a high level of agreement between the two raters, Happé's methodology can be criticised for relying too much on the subjective judgements of just two people. Additionally, these dichotomous, right-or-wrong judgements are arguably too conservative, and offer no room for people showing the emergence of an understanding. Moreover, right/wrong judgements do not generate enough variance to be sensitive to other factors like verbal and executive ability. This is especially important because of the heterogeneity in autism, which is not adequately addressed by matching groups on verbal ability or other criteria.

In computer role-play, participants could *show* nonliteral language comprehension. The actual text they create could then be rated for understanding, on scales which are sensitive to more than just all-or-nothing comprehension. Comparing a computerised version against a 'paper and pen' version would, additionally, enable us to contrast the demands different tests make. Swettenham (1992) did this by comparing performance on a computerised version of the unexpected transfer task with the conventional Sally-Anne version. He found no difference in the results for each form of presentation for children with autism and control groups, though these results are not published. Such research, however, may provide reasons as to why some individuals pass and some fail traditional mentalistic tests. These differences in task demands may afford clues as to why some individuals do well on laboratory tests of theory of mind and yet show poor mindreading in every day life.

Since our vision of autism is limited, the investigations, described in the following three chapters, were designed to further our understanding of what makes autistic communication autistic. They were designed to answer this question in differing, but methodologically new ways. Chapter five describes the conversational analysis of autistic communication using a corpus of data generated in computer-mediated role-play. This investigation was devised to investigate if part of what makes autistic communication autistic is a absence of asking questions. Chapter six details an experiment using computer-mediated role-play to investigate the factors which influence nonliteral language and social understanding in individuals with Asperger syndrome. Finally, Chapter seven outlines a study which challenges, and tests, the notion that autistic communication is the same across different media, by comparing autistic communication via text chat and the telephone.

Chapter 5

What makes autistic communication autistic?

" Marry me and I'll never look at another horse."

(Groucho Marx from *A Day at the Races*)

5.1 Introduction

Fritz V., one of Hans Asperger's patients (1991/1944), spoke his first words at 10 months, several months before he learned to walk. He showed, however, communication impairments from the beginning including difficulty initiating and sustaining conversations, stereotyped and repetitive speech (Miller & Ozonoff, 1997). Hence, from the earliest clinical description of the syndrome it seems that, despite having the building blocks of language, individuals with AS have difficulties using it.

What is it, though, about autistic communication that makes it uniquely autistic? Answering this question would not only tell us about autistic interlocution, but also about 'normal' communication; about what makes effective communication and the relation between understanding language and understanding the mind. For it seems that understanding language and understanding communicative intention may be different processes for individuals with autistic spectrum disorders.

5.2 The importance of questions in being social

Like Fritz V., many autistic individuals have difficulty initiating and sustaining conversations. This aspect of communication is arguably vital in social interactions. Hence, an inability to ask questions may be a fundamental characteristic of autism and lead in turn to social isolation.

As part of their intervention study, Sherer et al. (2001) requested children with autism to ask questions about the person to whom they were speaking. The researchers wanted these children to learn how to answer and ask socially based questions: for example, "What are your favourite games?", "What school do you go to?" and so on. As part of the intervention, autistic children were cued to not only answer these questions, but also to ask the very same questions back. This resembles a conversational strategy typically developing individuals often use in everyday life, that is answering a question about themselves (I live in Nottingham) and asking that very same question of the questioner (Where do you live?). Thus, part of what makes autistic communication autistic may be that these individuals do not appreciate that through asking questions, a person is not only keeping the conversation flowing, but also showing an interest in their conversational partner.

Additional evidence for the importance of self-initiating verbal behaviours, such as asking questions, comes from Koegel, Camarata, Valdez-Menchaca and Koegel (1998). They argue that the lack of these behaviours severely limits autistic children's social and learning opportunities. Hence, in their intervention study they encouraged children to ask questions. Koegel, Koegel and McNerney (2001) reiterate this point by stating that self-initiations, through asking questions, is a so-called 'pivotal area' for outcome, and so when increased can lead to social and pragmatic development. Koegel et al. (2001) describe pivotal areas as aspects of behaviour which have the greatest influence on future development. They argue that these areas are the ones best targeted for intervention programmes. An example is a treatment study by Koegel, Koegel, Shoshan, and McNery (1999) in which they found teaching children to self-initiate promoted learning language, socials skills and pragmatics.

Therefore, any investigation of how people with autism ask and respond to questions may reveal ways in which to improve their communicative skills, and social skills at the same time. The latter is especially important because it is a misconception that individuals with autism do not want to make social relationships. This may be true for the Kanner-type autistic child, who may be considered a loner rather than lonely, but the Asperger-type child might wish to form relationships and not know how. Indeed, Bauminger and Kasari (2000) found that high-functioning children with autism do feel lonely and want to be involved with others. Prior et al. (1998) discovered that high-functioning individuals with autism were not only aware of, but wanted social relationships. Furthermore, Capps et al. (1995) found that high-functioning children with autism had extreme difficulty in maintaining social relationships.

Details of an autistic deficit in the ability to initiate questions might therefore be useful for interventions. This information may then be used in developing strategies to encourage autistic individuals to ask questions, and so link conversation skills with making friendships.

5.3 Is autistic language (micro level) mirrored in their behaviour (macro level)? Exchange structure in autistic dialogue

By looking at autistic conversation in more detail, greater insight could be gained into the problems that individuals with autism have in communication, socialisation, and restricted interests because arguably all three may be expressed through language. Specifically, by using conversation excerpts one could investigate exchanges on a microscopic level which may reflect what happens on a macroscopic or social level. For example if individuals with autism show problems initiating conversational exchanges or 'first parts' (McTear, 1985), this inability may hint at why they find establishing and maintaining relationships so difficult on an everyday level.

5.4 What can computer-mediated interaction in Asperger syndrome tell us about autistic communication?

A study by Rajendran and Mitchell (2000) generated a corpus of computer-mediated exchanges suitable for conversational analysis of first parts. This corpus is ideally suited to conversational analysis because the Bubble Dialogue program (Gray, Creighton, McMahon & Cunningham, 1991), used in the study, has an in-built exchange structure. That is, there are alternating exchanges between the two users. Bubble Dialogue does this by creating a comic-strip environment in which users communicate by typing text into speech and/or thought bubbles appearing above their character's head.

Using this program Rajendran and Mitchell (2000) assessed (1) the experience of computer-mediated role-play on the interpersonal, executive and verbal abilities of two adults with AS; (2) whether blind raters could distinguish the AS individuals from two individuals with emotional and behavioural difficulties (EBD). Six open-ended scenarios were developed for this study and the Bubble Dialogue scripts were rated by 33 people. The raters assessed the scripts on three dimensions: How emotionally-flat to emotionally charged they were, how polite to coarse they were and how much they pursued a topic too much or too little.

The results showed that there was no detectable improvement in the interpersonal understanding of the participants with AS, but there was an amelioration in their executive function scores. Additionally, the blind ratings revealed that only one of the AS participant's scripts were different from those generated by the individuals with EBD.

These ratings were, however, based on raters' judgements of the scripts rather of each individuals' speech acts. In order to get a more 'fine grained' analysis of the use of questions by people with autism, a more detailed system of coding is needed.

5.5 Specific Language Impairment (SLI), Pragmatic Language Impairment (PLI) and autism

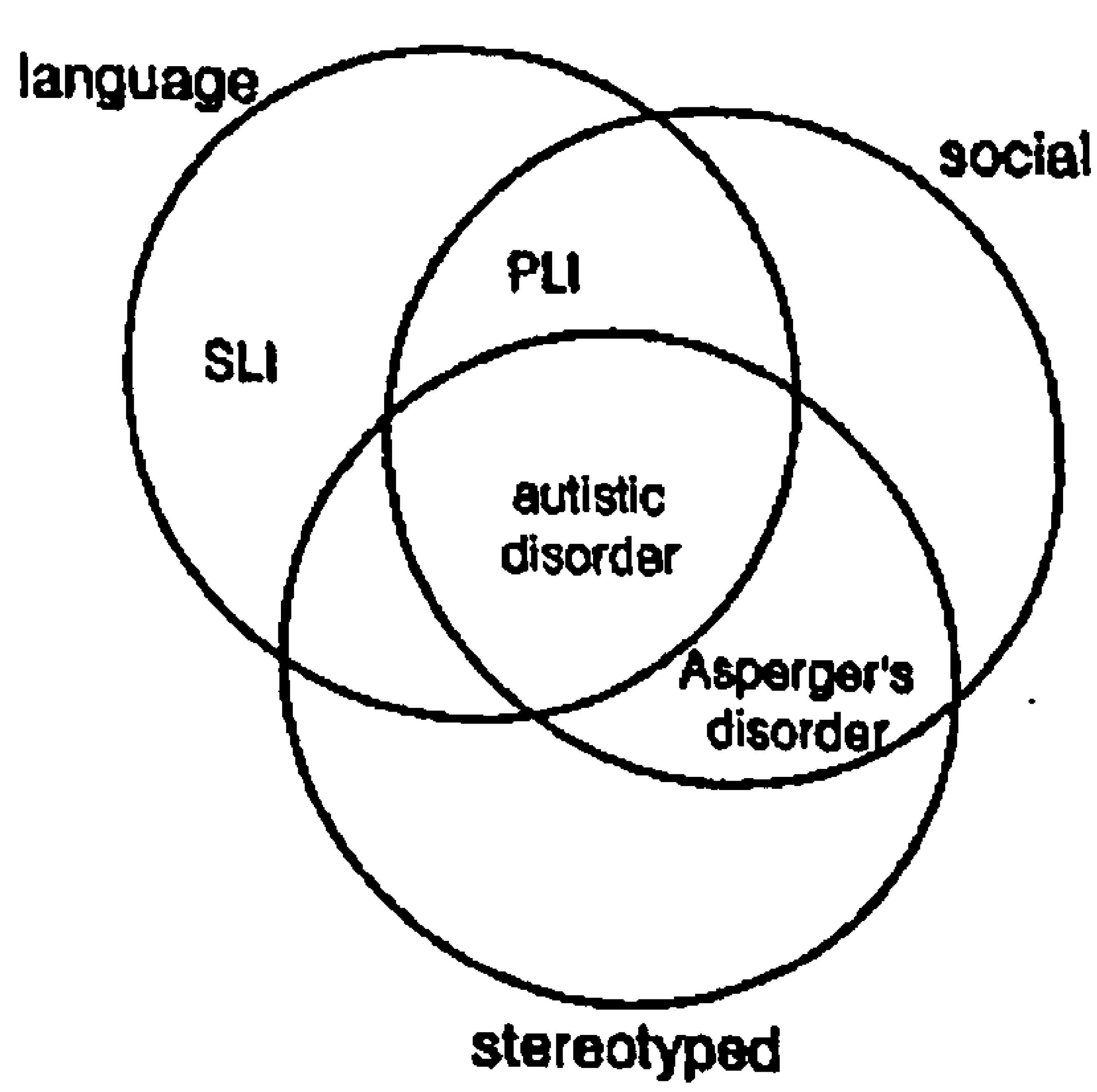
Techniques developed for investigating specific language impairment (SLI) can be adapted for investigating language structure in autism. These techniques might be especially valuable given the possible overlap between autism and pragmatic language impairment (PLI), which is a subgroup of SLI. SLI is a diagnosis given to children who have significant problems mastering language, but for no known reason: problems not attributable to autism, emotional or behavioural difficulties, mental handicap, acquired brain injury or deafness (Bishop, 2000). Children are labelled with SLI mainly because they are excluded from other diagnoses, and because they cannot do something rather than because they meet set criteria (Bishop, 1998). Thus, they can show a variety of differing problems: with language form (phonology and syntax) and language content and use (semantics and pragmatics)[6].

Perhaps unsurprisingly, children with SLI are heterogeneous, but despite this they have been difficult to subclassify (Bishop, 1998). Nevertheless, one area of subclassification may be of pragmatic language impairment. PLI was formerly known as semantic-pragmatic disorder and was first described by Rapin and Allen (1983) and Bishop and Edmundson (1987). The label has

[6]Phonology is the study of sound patterns in language, syntax is concerned with how words can be combined into sentences, semantics is the study of meaning, and pragmatics relates to how language is used.

been controversial because individuals with PLI have problems with language which are remarkably similar to those seen in autism. In fact The National Autistic Society suggests that this label is synonymous with high-functioning autism and is therefore unnecessary (Bishop & Norbury, 2000). However, Rapin and Allen (1987) regard pragmatic language impairment and autism as different levels of description rather than alternative diagnoses. Hence, they used the term 'semantic-pragmatic deficit syndrome' rather than 'disorder' because it could equally be applied to autistic and non-autistic conditions. Moreover, Bishop (1989) states that the distinction between autistic disorder, AS and PLI may be a case of degree rather than a sharp divide, and argues for overlap between disorders (see Figure 2).

Figure 2. A model depicting dissociable impairments in language structure, social use of language and interests, and how particular profiles map onto existing clinical categories - taken from Bishop (2000)



5.6 Conversational analysis of Asperger syndrome communication

A recent study by Bishop and Norbury (2002) looked at the borderlands of autistic disorder and SLI. They specifically tested the claim that all children with PLI would meet diagnostic criteria for autism. Standardised diagnostic measures of autism (including one of the 'gold standard' instruments: The Autism Diagnostic Interview-Revised, Lord, Rutter & Le Couteur, 1994) were used to assess children with PLI and children with more typical specific language impairments (SLI-T). The researchers found that a small proportion of children with PLI did meet the criteria for autism, but many did not. Bishop and Norbury argue that their results suggest that although the presence of PLI should prompt clinicians to investigate the possibility of autism, it is incorrect to assume that all children with pragmatic difficulties are autistic.

Regardless of whether PLI is simply autism by another name (see Lister Brook & Bowler, 1992, for a literature review of children with semantic-pragmatic syndromes/disorders), which seems doubtful now (see Bishop & Norbury, 2002), it is useful to autism researchers that coding schemes for investigating PLI have been developed differentiating sound, structure, meaning and use of language. In fact, in a recent study, Adams, Green, Gilchrist and Cox (2002), analysed conversations of individuals with AS using a coding scheme updated by Bishop, Chan, Adams, Hartley and Weir (2000).

Adams et al. (2002) found that the AS participants did not have across-the-board pragmatic difficulties, rather these problems arose when they communicated about emotions. The researchers argue that their conversational analysis evidence supports the view that individuals with AS have problems understanding emotional concepts. However, Adams et al. (2002) did not look at patterns of questioning and answering because they were not interested in investigating exchange structure. This leaves a gap in the understanding about the nature of AS communication. That is, researchers need to know if an aspect of AS communication is an inability to ask questions.

Researchers designing intervention studies place an important value on the asking of questions. Indeed, the future of an AS individual's social and pragmatic development may be pivotal to it. Yet, aside from clinical experience, there is little evidence suggesting that individuals with AS have problems asking questions. Any evidence suggesting this would support intervention studies which encourage autistic individuals to ask questions. Moreover, it would also suggest a relation between the social and linguistic nature of autism, independent of mentalising ability. That is, part of the social problems in autism may not solely stem from an inability to understand mental states, but from a more basic language problem. This problem is not likely to be due to motivational factors either because studies have shown individuals with AS want to have social relationships. It may be that AS individuals do not know how to initiate and maintain conversations by asking questions, so they may want to learn how to do this.

Thus, only by looking at, and appropriately coding, communicational exchanges can researchers find out if people with AS have problems asking questions. In order to do this distinct categories of communication needed to be identified to help investigate exchange structure. Initiation questions (IQs) and Extended responses (REs) are two units of exchange structure first devised as part of Adams and Bishop's (1989) coding scheme (updated by Bishop et al., 2000). They are the exchange categories most frequently used in the question and response aspects of communicative exchange, and so are of greatest use in investigating autistic questioning.

Initiation question (IQ)

Initiations are grammatical forms of question or command, but the criterion for using this code was the illocutionary force of the utterance, rather than the grammatical form. Hence, the rater has to judge what the speaker intended, rather than literal meaning of an utterance. For example, it is possible to ask a question using the grammatical form of a statement (Adams & Bishop, 1989):

" I suppose you haven't got a pen." IQ

Extended reponses (RE)

The term 'extended' refers to the content of a response, rather than its form: an extended response should be coded for any response giving more information than just a minimal yes/no/don't know reply, and it could consist of just a single word (Adams & Bishop, 1989). For example:

"Where did you go on holiday?"	IQ
"Brighton."	RE

By coding the exchanges in the Bubble Dialogue transcripts, using these two categories, it can be seen if individuals with AS ask questions and respond appropriately.

5.7 Method[7]

Participants

Two young adult males with Asperger syndrome (D. and N.) and two adolescent males (P. and W.) took part in this study. Both males with Asperger syndrome had been diagnosed by experienced clinicians according to standard criteria (DSM-IV, American Psychiatric Association, 1994) and lived in residential care homes. Both adolescents attended a residential school for children with emotional and behavioural difficulties. At the start of testing, D. and N. were aged 23 years 4 months and 23 years and 2 months and both had similar verbal mental ages (14 years 9 months and 14 years 7 months) respectively as measured by the British Picture Vocabulary Scale (Dunn, Dunn, Whetton, Pintilie, 1982). P. and W. were aged 14 years 9 months and 14 years 10 months respectively.

Children with EBD were recruited as a comparison group because children with autism and EBD share many similarities, but arguably for different reasons. The formal definition of emotional and behavioural difficulties in the U.K. refers to "children who...(present)...inappropriate, aggressive, bizarre or withdrawn behaviour", and who have, " developed a range of strategies for dealing with day-to-day experiences that are inappropriate and impede normal personal and social development and make it difficult for them to learn" (Jones, Price & Selby, 1998, p.67). Rock, Fessler and Church (1997) list six specific

[7]See Appendix for a reprint of Rajendran and Mitchell (2000).

critical deficits in individuals with emotional and behavioural difficulties: Cognitive processing, Executive functioning, Language functioning, Behavioural functioning, Social/Emotional functioning and Academic performance (often poor due to a disrupted schooling history). Rock et al. (1997) also list Environmental Variables (e.g, quality of social support) and Biophysical Variables (e.g., additional learning disabilities such as dyslexia) as factors which can affect the outcome of someone with EBD. However, unlike autism EBD is not a developmental disorder, nor do the characteristics of children with EBD stem from a triad of impairments.

Furthermore, Bubble Dialogue has already been used by Jones and colleagues to explore self expression and communication in children (Jones & Selby, 1997), to support learning in children with EDB (Jones, 1996), and explore their responses to interpersonal conflict in mainstream and EBD schools (Jones et al., 1998). Bubble Dialogue has therefore already proven helpful in facilitating communication in children with EDB who find communication problematic and are often difficult to engage. Hence, because of the similarities between the autistic and EBD populations, it would seem valuable to compare the dialogues produced by individuals with EBD with those produced by individuals with Asperger's syndrome.

<u>Bubble Dialogue Sessions</u>

The Bubble Dialogue sessions took about one hour each with the frequency of approximately 1 per week for 6 weeks. D. and N. were tested and had the

Bubble Dialogue sessions in their own homes. P. and W. had the sessions in their school library.

The theory of mind-inspired scenarios, 1 to 6 below, were given in that sequence below.

1. Simple Perspective taking

Understanding sources of informational access: "seeing leads to knowing"

2. Complex perspective taking

Understanding implications of physical disability

3. False Belief

Communicating with someone who holds a false belief

4. Deception - Lie

Lying to a parent about your whereabouts

5. Deception - "White" lie

Organising a surprise birthday party

6. Making a friend

Introducing yourself to a stranger

<u>Procedure</u>

Each participant was shown the scenario for that session and read it as often as he wanted. When the participant was ready, the experimenter (myself) clicked on the speech icon for the character he would play. Once he had inserted into the speech bubble what he wanted his character to say, he clicked on the thought icon. The speech bubble disappeared and was replaced by a thought bubble. The experimenter proceeded to type in what his character thought and then clicked on the participant's character's speech icon. When the empty speech bubble for the participant's character appeared, the previous speech of the experimenter's character reappeared. When the participant had typed what he wanted to say, the experimenter clicked on the thought icon and a thought bubble replaced the speech bubble. Once the participant understood the procedure of clicking on the icons to bring up the thought and speech bubbles, that task was left entirely to him. The participant and the experimenter continued the dialogue until they either ran out of time or had exhausted all the avenues to progress further with the dialogue.

The participant was asked if he wanted to review what he had written. If he did, the experimenter clicked the review icon and both users had opportunity to go back through the entire dialogue and change whatever they wanted.

Rating Bubble Dialogue scripts

The speech and thought bubble dialogues for all four participants were typed by myself, and the scripts resemble play scripts or screen plays. Additionally, thoughts were italicized, so that raters could easily discriminate them from speech.

Thirty-three "blind" raters were recruited to assess the dialogue scripts. The raters were psychology third/final year undergraduates following a course in theory of mind. They knew, in advance, that some of the scripts were produced by participants with Asperger's syndrome, but did not know which.

They were randomly assigned to one of three teams (11 in each). Eleven raters rated all the four sets of six scripts (4 participants, 6 scenarios), along one of three dimensions:

1. Emotionally flat – emotionally charged
2. Polite – coarse
3. Pursuing a topic too little – pursuing a topic too much

The raters were asked to rate the dialogues of both characters (one of which was played by the participant and the other played by myself) by circling one line on a 6 point bi-polar scale. The raters were deliberately not given any examples of what constitutes "emotionally flat or charged" and the same was true for the other two dimensions. The basis of interpretation was left to their own judgement and so a large number of raters (relative to the number of participants) were employed to ensure that even small effects would surface.

Because the discourse was between two people, the participants' scripts should not be rated in isolation. Therefore, the raters were asked to rate my scripts as well. There were two scales, one for each character. My rated scores were then subtracted from the participant's. This gave a number which reflected the interaction between both Bubble Dialogue users and was subsequently analysed quantitatively. It reflected, for example, how emotionally flat or emotionally charged the participant's character was relative to mine. A negative value would indicate that the participant was rated emotionally flat relative to myself. The subtracted ratings where then summed across the scenarios.

These Bubble Dialogue exchanges from Rajendran an Mitchell (2000) were coded using part of the scheme devised by Adams and Bishop (1989). Because the scheme was designed for coding spoken conversations, some of the coding categories were inappropriate for typed computer-mediated exchanges. Despite being typed, however, the Bubble Dialogue transcripts from Rajendran and Mitchell (2000) were open-ended and so resembled a spoken conversational exchange which made it suitable for this kind of coding. See Appendix (p. 254) for the complete list of category codes used to classify conversational behaviour devised by Adams and Bishop (1989).

Unlike telephone or text chat conversations, however, Bubble Dialogue has built-in turn-taking structure, whereby users always follow one another. Therefore, this ruled out coding the Bubble Dialogue scripts for Turntaking, as well as Repairs and any non-verbal behaviours.

Focussing on exchange structure, the Bubble Dialogue transcripts for all four participants and the researcher (myself), in Rajendran and Mitchell (2000) where coded, and summed across five of the six scenarios. One scenario was omitted because participant D. produced only once sentence for that scenario. Two conversational categories were statistically analysed: Initiation Questions (IQ) and Extended Responses (RE). This was done for two reasons: firstly, IQ and RE are the exchange categories most involved in the question and response aspects of conversation, and so are of most interest; secondly, using two categories makes the statistical analysis simpler to interpret.

Reliability

A second rater, blind to the purposes of the study, coded the transcripts for IQ and REs only. Analysis of the inter-rater agreement between myself and the second rater revealed an agreement of 94 percent. Due to this high level of agreement, my coding frequencies were used in the analysis.

5.8 Results

A hierarchical loglinear analysis was conducted using a saturated model with participant or researcher as one factor; frequency of initiation questions or extended response as the second factor; and each of the four participants as the third factor: $\chi^2(3) = 29.3$, $p < .001$ (see Table 1 for the full $2 \times 2 \times 4$ contingency table). The analysis shows a three-way interaction revealing that the role of being either researcher or participant, and the particular participant in question is involved in accounting for the frequency of each response category.

Table 1 The number of IQs and REs made by all four participants and myself

	Participant D.'s exchange structure		Participant N.'s exchange structure		Participant W.'s exchange structure		Participant P's exchange structure	
Code	Participant	Researcher	Participant	Researcher	Participant	Researcher	Participant	Researcher
IQ	0	26	18	28	1	9	4	12
RE	24	5	24	23	19	12	11	12

The frequency of each IQ/RE 'utterance' was separately analysed for each of the four participants. Table 2 shows this for the first case, D. (who has AS) who does not make a single initiation question, but makes 24 extended responses. In contrast the experimenter made 26 initiation questions and 5 extended responses. For D., there was a was a significant difference in the association of responses, χ^2 (1)=38.2, p <0.001.

Table 2. The number of IQs and REs made by participant D. and myself, with expected frequencies in parentheses

Code	Participant D. (AS)	Researcher
IQ	0 (11.3)	26 (14.7)
RE	24 (12.7)	5 (16.3)

From the frequencies, it can be seen that the experimenter is making all the conversational effort in terms of keeping the conversation moving forward. If the experimenter had made just extended responses, then the conversation would have quickly ground to a halt. In contrast, D. is merely responding, and although the utterances are more than yes/no answers, he is not moving the dialogue on. Interestingly D. was rated, by the blind raters in Rajendran and Mitchell (2000), as the most emotionally flat and as the one who pursued a topic the least. It may be that a correlate of emotional flatness and D.'s lack of reciprocity is this very aspect of conversational exchange. In the example of D., his affect may have been rated as flat and pursuing a topic too little because the dialogue between him and the experimenter is very unbalanced, with the experimenter asking all the questions.

In contrast to D., N. (who also has AS) makes 18 initiation questions and consequently the number of the experimenter's of extended responses increases. For N., $\chi^2(1) = 1.34, \underline{p} = 0.25$, was found, therefore showing a more balanced pattern of initiation questions and extended responses. Thus, at least on this aspect of analysis of conversation, N. shows an ability to initiate conversations. Indeed the blind raters did not rate N. as significantly different from the two comparison participants with EBD along the dimension of emotionally-flat to emotionally charged and pursuing a topic too little to pursuing a topic too much (Rajendran & Mitchell, 2000). Despite the similar ratings on those dimensions, however, the dialogues N. wrote were very unusual in their quality and content, if not in their structure. For example, in the making a friend scenario, when two people meet for the first time, N.'s personal obsession with German is evident in his role-playing of Tony:

Tony says: " Did you know I'm German, actually I'm from the small province of Rhine. Can you speak German at all, I love to here (sic) you speak German have go?"

Table 3. The number of IQs and REs made by participant N. and myself, with expected frequencies in parentheses

Code	Participant N. (AS)	Researcher
IQ	18 (20.8)	28 (25.2)
RE	24 (21.2)	23 (25.8)

Looking at the pattern of responding (Table 4) for the dialogues involving P. (who has EBD), there is a similarity between P. and D., in terms of the ratio of the small number of initiation questions he makes relative to the number of extended responses. However, in contrast to the pattern of responses involving D., the experimenter's stories shows an almost equivalent number of initiation questions and extended responses. This suggests a more balanced pattern of questions and responses on my behalf.

Table 4. The number of IQs and REs made by participant P. and myself, with expected frequencies in parentheses

Code	Participant P. (EBD)	Researcher
IQ	1 (4.9)	9 (5.1)
RE	19 (15.1)	12 (15.9)

For P., a Fisher's exact analysis revealed a significant difference in the association of responses ($p = 0.009$), suggesting an imbalance in the rate of asking and responding to questions[8].

The dialogues involving W (Table 5), who has EBD shows a more balanced

[8]Fisher's exact was used because 1 cell has an expected frequency of less than 5, therefore for a 2 x 2 table Fisher's exact test is safer to use (Hays, 1995). When there is only a single degree of freedom, a minimum expected frequency of 10 is much safer (Hays, 1995).

pattern than those involving D. or P., and the Fisher's exact analysis gives a non-significant value, $\underline{p} = 0.19$[8].

Table 5. The number of IQs and REs made by participant W. and myself, with expected frequencies in parentheses

Code	Participant W. (EBD)	Researcher
IQ	4 (6.2)	12 (9.8)
RE	11(8.8)	12 (14.2)

5.9 Discussion

From the analysis it seems that, although D. and N. have identical diagnoses of AS their Bubble Dialogue structures were different. D. is perhaps similar to the PLI children in Bishop et al.'s (2000) study who, despite appropriate grammar and vocabulary for their ages, were not likely to respond either verbally or non verbally.

The blind raters in Rajendran and Mitchell (2000) found that N. was not rated as significantly different from both participants with EBD on the dimensions 'emotionally-flat to emotionally-charged' and 'pursuing a topic too little-pursuing a topic too much'. Hence, there appears to be a correspondence between independent blind ratings of the dialogues and the analysis of conversational acts. This agreement, firstly, suggests that blind raters may be picking up on the global aspects of the communication. Secondly, it suggests that the use of rating scales and conversational analysis can both be used to tap into the same dimension. This agreement suggests that rating scales and conversational analysis can be used both independently and/or together and provide a similar picture of communication, though from different perspectives. Additionally, this method of assigning different utterances into distinct categories can be used to investigate autistic dialogue produced through the computer, using programs like Bubble Dialogue.

Moreover, this problem of communicational exchange in autism is particularly interesting because Tager-Flusberg (1993) suggests that this inability of people with autism to use language to transmit information is the key area of communication breakdown: " Autistic children do not seem to develop the understanding that conversation ought to entail the exchange of information. This appears to be at the heart of what makes communication with autistic people so difficult"(p. 153).

The fact that some autistic individuals do not ask questions, as in the case of D., suggests that this may be one manifestation of autistic communicative impairment. Other AS individuals may have problems with the pragmatics of language, for example comprehending nonliteral language. Either way, both problems may be thought of as autistic because they fall under the large umbrella of disordered communication required for a diagnosis of autism.

N's pattern of questions and answers, however, suggests that problems of exchange structure are not universal in all individuals with AS. This indicates that AS language may be as heterogeneous and as idiosyncratic as each individual with AS. Despite the reciprocal pattern of questions and answers between myself and N., the content of his communication, notably his obsession with the German language is evident. This suggests that some individuals with AS may have problems in the social use of language if not its syntax. For others their conversation language structure and/or language content may be problematic. Hence, it may be that the exact nature of autistic communication remains arguably as enigmatic as the condition itself. Thus, what makes autistic communication autistic may remain unanswered if people persist in using 'autistic' as an adjective and then try to define it.

Adams et al. (2002) argued that although there is clear evidence, from both clinical experience and research, individuals with AS show problems in language use, indeed there has not been a systematic examination of AS language. However, their study, the one by Rajendran and Mitchell (2000), the analysis reported in this chapter, and subsequent chapters attempt to address this short-coming.

5.10 Qualitative vs Quantitative analysis of dialogue

Adams et al. (2002) suggest, however, that some care needs to be taken in using such a quantitative technique as conversational analysis. They found that individuals with Conduct Disorder (CD) made more 'first parts'/ initiations when talking about emotions compared to when they were talking about a non-routine event, like a leisure activity. This contrasts with the clinical experience of individuals with CD having difficulties with conversations about emotions. Therefore, conversational analysis may offer great detail, but at the risk of losing the connectedness of the entire conversation (Adams et al., 2002). This suggests that asking people to rate the entire exchange, as in Rajendran and Mitchell (2000), rather than analysing speech act by speech act may be the most appropriate way of evaluating autistic communication.

It seems, therefore, that conversation analysis of AS reveals both the heterogeneity and the shared pragmatic problems of these individuals. However, this method is extremely time consuming and requires training and experience to use the entire system. It also risks giving a false impression of individuals because of its focus on individual communication acts which in reality are related.

The analysis reported in this chapter and Adams et al.'s (2002) raise some interesting issues regarding how to best describe the nature of communication. From my analysis it seems that rating scales (completed by blind raters), and conversational analysis can both be used to generate numerical values to describe autistic communication. Moreover, there also seems to be some congruence between the macro and micro levels of description.

Adams et al.'s (2002) study suggests, however, that there is no substitute for clinical evidence and that conversational analysis can be misleading if used in isolation. Arguably this is why it is appropriate for diagnoses to be made by clinicians based on qualitative diagnostic systems. Furthermore, the exact nature of what makes autistic communication uniquely autistic remains an open question.

5.11 The role of computers in autistic communication

One advantage that computers have over other ways of communicating, especially for autistic individuals, is their reciprocal exchange structure: this is inherent in programs like Bubble Dialogue, as well as email and text chat. Therefore, unlike face-to-face interactions, part of the built-in protocol of computer-mediated communication is that of initiating and replying. In order to receive a communication one has to be sent. Moreover, you are cued when it is your turn to reply by actually receiving a communication. Arguably this is easier to process for people with autism than waiting for a non-verbal gesture, or pause, to signal that it is their turn to speak.

Chapter six describes an experiment in which Bubble Dialogue was used to investigate nonliteral language and inappropriate requests in AS individuals. In previous studies participants' reflective understanding of nonliteral language was investigated, by asking test questions after they had first read a vignette. In the next study, however, participants' working understanding was measured through computer role-play of scenarios designed to tap into their understanding of nonliteral language and their responses to inappropriate requests. These responses were then rated by blind raters, rather than one or two trained coders.

Chapter 6

How do individuals with Asperger syndrome respond to nonliteral language and inappropriate requests in computer-mediated communication?

"Giving a man space is like giving a dog a computer: the chances are he will not use it wisely."

(Bette-Jane Raphael)

6.1 Introduction

The results from Happé's (1994) and Jolliffe and Baron-Cohen's (1999) replication of the Strange Stories test (see Section 4.2, p. 74) suggests that individuals on the autistic spectrum are impaired, relative to typically developing individuals in understanding nonliteral language. These researchers view this relative poor performance as evidence that individuals with autism have a deficit in their theory of mind.

It would not necessarily be appropriate to generalise from the findings of these studies to the quality of autistic communicative performance. However, Happé's (1994) procedure seems to tap into a level of reflective understanding of nonliteral language, a level that is one-step removed from the working understanding required to respond appropriately to a person who uses nonliteral language during conversation. It is conceivable that while individuals with autism are poor at reflectively explaining what a speaker meant by a certain expression, they can nonetheless respond appropriately to a nonliteral utterance as if venturing beyond the literal interpretation. Presumably, an ability to respond appropriately to nonliteral communication is relevant to practical communicative proficiency and general social integration, so it is especially important to investigate the working understanding of nonliteral communication.

Additionally, performance at the reflective level does not necessarily translate into proficiency in a natural social context. Hadwin et al. (1996) found that although it was possible to teach individuals with autism to give correct judgements on a selection of false belief tests, there was no corresponding improvement in social functioning. The test of false belief requires a verbally explicit response of what a person is thinking, and in this respect it seems to tap into understanding at a reflective level, as in Happé's (1994) study.

The formidable challenge faced by myself, then, was how to contrive a communicative exchange such that nonliteral language could be introduced whilst also taking a sensitive measure of the participant's understanding. Role-play would be ideal, except that it is notoriously difficult to coax individuals with autism to entertain the required level of make-believe.

In principle, Bubble Dialogue (Gray et al., 1991, described in Chapter 5) seems like a promising tool for engaging individuals with autism in role-play because computer-based tasks are ideal for investigating aspects of autism for the reasons suggested by Swettenham (1996): first, computers provide social and emotional distancing by acting as an interface between interactants, which might help to reduce the social anxiety that is typically experienced by individuals with autism; second, the computer accommodates the autistic need for sameness and predictability; third, it allows the individual to take control and work at his or her own speed. Additionally, there might be benefits in not conducting interactions face-to-face, given that there is no competing visual information that might cause distraction. Autistic individuals are known to have sensory and perceptual abnormalities (O'Neill & Jones, 1997), and the heavy visual processing accompanied with face-to-face interaction could be at the cost of the processing needed to conduct a conversation. Moreover, many individuals with autism seem to have an affinity with computers (Prior et al., 1998) and it might be possible to exploit this special interest as a vehicle for engaging them in social interaction (see Baker, Koegel & Koegel, 1998).

The prologues of Bubble Dialogue were modified in order to portray a context borrowed from Happé's (1994) study that would allow myself to begin my dialogue with a nonliteral utterance. How would participants respond? Would they behave as if taking the utterance literally, as might be expected from Happé's results, or would there be signs that they interpreted nonliterally, thereby demonstrating a working understanding of nonliteral language?

A supplementary dimension to my dialogue was also scripted. In-role, the experimenter (played by myself) made a couple of socially inappropriate requests. One was for the loan of a large sum of money (£100) and another was for details of the participant's character's home address. The purpose was to begin to investigate social naivety in autistic communication. According to Frith (1989), individuals with autism characteristically lack common sense and in consequence could be socially vulnerable. Hitherto, there is no information on the relation between communicative discretion and other aspects of communication, such as being able to interpret nonliterally. Specifically, even if individuals show a level of proficiency in responding to nonliteral communication, they might still divulge personal details or inappropriately agree to lend a large sum of money. The current study serves as a first attempt to investigate this possibility.

6.2 Are problems in understanding nonliteral language and responding inappropriately to social situations unique to individuals with autism?

The composition of the clinical comparison group requires special consideration and a group of individuals with Tourette syndrome (TS) was settled. As with many developmental disorders, TS is most frequently seen in boys (Rickards, 1995). Though unlike individuals with autism and AS they seem to have social awareness. However, in common with AS, it is a neurodevelopmental disorder with many individuals having obsessional behaviours; for example Robertson, Trimble and Lees (1988) found that 37%

of their group of 90 patients reported obsessive compulsive behaviour. Additionally, some individuals with TS are echolalic (Rickards, 1995) and characteristically have impaired executive abilities (Bornstein, 1990, 1991). Therefore it is especially important to demonstrate that any autistic tendency to interpret literally is substantive rather than secondary to a failure of inhibition due to executive dysfunction (Mitchell, Saltmarsh & Russell, 1997). If individuals with autism have a tendency to interpret literally and this is primarily due to executive dysfunction, then a similar level of performance should be witnessed in individuals with TS who also have executive dysfunction. On the other hand, if any tendency to interpret literally is primarily a consequence of a peculiarly autistic impairment in mentalising, then perhaps a tendency to be too literal will be confined to those with autism. Similarly, it could be that a tendency to interpret literally is secondary to general linguistic impairment in autism (see Happé, 1995), in which case clinical diagnosis will not contribute anything to the accuracy of prediction, over and above measures of general verbal ability. Hence, measures of executive functioning in the clinical samples were taken along with measures of verbal ability in the autistic and normal participants.

Precisely the same arguments can be made about the relation between responding to inappropriate requests, executive dysfunction and general verbal ability. Evidently, one needs to inhibit a response to an inappropriate request, which in turn requires a certain level of executive control. Hence, the provision of a TS comparison group and the measure of executive ability is pertinent to this issue. Also, the nature of one's response to an inappropriate request might be linked with general linguistic abilities, and so a measure of this would be valuable as well.

6.3 Method

Participants

Nine people with AS and three with HFA were recruited. One participant with HFA was originally diagnosed with AS, but this was later changed to HFA by their clinician according to his mother. Twelve individuals with TS and 12 typically developing participants (control group) were also recruited. The gender composition in each group was eight males and four females.

The AS and HFA participants were recruited via the Leicestershire Autism Outreach Team, or through the Leicestershire and Derbyshire Autistic Support Groups which require students and members to have formal diagnoses. Those who were students (n = 11) had statements of special educational needs. None were known to have a diagnosis co-morbid with any other disorder. For the purposes of this study, the HFA individuals were combined with AS individuals since it has proven diagnostically and experimentally difficult to distinguish between the two (see Baron-Cohen et al., 1999, for a concise rationale).

The members of the TS group were recruited as outpatients from The Queen Elizabeth Psychiatric Hospital, Birmingham, and all met DSM IV-TR criteria (American Psychiatric Association, 2000) and were not co-morbid with AS.

The control group members were selected to match the AS/HFA participants in terms of gender and as closely as possible in terms of age, level of education and verbal IQ. Table 6 provides details of chronological age (CA), verbal IQ (VIQ), performance IQ (PIQ) and full-scale IQ (FSIQ). Four control participants were class-mates of four of the AS/HFA individuals. One was a University of Nottingham manager, and the other seven attended a local school. All the participants were tested in a quiet space either at their place of education, place of work, hospital interview room, or home. Four one-way ANOVAs showed no significant differences between the groups on any of the variables: CA, F (2, 33) = 2.41, p =.11 ; VIQ, F (1, 22) = 0.06, p = .81 ; PIQ, F (1, 22) =2.23, p = .15 ; FSIQ, F (1, 22) = 0.84, p = .37, BADS profile score (see below), F (2, 33) = 3.04, p = .06.

Table 6. Participants' characteristics

Participant[a]	CA	VIQ	PIQ	FSIQ	BADS
AS/HFA					
M	16.46	110.25	93.25	102.00	14.08
SD	6.81	22.47	22.77	23.13	4.89
Range	11-36	73-148	58-128	70-139	7-21
Control					
M	16.78	111.83	104.50	109.00	17.83
SD	7.38	14.28	14.44	13.03	2.52
Range	12-39	86-137	76-123	90-133	13-22
TS					
M	23.85	-	-	-	16
SD	12.65	-	-	-	3.39
Range	11-47	-	-	-	12-21

[a]n = 12 in each group

Materials

The main piece of hardware was an Apple Macintosh 500 series powerbook, installed with Bubble Dialogue (Gray et al., 1991) and Hypercard.

Measures

There are features of autism which fall outside Wing and Gould's (1979) triad of impairments, such as the autistic individual's need for sameness, difficulty switching attention, a tendency to perseverate and a lack of impulse control. These symptoms are similar to those shown by individuals with frontal lobe brain lesions in dysexecutive syndrome (Baddeley & Wilson, 1988). Therefore all 36 participants were tested with the Behavioural Assessment of the Dysexecutive syndrome (BADS, Wilson et al., 1996), which according to Evans, Chua, McKenna and Wilson (1997) is an ecologically valid test of executive function, assessing the everyday difficulties associated with dysexecutive syndrome. The BADS is composed of six subtests and assesses a range of cognitive functions representative of executive abilities such as cognitive flexibility (Rule Shift Cards), novel problem solving (Action Programme), planning (Key Search, Zoo Map, Action Programme and Modified Six Elements), judgement and estimation (Temporal Judgement), and behavioural regulation (Key Search, Zoo Map, Modified Six Elements). Evidently some of the subtests have multiple components: Planning, problem solving and monitoring behaviour are required for the Zoo Map and Modified

Six Elements (Norris & Tate, 2000). For each subtest a summary profile is obtained (with a maximum of 4 and minimum of 0), and these are summed to produce an overall profile score out of 24.

Additionally, the AS/HFA group and the control group were tested with the Wechsler Abbreviated Scales of Intelligence (WASI – Wechsler, 1999) which consists of four subtests: Two assess expressive VIQ and two assess PIQ - also known as non verbal IQ. Both scales combine to give a FSIQ score.

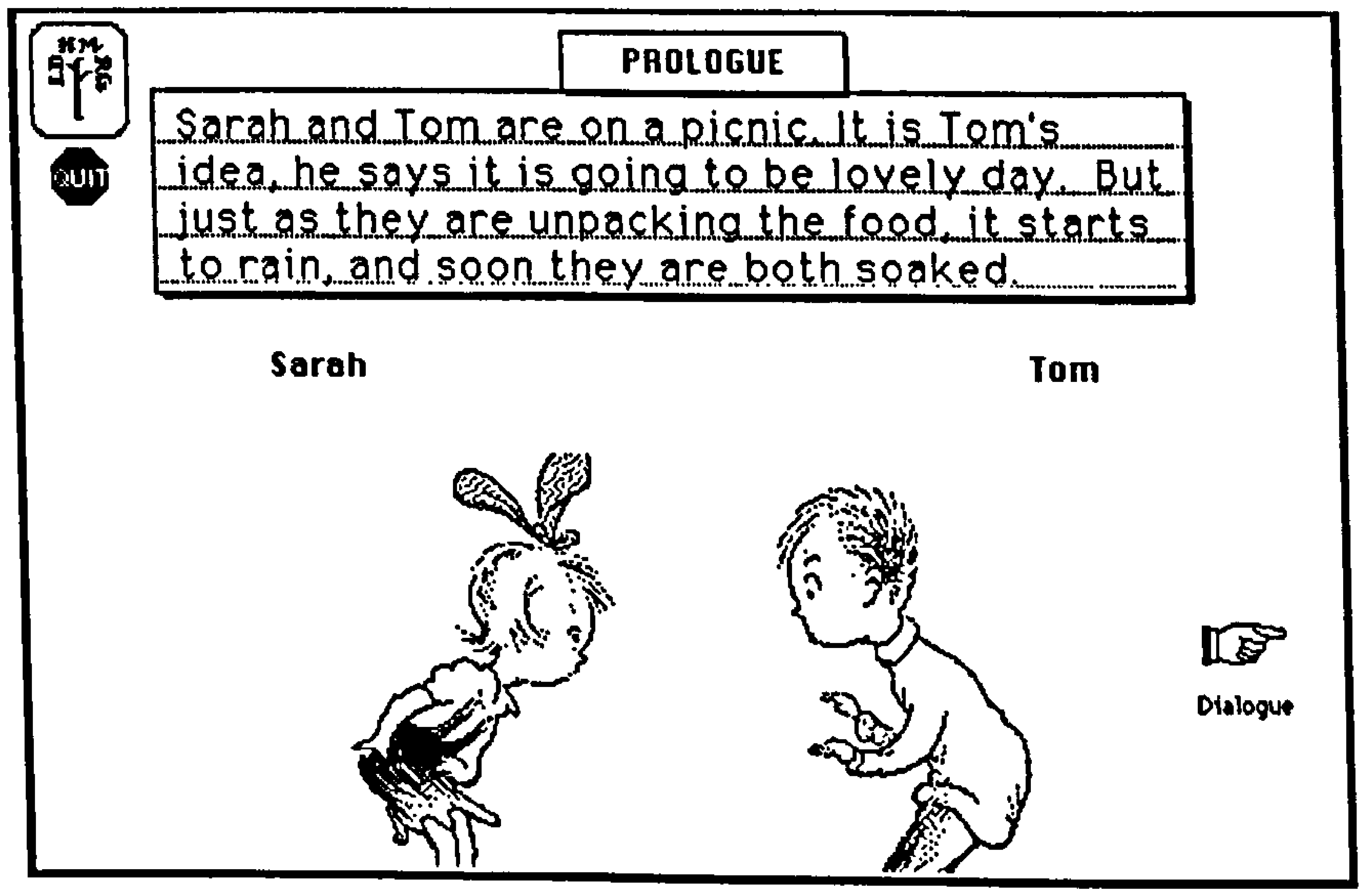
Bubble Dialogue scenarios

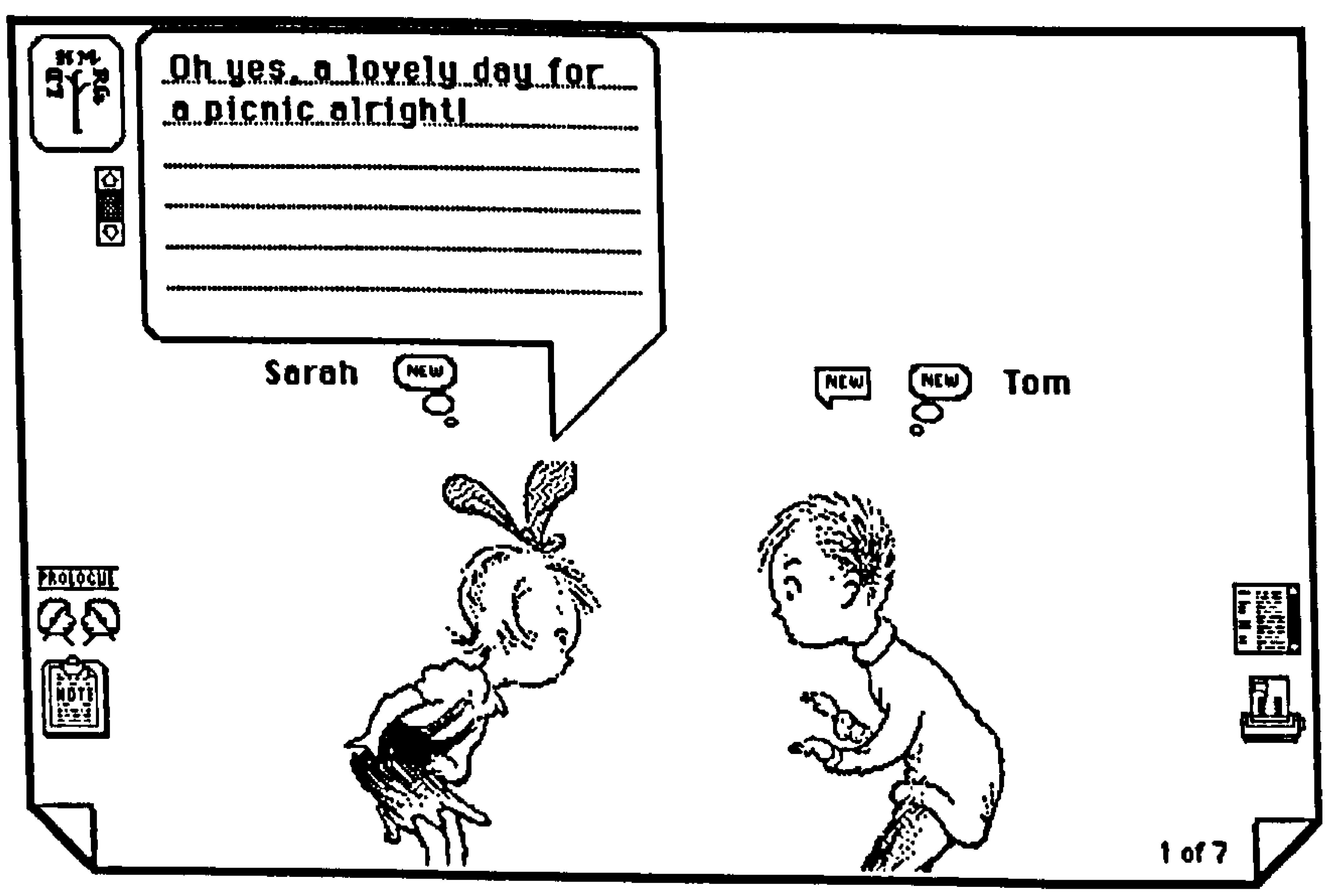
The Sarcasm and Figure of Speech vignettes from Happé (1994) were identified as the ones most easily adaptable for role-play in Bubble Dialogue. In this program, a prologue can be created for the users to read before role-playing their characters. The top part of Figure 3 (p.136) shows the prologue for the Sarcasm scenario in Bubble Dialogue. The prologues for the Figure of Speech and Sarcasm scenarios were almost identical to Happé's (1994) vignettes. The few word changes enabled the scenario to fit in the prologue box, which only accommodates a limited number of characters. Unlike Happé's study, however, participants were not asked comprehension and justification questions. Instead, the participants role-played one of the characters involved in the stories.

The prologue for the Figure of Speech scenario was, "Daniel and Ian see Mrs Thompson coming out of the hairdresser's one day. She looks a bit funny because the hairdresser has cut her hair much too short". After reading the prologue, the experimenter (myself) took on the role of Daniel by typing into a speech bubble appearing above Daniel's head, "She must have been in a fight with a lawnmower!" The participant was then asked to type in whatever s/he wanted in Ian's bubble. If the participant seemed unsure how to respond, the experimenter stated that there was not a right or wrong thing to type. The participant and the experimenter continued their dialogue until they could not take it further or until the participant had to leave for their next lesson or return home. The same procedure was followed for all the scenarios.

In the Sarcasm scenario, after reading the prologue, the following test questions were asked to check that the participants understood what was happening in the scenario and hence why this might provoke a sarcastic response: Whose idea was it for the picnic? What kind of day does Tom say it is going to be for the picnic? What happens just as Tom and Sarah are unpacking the food?

Figure 3. Prologue from the Sarcasm scenario and researcher's standard opening response





Once the participants answered the questions correctly (which they all did), the experimenter took on the role of Sarah and typed, "Oh yes, a lovely day for a picnic alright!". The participant then role-played Tom. The bottom part of Figure 3 shows Sarah's opening question.

A third scenario (not based on Happé, 1994) was used to investigate socially appropriate behaviour based upon first meeting someone. The 'Appropriacy' scenario was designed to investigate how participants respond to an inappropriate request and was 'Making a friend' taken from Rajendran and Mitchell (2000). The opening exchange was read by the participant and then the character Katie, played by the experimenter, continued the conversation by saying, "Tony, I know we hardly know each other, but I wonder if you would lend me some money. About £100 ought to be enough." (Note that Katie reiterates the point that she and the man do not know each other. Even if the participants did not fully appreciate from the scenario that the two characters have only just met, this is made explicit in the first typed sentence). The participant then took on the role of Tony. Later in the exchange, Katie inquires about Tony's address with the following question, or something very similar: "Where exactly do you live Tony? Or "I would like to know where you live."

<u>Procedure</u>

Most of the participants were tested on three separate occasions, one for the 3 Bubble Dialogue scenarios, one for the BADS and another for the IQ test. The testing orders randomly varied for all participants, except that the AS/HFA group were tested with the WASI in their final session. The TS group, being outpatients, could only participate in one session and so were tested with Bubble Dialogue and the BADS, though not the WASI. The three Bubble Dialogue scenarios were given in different orders.

Rating Bubble Dialogue scripts

The Bubble Dialogues for all 36 participants were typed and collated into rating booklets by myself. The transcriptions looked like play scripts and were randomly ordered into nine different template booklets (i.e. three booklets per scenario). The only proviso was that the participant groups were represented equally in the first transcript.

Sixty-two 'blind raters' were recruited to assess the transcripts. The raters were either prospective undergraduates, current undergraduates, postgraduates or research assistants at The University of Nottingham and were essentially an opportunity sample. Sixteen individuals rated the Sarcasm transcripts, 24 rated the Figure of Speech transcripts and 22 rated the Appropriacy transcripts.

The raters were asked to rate the responses of characters played by the participants. For the Figure of Speech and Sarcasm scenarios, they were asked to rate 'How well does Ian understand figurative language?' and 'How well does Tom understand sarcasm?' respectively. They were asked to circle a line on a 6 point bi-polar scale, with 'No understanding' at one end and 'Good understanding' at the other.

Rajendran and Mitchell (2000) pioneered this method for generating variance using multiple raters, who were blind to diagnosis, to score transcripts according to set criteria. The technique allows a statistical comparison at the level of individual participants. It enables a sensitive analysis of clinical diagnosis, executive ability and general linguistic ability in predicting the rated character of Bubble Dialogue transcripts. The technique allowed me to examine whether there was an interaction between clinical diagnosis and executive (or language) ability. For example, participants may be rated as not performing well in responding to nonliteral language, but only if they have autism and have poor executive ability. Hence, my distinctive approach enables the autistic group appropriately to be treated as heterogeneous.

For the Appropriacy scenario, two rating scales were developed, one asking, 'How appropriate was Tony's response when asked for money?' and the other asking, 'How appropriate was Tony's response when asked about his home address?' For these scales, raters were asked to circle a line on a 6 point bi-polar scale, with 'Appropriate' at one end and 'Inappropriate' at the other.

In order to compare differences in performance between implicit (computer role-play) and explicit understanding of nonliteral language the AS/HFA participants were followed up approximately one year later, and given the Sarcasm and the Figure of speech vignettes using the original method devised by Happé (1994). At this time one participant had withdrawn from their place of education and was unable to take part.

Data structure and background to analyses

The rated scores from the Bubble Dialogues ranged from 1 to 6. Because these data were hierarchically structured, with raters' scores nested within individuals from different groups, hierarchical linear modeling (HLM) was used for the analysis (Bryk & Raudenbush, 1992; HLM/5 software Bryk, Raudenbush & Cogden, 2001; see Steiger, Gauvin, Jabalpurwala, Séguin & Stotland, 2000, for a concise description of HLM). HLM is a type of general linear model used in multiple regression, but accepts unbalanced hierarchically structured data. In HLM, different models can be tested to see which combination of variables provides the best fit. A measure of model fitness is given by the deviance statistic: the higher the deviance, the poorer the fit. The deviance is not interpretable directly, but differences in deviances between models have a chi-squared distribution and so can indicate a significantly improved model fit. An indicator of the proportion of variance accounted for by between-participant variability is given by the intraclass correlation coefficient (ρ). Reliability estimates of the models (which range from 0 to 1) indicate how reliable the sample means are as indicators of the true mean. In this study the reliability estimate gives an indication of the level of agreement between raters of the true rating of the participant.

In HLM the dependent variable must be at Level 1. So in this study, the Level 1 model represents the ratings each participant received from each rater and Level 2 represents the participant's clinical diagnosis, verbal ability or executive ability. Bryk and Raudenbush (1992) recommend a "step up" approach in which variability at Level 1 is modelled first and then Level 2 is considered using higher order predictors.

6.4 Results

Table 7 (overleaf) displays the mean rated scores for each experimental group, with higher scores showing better understanding of the two nonliteral speech scenarios, and better responses to inappropriate requests[9]. In the first part of the Results section I compare the performance of individuals with AS/HFA with the control group using HLM modeling. The second part is analogous, except that individuals with AS/HFA are compared with the TS group.

[9]For the Sarcasm scenario, Rater 2 omitted rating participant 5. Therefore this rating was included as the mean score given to participant 5 by the other 15 raters. Additionally, the rating scale for the Sarcasm scenario for participant number 25 was incorrectly labelled, so two analyses were performed, one including and one excluding participant 25. There was virtually no difference between the analyses, so participant 25's scores were included in all the reported analyses.

Table 7. The mean rated scores (with standard errors in parentheses) for each participant group, with higher scores showing better understanding of the two nonliteral speech scenarios, and better responses to inappropriate requests

Group	Figure of Speech	Sarcasm	Appropriacy - lending money	Appropriacy-disclosing home address[b]	Appropriacy-combined scales[b]
AS/HFA	3.65 (0.14)	3.68 (0.11)	3.34 (0.08)	3.05 (0.10)	6.48 (0.17)
Control	4.27 (0.17)	4.07 (0.11)	4.34 (0.10)	3.74 (0.09)	8.03 (0.15)
TS	4.41 (0.14)	4.13 (0.12)	4.03 (0.11)	3.42 (0.11)	7.77 (0.19)

[b]For the Appropriacy - 1 participant in the AS/HFA group and 3 in the TS group did not continue the dialogue far enough to give responses when asked for their home address, and were not rated.

Comparisons between AS/HFA and the control group

It was investigated whether individuals with AS/HFA have problems understanding nonliteral speech and inappropriate requests that are independent of the characteristics of their general verbal ability. Specifically, is there a significant difference at the group level after verbal ability is statistically taken into account, with the control group rated as showing better understanding? Raw verbal score, as opposed to verbal IQ, was used in the ensuing analysis in order to remove the participants' age as a covariant.

For the Figure of Speech scenario, the initial HLM model was run without Level 1 and Level 2 predictors (this is also known as the empty model because it contains no explanatory variables). The average mean rated score for all 24 participants was 3.96 and the reliability of this estimate was high (0.87) which indicates that the sample means tend to be quite reliable as indicators of the true individual means. A significant chi-square for the variance component [χ^2 (23) = 180.69, $p < .001$] suggested that the Level 1 intercept was indeed a random effect and so there is variability which needs to be explained. The intraclass correlation coefficient showed that 21 percent of the variance in rated score is between participants (and consequently 79 percent is within participants). This established, the fixed effect of raw verbal score was included as a Level 2 predictor in the next model. The raw verbal score coefficient was significant (t (22) = 3.58, $p = .002$) so group was then added to the model which further improved the fit to the data, indicated by a significant reduction in the deviance: χ^2 (1) = 5.28, $p = .02$. Therefore, the final model included both raw verbal score and group and the reliability estimates for this final model intercept remained reasonably high (0.75) and accounted for approximately 53 percent of the variance. A model which included only the verbal score as a predictor accounted for approximately 38 percent of the between-participant variance. A model which used only group accounted for about 19 percent of the variance. In other words, both verbal ability and clinical diagnosis predict the ratings participants received for their understanding of a figure of speech. Notably, clinical diagnosis accounted for variance in rated understanding of figure of speech independently of verbal ability.

Figure 4. Rated understanding of figure of speech in the AS/HFA and control groups, plotted against verbal score. The 'predicted' control line is derived from the relation between rated understanding and verbal score in the control group. Asterisk superimposed on the points on the graph indicate significant difference from the predicted control

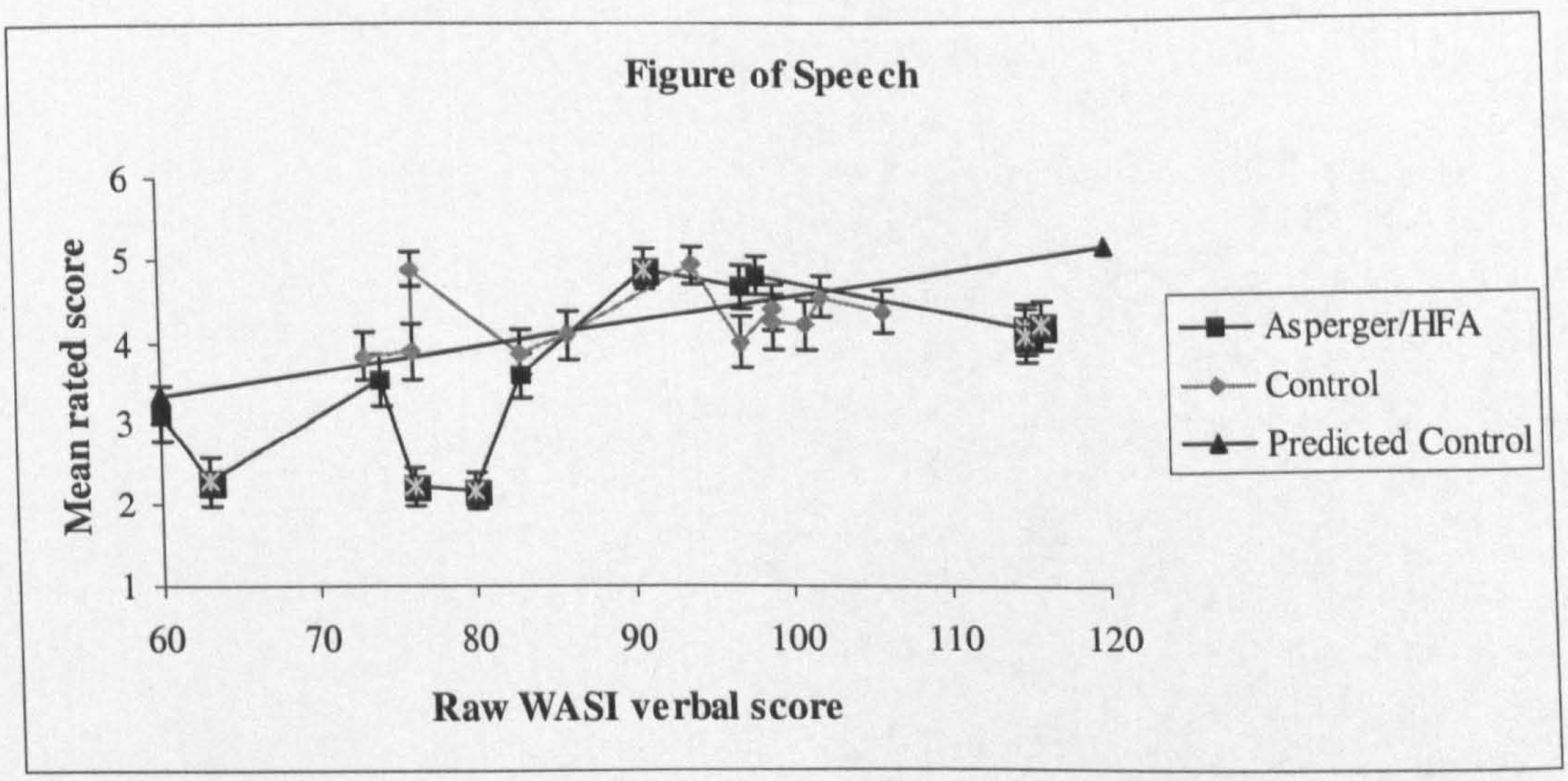


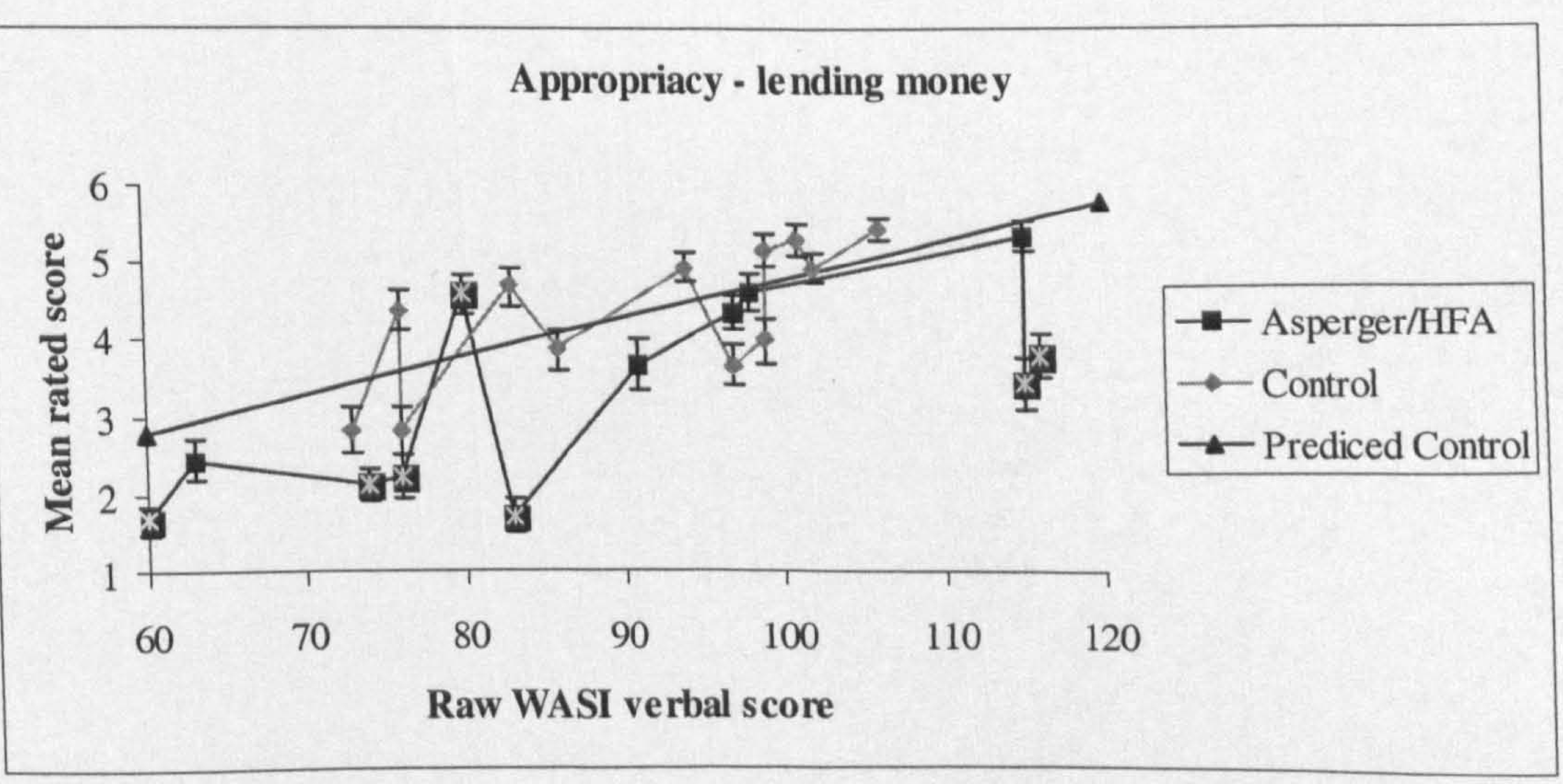
Figure 4 suggests a distinct lack of uniformity in rated understanding within the AS/HFA group. In order to describe this state, the relation between rated score and verbal ability in the control sample was plotted and a linear regression line was fitted on top of these data using the coefficients from the final HLM model. Hence, for any value of verbal ability, rated score could be predicted. The data from the AS/HFA group was then examined to determine how many of the rated means differed from the prediction, using one-sample t-tests. Figure 4 shows that half of the participants with AS/HFA fell significantly below the predicted level in their rated understanding ($p<.02$ in all cases). Most of the remaining participants were not different from the predicted level of performance and one was even significantly above the predicted level (p=.02). In other words, many of the participants in the AS/HFA group underperformed in their rated understanding of figurative speech, but this was not inevitable and neither was it purely incidental to measured verbal ability. The same strategy was used in the ensuing analyses.

For the Sarcasm scenario, the mean rated score for all participants was 3.87 and the reliability of this estimate was high (0.90). A significant chi-square for the variance component [χ^2 (23) = 236.47, p < .001] suggested that the Level 1 intercept was a random effect and so there is variability which needs to be explained. The intraclass correlation coefficient (ρ) showed that 36 percent of the variance in rated score is between participants. Level 2 models showed that raw verbal score did not significantly predict rated score (t (22) =1.54, p = .14) and neither did the inclusion of group membership (t (22) = 0.91, p = .37). In other words, rated score did not vary with measured verbal ability, nor did it differ between groups.

For the Appropriacy - lending money scenario, the mean rated score was 3.84 and the reliability estimate was very high (0.96). A significant chi-square for the variance component [χ^2 (23) = 531.56, p <.001] suggested there is variability to be explained and the intraclass correlation coefficient (ρ) was 49 percent. The Level 2 model that included raw verbal score significantly predicted rated understanding (t (22) = 4.16, p < .001) and prediction increased even further with the inclusion of group membership as a variable: χ^2

(1) = 7.35, p <.01. Reliability estimates for the intercept of this model remained reasonably high (0.89). A model which included only the verbal score as a predictor accounted for approximately 46 percent of the between-participant variance. A model which included only group accounted for about 19 percent of the variance. The model using both Level 2 predictors accounted for approximately 61 percent of the variance. In other words, both verbal ability and clinical diagnosis predict the ratings participants received for the appropriateness of their responses when asked to lend money. Clinical diagnosis accounted for variance in rated appropriateness independently of verbal ability.

<u>Figure 5. Rated understanding of Appropriacy - lending money - in the AS/HFA and control groups, plotted against verbal score. The 'predicted' control line is derived from the relation between rated understanding and verbal score in the control group. Asterisk superimposed on the points on the graph indicate significant difference from the predicted control</u>



Using the same strategy developed for analysing figure of speech, the relation in Figure 5 between rated appropriacy score and verbal ability in the control sample was plotted and a linear regression line was fitted on top of these data using the coefficients from the final HLM model. The Figure shows that half of the participants with AS/HFA fell significantly below the predicted level in the rated appropriacy of their response (one-sample t-tests, $p<.001$ in all cases) and one was significantly above the predicted level ($p=.005$).

For the Appropriacy - disclosing home address scenario, the mean rated score was 3.41 and the reliability estimate was high (0.89). A significant chi-square for the variance component [χ^2 (22) = 207.30, $p < .001$] suggested there was variability to be explained, and the intraclass correlation coefficient was 27 percent. A Level 2 model that included raw verbal score significantly predicted rated appropriacy (t (21) = 2.51, $p = .02$) and prediction increased even further with the inclusion of group membership as a variable: χ^2 (1) = 5.16, $p = .02$. Reliability estimates for the intercept of this model remained reasonably high (0.83). A model which included only the verbal score as a predictor accounted for approximately 22 percent of the between-participant variance. A model which included only group accounted for about 18 percent of the variance. The model using both Level 2 predictors accounted for approximately 40 percent of the variance. Hence, both verbal ability and clinical diagnosis predict the ratings; clinical diagnosis accounted for variance independently of verbal ability.

Figure 6. Rated understanding of Appropriacy - disclosing home address - in the AS/HFA and control groups, plotted against verbal score. The 'predicted' control line is derived from the relation between rated understanding and verbal score in the control group. Asterisk superimposed on the points on the graph indicate significant difference from the predicted control

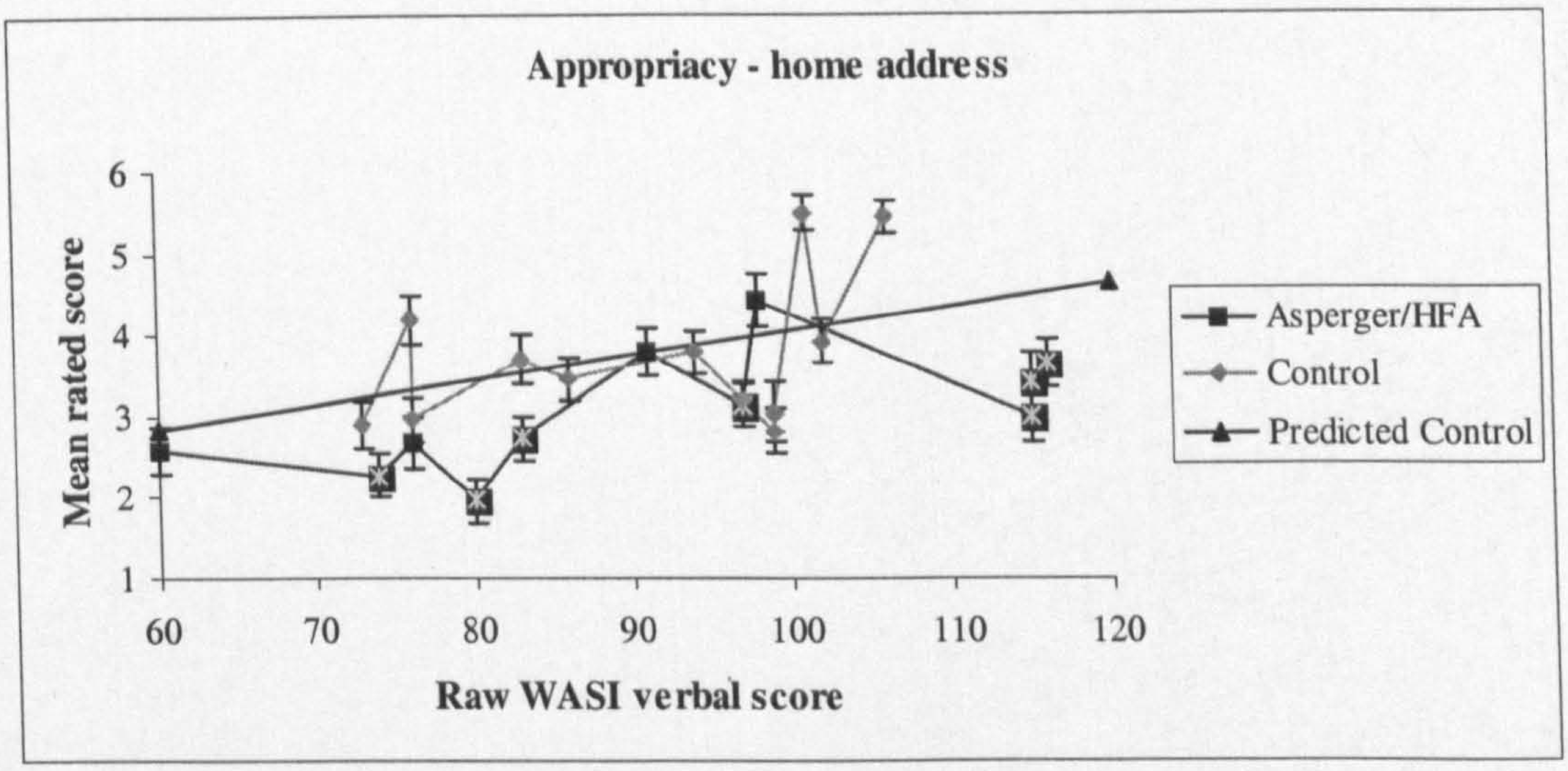
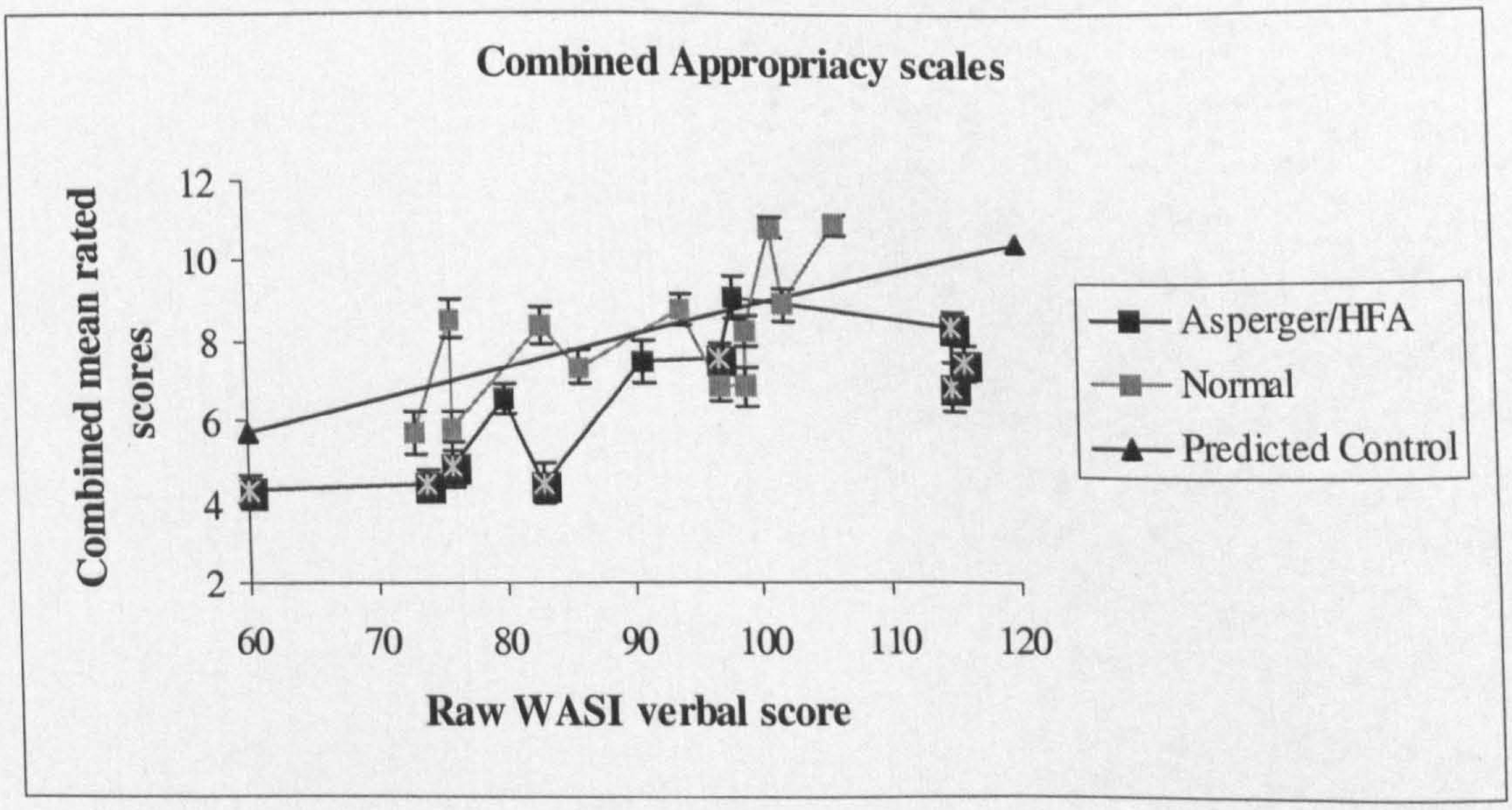


Figure 6 shows the relation between rated appropriacy score and verbal ability, along with a linear regression line based on data from the control sample using coefficients from the final HLM model. One-sample t-tests showed that over half (7 out of 11) of the participants with AS/HFA fell significantly below the predicted level in the rated appropriacy of their response ($p \leq .02$ in all cases).

In the total sample of 32, those rated as responding inappropriately in one scenario tended also to be rated as responding inappropriately in the other: $r = 0.56$, $p=.001$ ($N = 32$, 2-tailed). An HLM analysis on data combined from the two scenarios for AS/HFA and control participants was conducted, which confirmed the trends from the two Appropriacy scenarios when analysed separately. Figure 7 presents the relevant data and shows that 8 participants with AS/HFA were rated significantly below prediction (one-sample t-tests, $p \leq .006$ in all cases).

Figure 7. Rated understanding for combined Appropriacy scenarios in the AS/HFA and control groups, plotted against verbal score. The 'predicted' control line is derived from the relation between rated understanding and verbal score in the control group. Asterisk superimposed on the points on the graph indicate significant difference from the predicted control



To gain further insight into the basis of the ratings of inappropriacy in the AS/HFA group, participants' responses were coded according to whether they offered to lend money (any amount, not just £100), the full £100, and if they disclosed a full home address (house number, road name). These classifications were then point-biserially correlated with the mean rated appropriacy scores for the AS/HFA group. There was a significant correlation of $r_{pb} = 0.69$ ($N = 12$, $p = .01$, 2-tailed) when the criterion was offering to lend (any) money. The correlation was r_{pb}=0.57 (N = 12, p=.05, 2-tailed), when the criterion was offering to lend the full amount; it was r_{pb}=0.72 (N = 11, p=.01, 2-tailed) when the criterion was disclosing the home address. Apparently, raters were heavily influenced by whether or not participants offered to lend money and disclose their home address, though not all the variance in rated appropriacy is explained by these criteria. Perhaps raters were also influenced by other aspects of the interaction and were rating not only what was said but how it was said.

Comparisons between AS/HFA and the TS group

If individuals with AS/HFA have problems understanding nonliteral speech and with inappropriate requests, independent of executive ability, then there should be a significant difference at the group level, with the TS group rated as having better understanding or responding more appropriately (hence, despite the difference between all three experimental groups approaching significance on BADS profile score, this is taken into account statistically on an individual level in HLM). To address this question, I conducted a series of analyses analogous to those presented above.

For the Figure of speech scenario there were no Level 1 or Level 2 predictors and the intercept was allowed to vary randomly. The mean rated score for all 24 participants was 4.03 and the reliability estimate was high (0.90). A significant chi-square for the variance component [χ^2 (23) = 247.97, p < .001] suggested that the Level 1 intercept was a random effect and the intraclass correlation coefficient was 28 percent. This established, the fixed effect of BADS profile score was included as a Level 2 predictor and the associated coefficient was significant ($\underline{t}$ (22) = 4.37, $\underline{p} < .001$). The inclusion of group did not significantly increase the level of prediction. A model which included only the BADS profile score as a predictor accounted for approximately 39 percent of the between-participant variance, while a model which used only group accounted for about 20 percent of the variance. The model using both Level 2 predictors accounted for approximately 48 percent of the variance and reliability remained high (0.83). In other words, any difference in rated score between groups could largely be accounted for by differences in measured executive ability.

A pattern that was somewhat less clear emerged for the Sarcasm scenario. The mean rated score for all participants was 3.90 and the reliability of this estimate was high (0.87). A significant chi-square for the variance component [χ^2 (23) = 184.60, $p < .001$] suggested there was variability to be explained and the intraclass correlation coefficient was 29 percent. Level 2 models showed that the use of BADS score as a coefficient did not significantly predict rated score ($\underline{t}$ (22) =1.97, $\underline{p} = .06$) and neither was there an increase in the level of prediction when group membership was added to the model ($\underline{t}$ (22) = 1.15, $\underline{p}$ = 0.26). In other words, rated score did not differ between groups and did not vary with measured executive ability.

For the Appropriacy - lending money scenario, the mean rated score for all 24 participants was 3.69 and there was a high reliability estimate (0.95). A significant chi-square for the variance component [χ^2 (23) = 525.38, p < .001] suggested that there was variability to be explained and the intraclass correlation coefficient was 49 percent. This established, the inclusion of the fixed effect BADS profile score yielded a significant coefficient (t (22) = 4.39, p <.001). However, the inclusion of group alone as a Level 2 predictor did not give rise to a significant coefficient and the model that included both group and BADS had no advantage over a model that included BADS alone in explaining rated appropriacy. The final model which included only the BADS profile score as a predictor accounted for approximately 37 percent of the between-participant variance, with the reliability of the estimates for the intercept remaining high (0.93). In other words, participants with higher measured executive ability tended to be rated as responding more appropriately to the request, irrespective of which clinical group they belonged to.

A very similar picture emerged for the Appropriacy - disclosing home address scenario. In a Level 2 model including BADS but not group, the coefficient was significant (t (18) = 2.66, p = 0.02), but the level of prediction did not increase further when group was added. Moreover, a Level 2 model using group on its own failed to generate a significant coefficient. The final model which included only the BADS profile score as a predictor accounted for approximately 31 percent of the between-participant variance, with the reliability of the estimates for the intercept remaining high (0.80). An analysis based on the combined appropriacy scores confirmed that measured executive ability but not clinical diagnosis predicted rated appropriacy.

Reflective versus working understanding of nonliteral language

To see if AS/HFA participants were more likely to show understanding in Bubble Dialogue than in answer to story comprehension questions, participants were given the original 'paper and pencil' version of the Strange Stories test (Happé, 1994) approximately a year after they had the computer-mediated role-play. One of the original 12 participants did not take part in this follow up having withdrawn from school. The remaining 11 participants were given the Sarcasm and Figure of Speech Strange Story vignettes either by their teacher or by myself.

Using the coding scheme from Happé's (1994) study, participants' responses to the 'why questions' were scored either correct or incorrect, and either involving mental state or physical state justifications. The degree of concordance between two raters was initially 72 percent and 82 percent for the Sarcasm and Figure of Speech vignettes respectively. After discussion between the two raters, and changes from both parties, the rates rose to 100 percent and 92 percent. The 8 percent disagreement was due to one unresolved response, and my judgement that the participant used a correct mental state was used in the analysis. This is consistent with Happé's (1994) protocol that the participant should be given credit of their best answer. These differences in agreement and subsequent negotiations do highlight, however, the potential pitfalls of relying on only two raters, in that it is not always easy to agree upon what constitutes correct mental/physical state understanding.

Eight out of the 11 participants were scored as giving correct mental state justifications for the Figure of Speech Strange Story, and 9 out of 11 were credited with correct mental state answers for the Sarcasm vignette. This suggests that the AS/HFA participants in this study are amongst the most able in terms of judging reflectively on nonliteral speech. These scores were then point-biserally correlated with the mean rated scores from computer-mediated role-play scripts for understanding sarcasm and figure of speech.

For the Figure of Speech, a significant correlation of r_{pb}= 0.63 (N = 11, p =0.04, 2-tailed) suggested that individuals who were rated as showing reflective understanding in Happé's (1994) procedure were likely to be rated as showing working understanding when they computer role-played the scenario. This was supported by the fact that two of the three participants who did not give correct justifications were rated significantly below the predicted mean for their rated understanding of figure of speech (see Figure 4). This analysis suggests that both computer role-play and comprehension of a relevant vignette overlap in tapping into understanding of figure of speech.

For the Sarcasm scenario a non significant correlation of r_{pb}= 0.03 (N = 11, p =0.93, 2-tailed) was found. Because there was a large proportion of individuals coded as understanding sarcasm in Happé's (1994) story (9 out of 11), perhaps there was insufficient scope to demonstrate a significant relation between the two measures. Curiously, some of the participants who had relatively low blind ratings for understanding sarcasm were rated as giving a mental state response in Happé's version on follow up.

6.5 Discussion

Reputedly, it is notoriously difficult to coax individuals with autism to participate in role-play. In the current study, however, individuals with AS/HFA took to the computer-meditated role-play and adopted their character as introduced in the prologue. The dialogues generated by the participants included details that were appropriate for their character and were not merely a literal rendition of their own details. This in itself is surprising when considering results from studies which suggest individuals with autism have difficulty with generativity (Turner, 1999).

Generally, the data reported convey the heterogeneity of autistic performance. It was not the case that individuals with AS/HFA uniformly underperformed on the various measures. Some performed well and some performed not so well. This gives a preliminary impression that there is not something essentially autistic that leads individuals with AS/HFA to underperform in understanding a figure of speech or in responding to an inappropriate request. A cocktail of autism and certain levels of verbal or executive ability might predict understanding of nonliteral language and responding suitably to inappropriate requests. This possibility is considered below.

It seems appropriate to begin by asking what the ratings of performance were measuring. The rating of understanding figure of speech tapped into a level of understanding that participants with AS/HFA were able to articulate reflectively. There was a distinct relation between participants' rated understanding in computer-mediated role-play and their ability to answer story comprehension questions roughly one year later that were designed to probe understanding of figure of speech. It was reasonable to expect that there might not have been a strong relation, if the two methods had probed different levels of performance. In that context, it is interesting that a measure of reflective understanding and a measure of working understanding should correlate, especially when considering the long period of time that elapsed between the two testing sessions. Apart from indicating that the two measures are reliably testing the same ability, it suggests considerable stability in performance that endures over a period of a year.

Participants with AS/HFA performed surprisingly well in the test of reflective understanding which indicates that these participants are among the most able in the autistic population. Another possibility, though, is that performance on the reflective test was elevated by the experience of computer-mediated role-play one-year previously. The possibility that computer-mediated role-play could serve as a useful educational tool is beyond the scope of the current study but deserves priority for investigation in future research.

Turning to the Appropriacy scenarios, it seems that raters were influenced by whether or not the participant offered to lend money or disclosed their home address. The correlation between ratings and these categorical data were strong but imperfect, suggesting that other aspects of communication were also influencing the raters, perhaps concerning the manner in which participants responded to the inappropriate request.

Participants' rated understanding of figure of speech and responses to inappropriate requests was predicted by measures of their general verbal ability, though several members of the AS/HFA group underperformed in their rated understanding in a way that was not predicted by general verbal ability. Participants' rated understanding of figure of speech and responses to inappropriate requests was also predicted by their measured executive ability. Indeed, after taking into account measured executive ability, it was not possible to discriminate between the rated performance of individuals with AS/HFA and TS. In short, autistic rated performance in these tasks has something to do with verbal ability and executive ability. The relation between executive and language ability has been closely investigated by Bishop and Norbury (two papers under review) who found that non-autistic children with pragmatic language impairment (PLI) were just as impaired as children with autism on a test of response inhibition and had problems generating novel ideas ('generativity', see Turner, 1999). Additionally, Liss et al. (2001) found that differences in performance on the Wisconsin Card Sorting Task between language impaired and autistic children were no longer significant when verbal IQ was covaried.

In the current study the clinical diagnosis of the participant as having AS/HFA does not explain any additional variance in rated performance after measured executive ability is statistically taken into consideration. Moreover, there was no difference in the rated performance of a group of individuals with AS/HFA compared with a TS group which also had a distinctive executive profile. In other words, there is nothing mysteriously autistic in the performance on these tasks by individuals with AS/HFA. Hence, my results offer no grounds for looking beyond executive abilities in explaining rated understanding of figurative language and rated responses to inappropriate requests. This suggestion is somewhat surprising in relation to Happé's (1994) conclusion. She found a link between understanding figurative language and being able to diagnose higher-order beliefs. Her account seems to suggest that a uniquely autistic deficit in mentalising can explain autistic difficulties with figurative language.

The results suggest, then, that not all of these participants with AS/HFA had problems with figurative language and inappropriate requests. Moreover, any such problems seemed to be secondary to aspects of verbal ability and executive functioning. This finding might pose a problem for the specificity claim of the theory of mind hypothesis of autism (Baron-Cohen, 1995), which states that autism involves a domain-specific deficit. The results of the current study, rather, are consistent with theories which propose that impairments in mentalising are subordinate to more general cognitive or executive impairments (Frye, et al., 1995; Riggs, Peterson, Robinson & Mitchell, 1998). Neurological evidence also points to interlinking in mentalising and executive function, given that both kinds of ability are located in the frontal lobes (Stuss et al., 2001). On the other hand, Fine et al. (2001) report a single case of a man with early left amygdala damage who performed well on a battery of executive function tasks, including the BADS, but failed a number of theory of mind tests, including Happé's Strange Stories.

Apart from the possibility that some individuals with AS/HFA responded to figurative language and inappropriate requests in a suitable way, I also found that some individuals without autism, notably some of those with TS, did not always perform ideally. It seems that individual differences in rated scores were attributable largely to executive ability, suggesting that executive ability may be a more important factor in predicting rated performance than clinical diagnosis. Hence, impaired performance on these tasks is not unique to autism.

Attending now to the value of using Bubble Dialogue as an investigative tool. The fairly high level of correlation between rated understanding based on Bubble Dialogue transcripts and the reflective understanding measured in Happé's (1994) procedure indicates that the two techniques measure the same thing. In as much as Happé's task measures mentalising, so it would seem that rated understanding of figurative language measures the same. Although my task might offer a valid measure of understanding, there needs to be an identification of further benefits for its use given that it is somewhat laborious to administer, score and analyse.

The procedure of using computer-mediated role-play to investigate understanding of nonliteral language comprehension is arguably more useful than a 'paper and pencil' test, both in principle and practically. It is a useful task in principle because participants demonstrate their working understanding in a simulated conversation, which might have more in common with real-life performance, in contrast to reflecting on a vignette whose relevance to real life is uncertain. Indeed, Green, Gilchrist, Burton and Cox (2000) found that despite good abstract understanding of social relationships, adolescents with AS showed a profound lack of social ability in every day life. Consequently, computer-mediated role-play of different scenarios may tap into a level of functioning that is closer to real-life behaviour than a test which probes reflective understanding.

Computer-mediated role-play is also a useful tool on practical grounds because the scripts can be blind rated by multiple raters on the degree of understanding. Hence, the procedure is sensitive to subtleties in levels of understanding and is not confined to categorising participants as either passing or failing. The limitations of dichotomus 'all-or-nothing' tests has been criticized by Klin (2000). He states that because success on theory of mind tasks depends on verbal ability, this results in too much discrepancy between theory of mind task performance and everyday social functioning in autism. This is because social ability is on a continuum, with degrees of competence, rather something that either one has or has not (Klin, 2000). My gradation of competence via use of blind raters and rating scales also allows statistical analysis at the level of the individual participant, thereby demonstrating the heterogeneity of performance within a group of individuals with autism. There was a striking level of consistency between raters, as indicated by high estimates of the average intercept reliability for all the empty models (i.e. the models without any Level 1 or 2 predictors). These high levels of reliability indicate good agreement in what raters thought of as evidence for showing understanding sarcasm, figure of speech and appropriate behaviour.

Given the high levels of inter-rater agreement, it was surprising to find a lack of correlation between rated understanding of sarcasm and other potential predictors. Rated understanding of sarcasm is quite different from rated understanding of figurative language in this respect. Evidently, it would not be wise to treat these two measures as tapping into the same underlying competence. While the main challenge posed by figurative language might be to understand what is meant rather than what is said, sarcasm might pose the challenge of understanding how an utterance alludes to an implicitly or explicitly stated expectation that has not come to fruition (Gibbs, 1986; Gibbs, 1994; Jorgensen, Miller & Sperber, 1984).

Apart from being a useful tool for investigating understanding of nonliteral language, computer-mediated role-play is also valuable for investigating aspects of socialisation, such as responses to inappropriate requests. The measure seems reliable, given that if a participant is rated as inappropriate in lending money, they are also likely to be rated as inappropriate in disclosing a home address. Impairment in socialisation is perhaps the most important of the autistic triad in the light of Gillman, Carter, Volkmar and Sparrow (2000) reporting that 48 percent of the variance in diagnosis is accounted by impairment in socialisation on its own.

Channon, Charman, Heap, Crawford and Rios (2001) state that although clinical reports show that individuals with AS have difficulties in social situations, these are seldom documented systematically. In the current study raters were essentially asked to make judgments about the appropriacy of specific responses to a social situation. The consistency of the raters, coupled with the strong correlation between Appropriacy scenarios, suggests that there is consensus about social norms; it is widely recognised as inappropriate to lend money on first meeting someone and to disclose your home address.

Two studies have attempted to investigate understanding of social behaviour in autism (Channon et al., 2001; Loveland, Pearson, Tunali-Kotoski, Ortegon & Cullen Gibbs, 2001), and both required participants to make reflective judgements about others' interactions or to supply solutions to problems arising in social contexts. Loveland et al. note that high-functioning individuals with autism sometimes show social understanding when asked to reflect on social behaviour and yet show inappropriate behaviour in everyday life. They suggest that either the measures of detection under test conditions are too coarse to detect subtle group differences, or that individuals with autism may know about social appropriateness, but may not act upon their knowledge.

Computer-mediated role-play might offer a more direct and valuable method of investigation because it allows us to observe how individuals apply their knowledge of social appropriateness, rather than merely reflect on what is appropriate or inappropriate.

Chapter 7

Autistic communication using different media: Computer versus telephone

"To understand another's speech, it is not sufficient to understand his words- we must understand his thought. But even that is not enough - we must know his motivation"

(Lev Vygotsky from *Thought and Language*)

7.1 Introduction

The results, from the study reported in Chapter six, showed that impaired communicative performance was explained, to some extent, by executive impairment. However, the precise role of executive function and how it relates to communication is not known. A clue to this relation may come from the affinity that individuals with autism seem to have for computers.

In the study reported in Chapter six, individuals with autism showed they could role-play characters in computer-mediated communication, and this supplements other evidence suggesting that they are at ease using computers in everyday life (Prior et al., 1998). Hypothetically, one of the benefits of internet-based communication may be that it mitigates some of the executive problems seen in the disorder, by slowing down the tempo of communication. Therefore, by investigating internet-based communication in individuals with autism, we may be able to ascertain the role of executive function in communication.

7.2 The internet and autism

Higher-functioning autistic individuals are known to use email and chat rooms because 'aspergers only' internet relay chat rooms are now available. What is it about communicating using the internet that seems to be so appealing to individuals with autism, despite their well documented verbosity (Happé, 1994)? Is there something about the internet that facilitates communication for everyone, or does it have a special significance for this population? In their own words:

"If you cannot or do not want to socialize in real life you may find some pleasure in doing it online. Meet people who are similar to you!"

"Communication is complicated for people with autism. It may be easier on IRC than in real life, but still difficult."

"#asperger is autistic territory! Channel conversation is private and to be held in the strictest confidence. We do our best to keep troublemakers out and provide a safe place for people on the autistic spectrum." Taken from the introductory page to the #asperger IRC channel (#aspergers, 2002).

There is clearly a suggestion that on-line communication may be more comfortable, easier and safer for people with AS/HFA. Experimental evidence also suggests that internet-based technologies may be appropriate for people with autism (e.g., Rajendran & Mitchell, 2000; Chapters five and six of this thesis). Additionally, virtual reality applications are being designed specifically for people with AS (e.g., The 'AS Interactive' Project', based at The University of Nottingham, Parsons et al., 2000. See Parsons & Mitchell, 2002, for a discussion of the merits of virtual reality in AS social skills training).

Despite the fact that people with autism use chat rooms, autistic communication via different media has yet to be compared. Rectifying this gap in our understanding may be useful because although autism is a disorder of communication, it may be that individuals with autism are able to communicate more effectively in some media than others; for example in text chat. This kind of information, as well as being of applied value, may also hint at the source of autistic communicative impairment. For example, if being in close proximity with another person is a problem for autistic individuals, then this can be overcome with a computer or telephone, thanks to the physical distance between interlocutors. Hence, individuals with autism would be expected to show similar competence in both media, despite one being spoken and the other written. However, if the problem lies with the immediacy of communication, then computer-mediated interaction should be a more effective media than the telephone. This is because communication via computer slows downs the tempo of exchanges. Thus, a conversation which in real-time might take minutes, could be drawn out almost indefinitely in text chat.

As well as improving communicational competence, by moderating the stream of incoming information, text chat may also mitigate some of the social problems seen in autism. For example, the prosodic aspects of autistic communication, like pedantic speaking style (Ghaziuddin & Gerstein, 1996), are not likely to be apparent through computer-based communication like text chat. This may be especially significant for individuals who are aware of their own speech idiosyncrasies, and have the knock-on effect of increasing their confidence, as well as eliminating any grounds for prejudice the listener may have. This social parity offered by internet communication may also benefit people with other disorders. For example, an individual with Tourette syndrome, who took part in the study reported in Chapter six, stated he preferred computer-mediated communication, because through this medium his motor tics remained unseen.

The recognition of the broader appeal of chat rooms has not been lost on sites like #asperger who realise that people aside from those with autistic spectrum disorders might want to use their service:

"#asperger is your channel if you are somewhere on the autistic spectrum. The autism spectrum includes autism, Asperger syndrome, and PDD-NOS. One thing we have in common is an impairment in nonverbal communication with neurologically typical ("normal") people that causes social difficulties. People with conditions such as hyperlexia, Tourette syndrome, schizoid personality disorder, social phobia, etc., may join the channel if there is also impairment in nonverbal communication. Loners with an autism-like condition are welcome."

7.3 Communication and executive ability

Rajendran and Mitchell (2000) argue that communicating via the computer offers more time for people to compose a response, and this may be beneficial for individuals with autism because they are known to have sensory-perceptual abnormalities (O'Neill & Jones, 1997). Unlike face-to-face conversation, which requires a lot of information to be processed quickly (e.g., facial expression, intonation), computer-mediated interaction slows down the speed of human communication. This may be especially significant because assessments of this population are usually done face-to-face, and often by people unknown to the participants. Thus, the assessor's unfamiliarity might create additional processing demands.

A study by Pascualvaca, Fantie, Papageorgiou and Mirsky (1998) found that children with autism performed as well as controls on a computerised version of the Wisconsin Card Sorting Test, but significantly worse than controls on the standard, non-computerised version. The researchers suggested that socio-motivational factors could be responsible for this result, that is individuals with autism might prefer to receive feedback about their performance from a computer rather than an examiner. However, an alternative explanation is that the computer reduces the distraction associated with human testing. For typically developing people, a change in the modality of testing may be inconsequential because they may be impervious to extraneous 'social noise'. However, for individuals with autism any noise reduction may be significant enough to elevate their performance because of their inability to filter it.

Additionally, more immediate forms of communication may require the quick generation of novel responses, something which individuals with high-functioning autism find difficult (Turner, 1999). Hence, by offering more time to respond, autistic individuals may be able to generate a greater number of novel questions. In this fashion the computer may be thought of as an executive or temporal buffer, because it slows down the speed of communication and responses.

Evidence for the temporal aspects of cognition and communication come from Bowler (1997) and Kaland et al. (2002) (see Section 4.6, p.86). Bowler found that individuals with AS were slower than typically developing individuals at answering both mental and non-mental state questions. Kaland et al. (2002) also used the time taken to answer test questions as an index of processing ability. These researchers found that an AS group took longer than a normal comparison group in answering physical inference questions based on reading a vignette, and that this difference was even more pronounced on answering the mental inference questions. The AS group also took longer on the mental inference questions than on the physical questions.

Kaland et al. (2002) interpreted these findings as evidence of Hermelin and O'Connor's (1985) 'logico-affective' states because the AS individuals may be using cognitive rather than affective mechanisms to work out the correct mentalistic answers, hence taking longer. Kaland et al. (2002) argue that this view of social impairment fits Bruner and Feldman's (1993) description of interacting with people with autism as similar to waiting for someone who is calculating his next move, or solving a complicated maths problem. This description of waiting for an ensuing move sounds remarkably similar to a text chat/email exchange. Thus, communication through text chat may provide autistic individuals with a cognitive rather than an affective route to understand others' communications, by offering more time to respond, as well as masking any slowness on their part. Hence, this is well tailored to their mode of functioning and, consequently, their communicative performance might be optimal in a text-based modality.

7.4 Is there a way of showing that computers are especially suited to people with autism as tools for communication?

Comparing text chat with telephone conversations may help to identify what aspects of communication are distinctive in this population. The telephone provides a social distance like the computer, but unlike the computer it has all the immediacy of face-to-face communication. However, one fundamental difference is that spoken language is used via the phone, whereas written language is used through the computer (at least until voice recognition programs become widely used).

This chapter reports a study in which individuals with AS were given an adaptation of Lloyd's (1991, 1992) referential communication route task. In his tasks, pairs of children spoke to each other over the telephone. They communicated directions across a model landscape, navigating via a series of landmarks including shops, churches and houses. Lloyd (1992) used this method to investigate the recognition of ambiguity in both listener and speaker, and the repairs children used to disambiguate communication.

This paradigm has its roots in a classic experiment by Krauss and Glucksberg (1969) in which they investigated children's ability to take into account the informational requirements of a listener. In this experiment, children were asked to describe a series of shapes to another child who had an identical set of shapes. Children got the game right if the listener arranged the shapes in the same order as the speaker pulled the shapes out of a dispenser. Hence the child who played the role of the speaker needed to describe each shape unambiguously. Crucially, the children were separated from each other by an opaque screen otherwise they would not have needed to verbally communicate with each other because the listener would have simply have had to look at the shapes.

The second generation of experiments, investigating referential communication, took the paradigm to a greater level of sophistication (see Robinson & Whittaker, 1987, for a review of these studies). Instead of describing shapes, children in the role of speaker were often asked to describe a set of similar items (varying on features like size, colour and form) so that the listener could identify the target among an identical set. Thus, the speaker must encode a message that uniquely describes the selected item so that the message receiver can identify the referent from the array provided. The results from these studies seem fairly consistent in that children under the age of six years old often do not realise that the verbal messages can be ambiguous (Robinson & Whittaker, 1987).

In Lloyd's route task the interlocutors were unable to see each other, this created a need for the child playing the role of the speaker to generate unambiguous verbal descriptions. Even if the interactants could see each other, but not their maps, it would still be unusual to ask the participants to work out a map route when the person who had the solution was sitting directly in front of them. This would be not be an ecologically valid condition. Hence, children communicated via the telephone in Lloyd's task. Typically developing children are known to produce bizarre responses, and make inappropriate inferences, when performing tasks for which they do not understand the purpose of (see Siegal, 1997, for a review for this research). In the case of individuals with autism, who have a disorder of communication, one has to be even more careful not to introduce any extraneous artefacts to the task itself which may subsequently affect the results. Hence, in this study Lloyd's (1991, 1992) telephone condition was supplemented with a text chat condition.

Lloyd (1992) argues that whenever the experimenter is an interlocutor, his or her contribution has to be acknowledged. One way to divorce the experimenter from the dyad is for the participants to directly communicate with each other, as in Lloyd's method. However, organising two individuals with AS to communicate with each other is fraught with practical and logistic difficulties. Hence, this leaves the experimenter as one of the interlocutors, and thus his/her role needs to be acknowledged and either statistically partialled out, or his/her responses should be standardised in some way.

In this study, participants were asked to work out map routes. They did this by asking the experimenter (myself) closed questions on the telephone, or by text chat. Thus my responses were limited to 'yes' or 'no' answers. Therefore, in addition to standardising the experimenter's responses, this method ensured participants did most of the conversational work. This is something that may require, amongst other things, executive ability to generate novel questions (Turner, 1999). The intriguing point is that usually the experimenter has to be wary of asking questions that are leading, ambiguous or confusing. In this study it was the participant who had to avoid these pitfalls in order to work out the correct route. Thus, the onus was on the participant to take the lead role in the communication and formulate questions. They could use the answers to work out the route taken. The hypothesis was that individuals with AS would be more efficient and effective on text-chat than on the telephone, at working out the routes, despite their renowned verbosity (Happé, 1994) which might be reflected in their telephone communication.

The benefit of this methodology is that it adapts an already well established telephone-based route solving task, and generates quantitative data such as scores for correctly working out the routes, the time taken to finish, and the number of conversational turns taken to completion. Additionally, the detail of what is actually typed and written can be viewed and analysed. This enables the strategies that the participants use to work out the routes to be looked at. Thus, this method allows the investigation of the relations between quantitative and qualitative data.

7.5 Method

Participants

Ten individuals with AS and one with HFA were recruited for this study. The sole participant with HFA was originally diagnosed with AS, but this was later changed to HFA by his clinician according to his mother. For the purposes of this study, the HFA individual was combined with AS individuals to form the AS group. These participants were recruited via the Leicestershire Autism Outreach Team, or though the Leicestershire, Derbyshire and Nottingham Autistic Support Groups which require students and members to have formal diagnoses made by clinicians. None were known to have a diagnosis co-morbid with any other disorder.

The typically developing comparison participants, known as the control group, were selected to match the AS participants in terms of gender, and as closely as possible in terms of age, level of education and verbal IQ. The gender composition of each group was nine males and two females. Table 8 provides details of chronological age (CA), verbal IQ (VIQ), performance IQ (PIQ) and full-scale IQ (FSIQ) - WASI (Wechsler, 1999). Four one way ANOVAs revealed no significant differences between the groups on any of the variables: CA, $F(1, 20) = <0.001$, $p = 0.98$; VIQ, $F(1, 20) = 0.34$, $p = 0.56$; PIQ, $F(1, 20) = 0.89$, $p = 0.36$; FSIQ, $F(1, 20) = 0.05$, $p = 0.82$; BADS profile score, $F(1,20) = 1.68$, $p = 0.21$.

Table 8 Participants' characteristics

Participant[a]	CA	VIQ	PIQ	FSIQ	BADS
AS					
M	21.70	114.45	95.36	105.72	16.72
SD	10.30	13.22	23.50	22.15	4.10
Range	14-45	88-148	58-128	76-139	10-22
Control					
M	21.79	110.36	103.36	107.55	18.45
SD	11.13	13.22	15.53	14.20	1.63
Range	13-46	94-137	76-121	86-133	15-21

[a]n = 11 per group

Materials

The hardware used were two PC lap tops (ACER 203TX and Compaq Pressario) installed with network cards and connected for text chat by a cross wire serial connection. The text chat program installed on both machines was RUThere version 3.4 (Szotten, 1999). The other software installed was KP Typing Tutor (Huang, 2001). Other hardware materials included a stopwatch, a Phonapart 2-way telephone conversation recorder and a dividing screen. Two maps were used, one of which was created by Lloyd, Peers and Foster (2001) as part of The Listening Skills Test (Figure 8), and the other (Figure 9) was created by myself using various clip art and Microsoft® Paint. For the purposes of this study Lloyd et al.'s (2001) map was known as the School Map and the map specially created for this study was called the Digger Map. The Digger Map was created in the likeness of the School map, in terms of the overall route layout, the number of landmarks and their location.

Figure 8 shows the map from The Listening Skills Test (Lloyd, Peers & Foster, 2001)

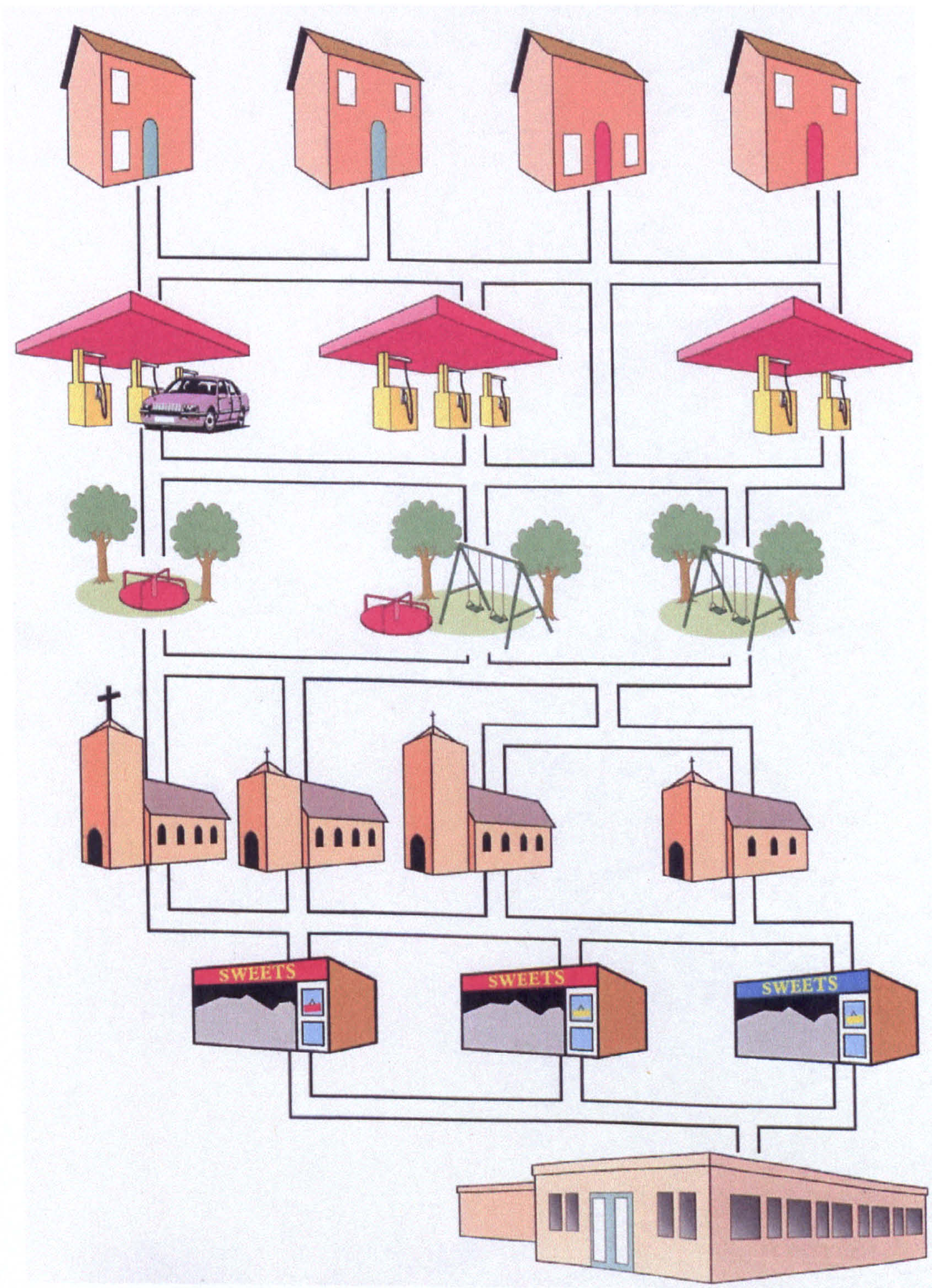
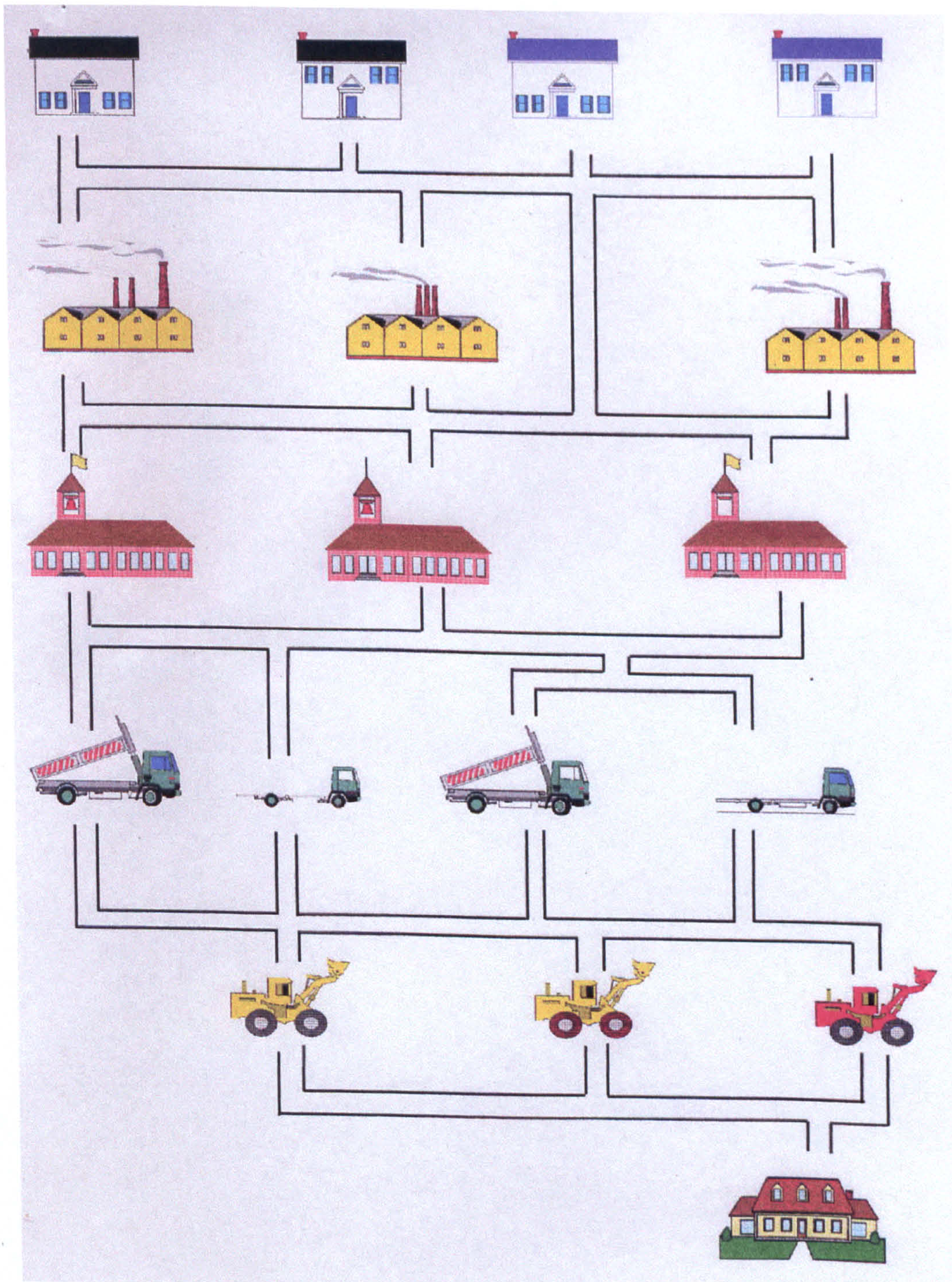


Figure 9 shows the may map created by myself, in the likeness of the map from The Listening Skills Test



Measures

All participants were tested with the Behavioural Assessment of the Dysexecutive syndrome (BADS - Wilson et al., 1996), and the Wechsler Abbreviated Scales of Intelligence (WASI – Wechsler, 1999) which consists of four subtests: Two assess expressive VIQ and two assess PIQ. Both scales combine to give a FSIQ score.

Design

The experimental design was such that half of the participants were given the text chat version of the task first, followed by the telephone version. The other 11 participants received the telephone version first, then the text chat version. The counter-balancing is shown in Table 9, and was designed so that any practice effect, or systematic map effect would be shared between the participants across all four trials. The solution routes for each map were different for each of the four trials, were the same for each participant, and were randomly predetermined before the testing phase.

Table 9. The counter-balancing of maps and media across participants

Participant	School	Digger	Digger	School
1	C	T	C	T
2	T	C	T	C
3	C	T	C	T
4	T	C	T	C
etc.	etc.	etc.	etc.	etc.

C= computer T= telephone

Procedure

All participants were tested in a quiet space either in their place of education, work, or home. Most of the participants were tested in three separate sessions: one for each of the BADS, WASI and text chat versus telephone tasks. The order in which they received the sessions varied.

In the experimental session, participants firstly completed three to four drills on KP typing tutor. This was to familiarise them with the keyboard as well as measure their typing speed. Then they were asked the following questions to elicit their usage of, and preferences for, the computer and telephone:

1) "Approximately how much time do you spend on the phone each week?",

2) " How much time do you spend on the computer each week?", and

3) "Do you prefer communicating with the telephone or computer? Why?".

Note that two measures of time spent on the computer were taken: one for time spent on the computer the other for time spent communicating via the computer. Two measures for time spent on the telephone were also taken: one for time speaking and another for time spent text messaging.

Participants were then given a pencil and a four page booklet with a map on each page. All the booklets were identical and comprised copies of the School Map on pages 1 and 4, and the Digger Map on pages 2 and 3. Laying the first page of the map booklet in front of the participants, the experimenter said, "Look at this map. One day I walk from this school [pointing on map] to one of these houses [pointing on map]. You have to work out which route I took to go from the school to one of these houses by drawing on the maps using the pencil. You may ask me as many questions as you want, to work out the route, but I can only answer 'yes' or 'no'. Also you are not allowed to ask me questions like, 'Is it the one on the left, or the right, middle?' and so on. Although I will be using a stopwatch to time our text chat and telephone conversations, the most important thing is working out which route I took and not how long our conversations take."

The participants were then asked if they understood the instructions, and if they knew how to ask questions which could only be answered with a 'yes' or a 'no'. Even if s/he said they knew how to ask closed questions, the participant was still given examples of closed questions by the experimenter. S/he was then requested to ask me closed questions in return.

Task in text chat

Ideally the text chat condition would have taken place with the experimenter and the participant in different rooms, and communicating via a network. However, because this was not practical, the condition was set up to simulate real life, and so the participant and the experimenter sat in front of our respective lap tops, hidden from one another by a portable screen. This was erected so that the experimenter and the participant could see neither each other, nor each other's maps, nor what they typed.

The participants were told to begin typing, asking the first question, and at this point the stopwatch was started. The to and fro of questions and answers between participant and the experimenter continued until the participant intimated that s/he had finished the task. At this point timing was stopped. The completed text chat exchange was then pasted into a Microsoft® Word document at the end of the entire testing session.

The text chat program was set up so that the participant's text box was re-sized, so that only one line of text could be seen at any time. This was done to prevent the participant looking at the 'chat history'. This reviewing of conversation is something which cannot be done via telephone. Hence, the resizing of the text box was required to keep the working memory demands of both media as similar as possible.

Task on the telephone

The participant was then taken to a nearby room, and asked to complete the second map. At this point, the experimenter re-stated the instructions regarding working out the route using closed questions. He then made his way to another room and from there rang the participant either using an internal telephone or mobile phone. This was done so that the participant and the experimenter actually communicated as in real life, that is we were in separate rooms and not able to see one another.

As soon as the participant lifted the receiver the Phonapart machine began recording the conversation. After a brief exchange, the participant was asked to start and at that point the timing commenced. It was stopped once the participant had said that they had finished. The participants then completed maps 3 and 4.

Scoring, text chat, tape transcriptions and analysis

Map score was calculated by comparing the participants' maps with a master map of the predetermined routes. One mark was awarded for each correct landmark, corresponding to the correct route. Thus participants could score a minimum of 0 and a maximum of 5 per map, and hence the range was 0-10 per media type. In text chat each person's turn appeared on a new line and this format was used for the tape transcriptions. Therefore the number of turns taken to complete the task could be calculated for each trial.

7.6 Results

Table 10 shows that the AS group did not score as highly on the map task as the control group in either media condition. Additionally, the AS group scored higher in the telephone condition than in the text chat condition. In terms of turns taken to complete the maps, the AS group took a similar number of turns in both media, as did the control group. However, the control group took fewer turns to complete the maps. Not surprisingly the time taken to complete the maps was longer in text chat than on the telephone for both groups, although the AS group took longer in both media compared with the control group.

Table 10. The means (with standard deviations in parenthesis) for map score, turns taken and time taken for both experimental groups, for both media

Group & Media	Map score	Turns taken	Time taken (mins:secs)
AS			
Text chat	7.7 (3.1)	11.7 (3.1)	8:12 (3:36)
Telephone	9.0 (1.6)	11.4 (2.7)	1:45 (0:38)
Control			
Text chat	9.8 (0.4)	9.5 (1.0)	5:20 (1:14)
Telephone	9.8 (0.4)	9.5 (0.7)	1:16 (0:33)

Table 11 shows that the AS group were slightly faster at typing than the control group (the accuracies were high with most participants scoring between 90 percent and 100 percent for each trial). This competence is perhaps a reflection of the similar amount of time that the two groups spend using computers. However, the AS group spent a smaller proportion of that time in communication. Additionally, they also spent less time speaking on the telephone. Hence, in general the AS group spent less time communicating with others.

Table 11. The means (sds in parenthesis) of typing speed, time spent on the computer/email-text chat and speaking on the telephone each week

Group	Typing speed (words per min.)	Time spent on the computer per week (hours:mins)	Time spent on text chat/email per week (hours:mins)	Time spent speaking on the telephone (hours:mins)[a]
AS	25.3 (10.1)	12:59 (10:17)	0:48 (0.52)	0:45 (0:54)
Control	23.5 (5.4)	14:57 (11:09)	4:48 (6:26)	2:38 (2:54)

[a] many participants spent a significant amount of time text messaging, hence spoken time on the telephone was calculated separately.

One-way ANOVAs revealed no significant differences between the groups on any of the variables: Typing speed, $\underline{F}$ (1, 20) = 0.27, $\underline{p}$ = 0.61 ; Time spent on the computer, $\underline{F}$ (1, 20) = 0.19, $\underline{p}$ = 0.67 ; Time spent speaking on the telephone, F (1, 20) = 4.1, $p = 0.06$; Time spent on email/text chat, F (1, 16) = 2.99, $p = 0.10$. However, the data for time spent on email/text chat was positively skewed. This is perhaps why there was no significance between the groups, despite a relatively large difference in group means. Note that three participants with AS and one control participant were not asked to differentiate between time spent on the computer and how much of that time was spent on email/text. Hence, their scores did not contribute to that analysis. Note also that a few control participants said that they constantly had message boxes open, and so stated they were communicating through the computer whenever they were using it. Hence, this may give a false impression of the actual time the control group spent communicating on the computer.

What are the indices of effective communication?

Correlations between dependent variables (map score, time taken and turns taken), across all participants, suggested that all three were measuring the same phenomena relating to efficient communication.

For text chat, a significant negative correlation of $r = -0.47$ (N = 22, $p = 0.03$, 2-tailed) revealed that participants who were taking longer were scoring lower, and vice versa. A further significant correlation of $r = 0.70$ (N = 22, $p < 0.001$, 2-tailed) indicated that individuals who took more turns were also taking longer to complete the task. A significant negative correlation of $r = -0.54$ (N = 22, $p = 0.01$, 2-tailed), indicated that those who took more turns scored lower.

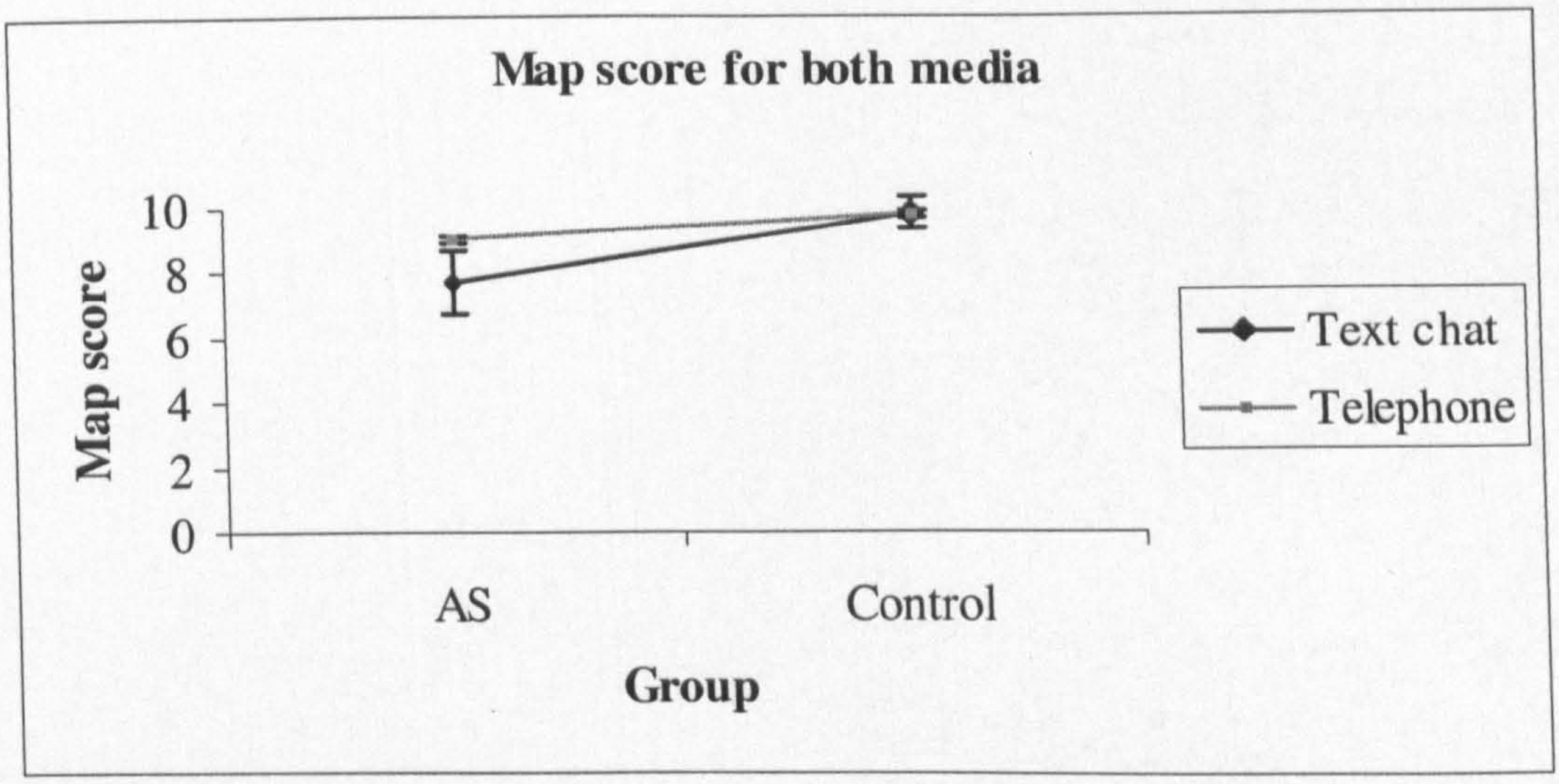
A similar pattern of correlations emerged for the telephone: a significant negative correlation of $r = -0.43$ (N= 22, $p = 0.046$, 2-tailed) between time taken and map score indicated that participants who took longer scored lower. A further correlation of $\underline{r} = 0.41$ ($N = 22$, $\underline{p} = 0.058$, 2-tailed) indicates that those who took more turns took longer to complete the task (the non-significance of this result was probably due to shorter times and smaller range of times on the phone than for text chat). A significant negative correlation of $\underline{r} = -0.58$ ($N = 22$, $\underline{p} = 0.01$, 2-tailed), indicates that individuals taking more turns scored lower.

The results of these correlations suggest that the dependent variables are all measuring aspects of the same phenomenon and that which ever measure is used in subsequent analyses, will predict performance of the others.

Using map score as the dependent variable

Figure 10 shows the mean map score for each group, per media type. Since the lines on the graph are not quite parallel, this suggests that the AS group might have found the task more difficult in text chat than on the telephone. This is relative to the control group who seemed to find it just as easy in both media. However, most of the control group performed at ceiling, as did some of the AS group, and thus the skewed nature of the data make them inappropriate for parametric statistical analysis. A Wilcoxon signed-ranks test for the AS group for map score, between both media, does however reveal a non significant result: $z = 1.49$, $p = 0.14$. This analysis was re-run, but without the data for participant P.R, who had a PIQ of 58. P.R. might have had visuo-spatial problems as indicated by his PIQ (which fell into the retarded range) and thus affected the group data given the nature of the map task. However, the result of the Wilcoxon signed-ranks test was non significant ($z = 1.12$, $p = 0.26$).

Figure 10. The mean map score for both media, for both groups



Turns taken

Using turns taken as the dependent variable, an ANOVA with group (AS or control) as a between subjects factor and media (text chat or telephone) as a within subjects factor revealed a significant main effect of group [F (1,20) = 7.12, p = 0.02], but not of media [F (1, 20) = 0.77, p = 0.79]. There was also a non-significant group by media interaction [F (1, 20) = 0.77, p = 0.79].

Figure 11. The mean number of turns taken to complete maps for both media, for both groups

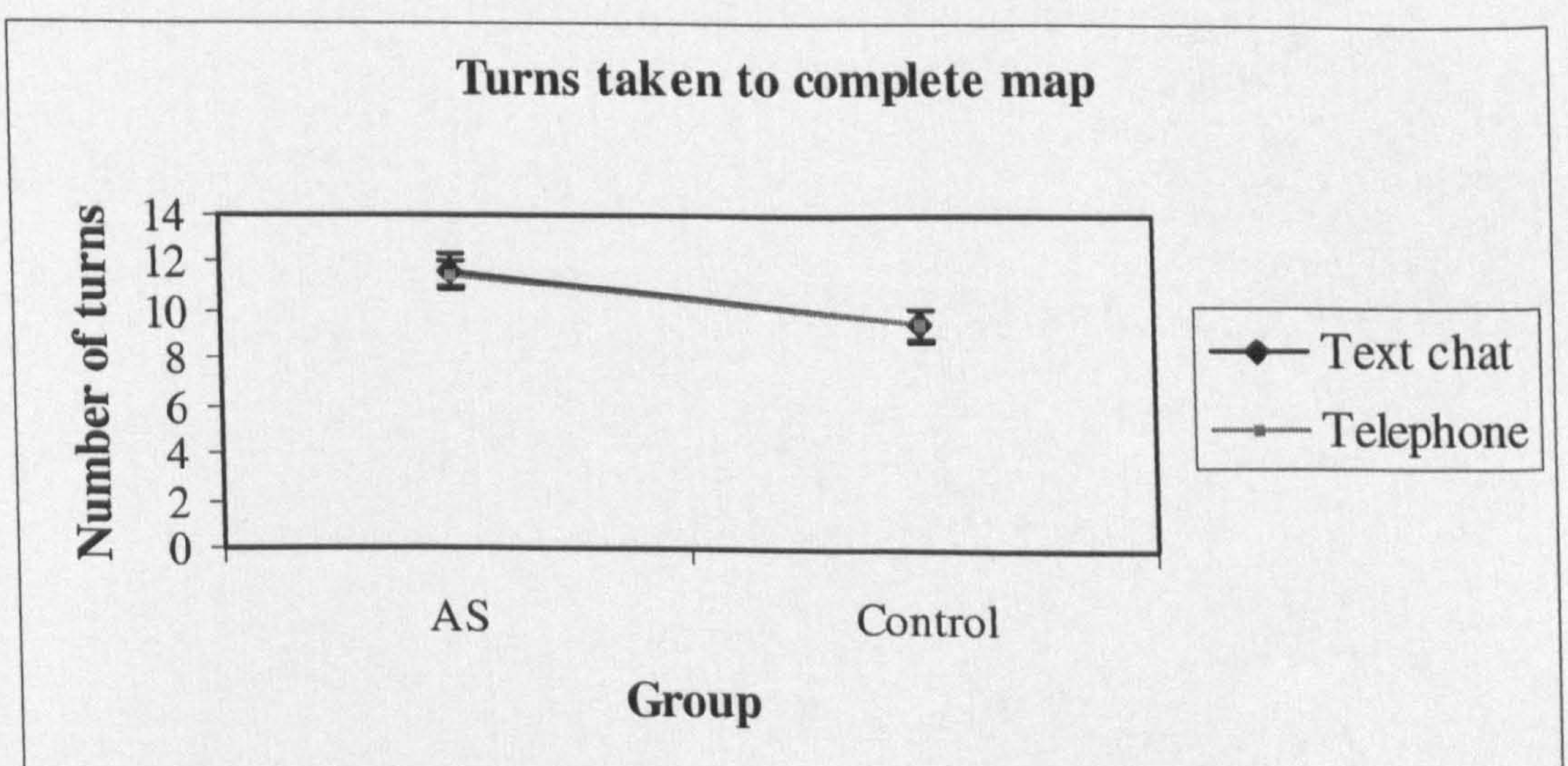
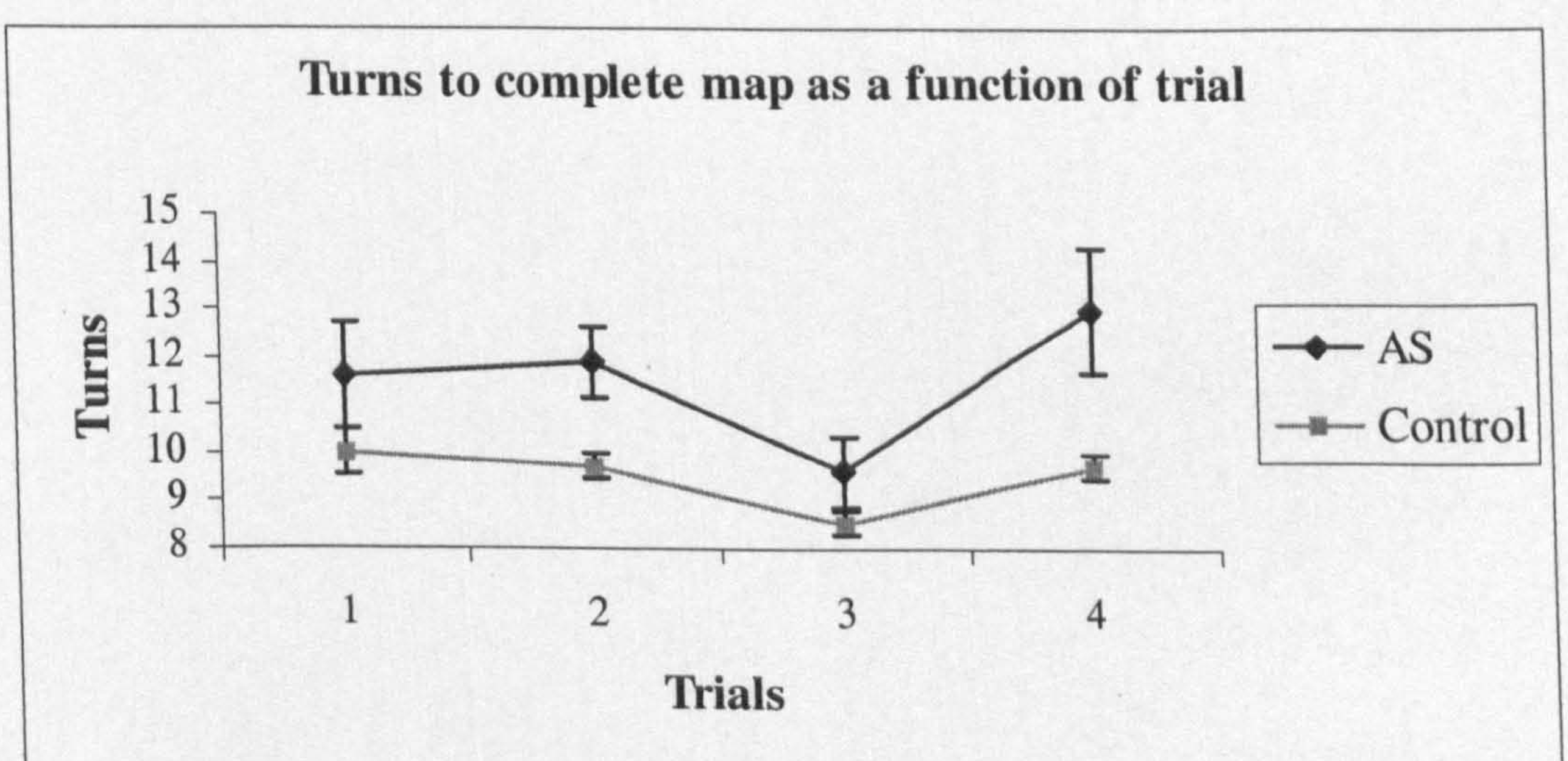


Figure 11 suggests that the AS group took more turns and therefore did not perform as well as the controls in either media. This result also suggests that the number of turns is independent of media and therefore this variable is independent of time as a measure of communicational efficiency.

The measurement of turns taken was used to investigate if there was a task learning effect. An ANOVA with trial as a within subjects factor and group as a between subjects factor revealed a significant effect of trial [F (3, 60) = 5.45, p = 0.002], and of group [F (1, 20) = 7.12, p = 0.02], but a non-significant trial by group interaction [F (3, 60) = 1.21, p = 0.31]. These results confirm that the AS group take more turns, but that there is learning effect. However, Figure 12 shows that the trial lines for both groups never meet, so there is never any parity between them. Interestingly the rise on the fourth trial after the dip on the third suggests that the participants were not performing as well as they had previously. This was perhaps due to experimental fatigue.

Figure 12. The number of number of turns taken to finish the task, as a function of trial

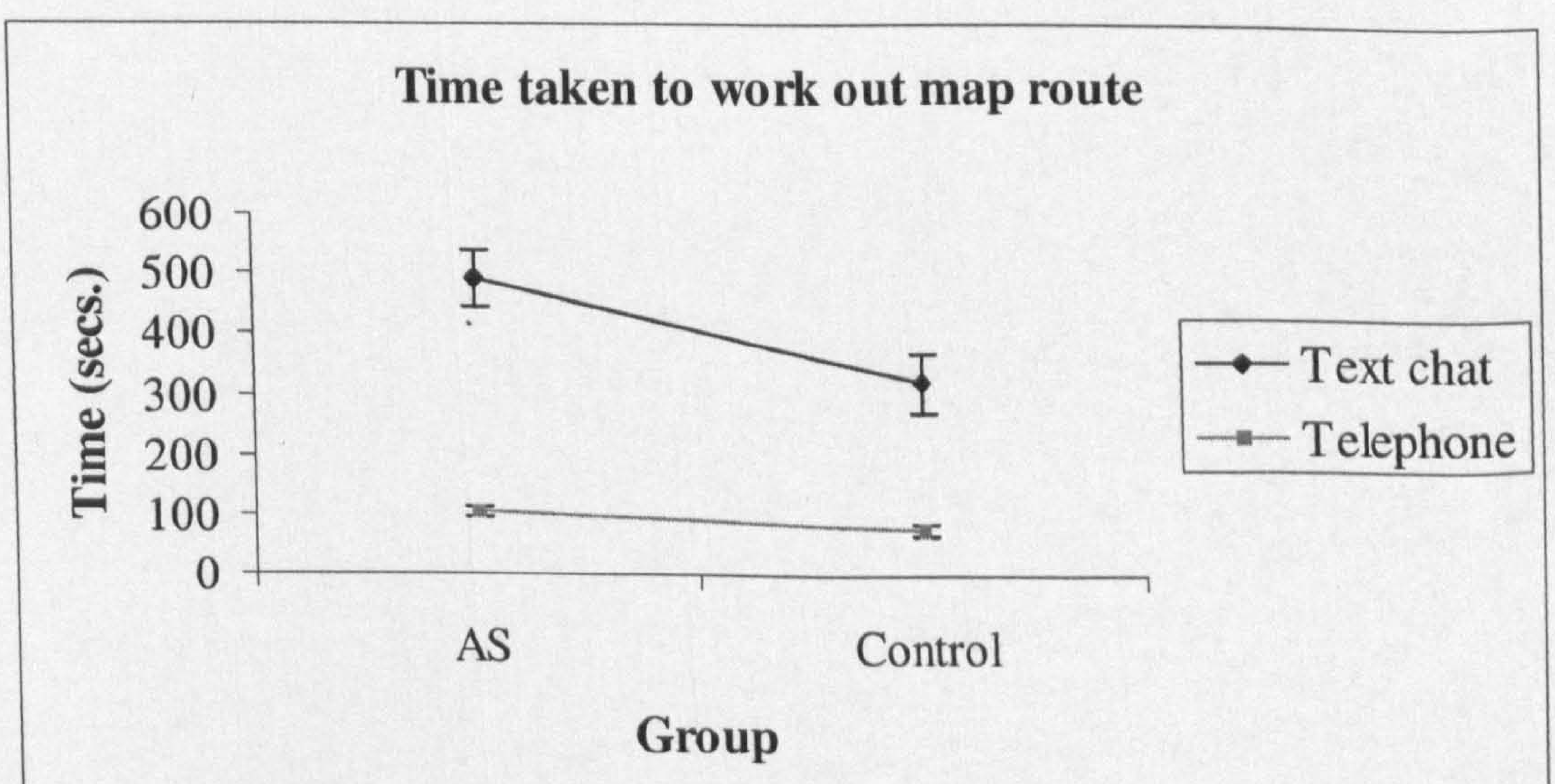


The suggestion of a practice effect is supported by the measures of time taken to complete the maps in both media. Paired sample t-tests reveal that participants from both groups were significantly faster on the second than first text chat trial, $\underline{t}$ (21) = 3.0, $\underline{p}$ = 0.007, and significantly faster on the second than first telephone trial, $\underline{t}$ (21) = 4.53, $\underline{p}$ <0.001.

Time taken

Using time taken as the dependent variable, an ANOVA with group as a between subjects factor and media as a within subjects factor revealed significant main effects of group [$\underline{F}$ (1,20) = 6.93, $\underline{p}$ = 0.02] and of media [$\underline{F}$ (1, 20) = 102.21, $\underline{p}$ <0.001]. There was also a significant group by media interaction [$\underline{F}$ (1, 20) = 5.28, $\underline{p}$ =0.03]. Figure 13 shows this interaction in graphical form.

Figure 13. The mean time taken to complete maps for both media, for both groups



Paired sample post hoc t-tests revealed that both groups were significantly faster on the telephone than the text chat version of the task: $\underline{t}$ (10) = 6.51, $\underline{p}$ = <0.001, for the AS group, and $\underline{t}$ (10) = 12.80, $\underline{p}$ = <0.001, for the control group. Independent sample post hoc t-tests reveal that the AS group were significantly slower than the control group on text chat [$\underline{t}$ (20) = 6.30, $\underline{p}$ = 0.021] and significantly slower than the control group on the telephone [$\underline{t}$ (20) = 5.42), $\underline{p}$ = 0.031].

This between groups difference is not, however, accounted for by group differences in typing speed and usage of computer and telephone, because all four variables were not significantly different from each other (see Table 11).

Thus far, these results suggest that the AS group were poorer at the map task in both media, compared to controls, and that they were especially poor relative to the control group on text chat. However, differences between groups in terms of their speed of completing the task, irrespective of media, may be accounted for by individual variations in executive ability. When BADS score was entered as a covariate, group differences for both media were no longer significant: for text chat, $\underline{F}$ (1, 19) = 4.05, $\underline{p}$ = 0.59, and for the telephone, $\underline{F}$ (1, 19) = 4.11, $\underline{p}$ = 0.57.

<u>The relation between executive ability and strategies to solve the map task</u>

The influence of executive ability may be seen in the strategies different participants used to complete the task. Each and every control participant used the map landmarks to deduce the route taken, asking questions including, " Did you pass a shop with a yellow sign on the door?". By contrast, five of the 11 AS participants asked questions such as," Did you go right?", or a combination of landmarks and left/right/up directions. These five individuals were consistent in this strategy, using it both in text chat and on the telephone. The remainder of the AS group used the map landmarks to work out the route taken, in both media, in the same way as the control participants. Table 12 shows a contingency table detailing the strategies used by both experimental groups. A chi-square calculation reveals that the different strategies used by the AS group and Control groups are unlikely to be due to chance: χ^2 (1)=6.5, $p = 0.01$.

Table 12. Strategies used to solve the map task by the AS and Control Groups, for both media

Group	Landmark	Left/Right/Up
AS	6	5
Control	11	0

Hence, there may be an association between strategy used and executive ability in so far as poor planning and organisation may account for the use of this relatively inefficient strategy. Thus, all participants were categorised as either using only landmarks, or left/right/up and other strategies to solve the map task. A significant point-biserial correlation $r_{pb} = 0.73$, ($N = 22$, $p < 0.001$, 2-tailed), revealed that BADS score and strategy used were associated. That is, individuals who had the lowest BADS scores tended to use left/right/up strategies and not use solely the landmark to work out the routes.

Correlating strategy with time taken on text chat, revealed a significant association, $r_{pb} = 0.627$, ($N = 22$, $p = 0.002$, 2-tailed). This suggests that individuals taking the longest time to complete the task used left/right strategies. For the telephone version of the task, a significant correlation, r_{pb} = 0.46, (N = 22, p = 0.03, 2-tailed) suggests again that individuals taking the longest time to complete this task used strategies other than referring to the landmarks.

A stepwise multiple regression (R = 0. 627, B = 263.9, SE B = 73.2, β = 0.627) revealed that strategy accounts for most of the variance (R^2 = 0.394), in time taken on text chat. Moreover, neither the addition of BADS score nor group made a significant contribution to the model. Due to the association between BADS score and strategy used, this suggested that those individuals with AS who have the lowest BADS score are those who have the least effective strategies for solving the task, irrespective of whether it is via the telephone or computer.

A similar pattern emerges for time taken on the telephone. A stepwise multiple regression for time taken on the telephone revealed that group accounts for most of the variance (R^2 = 0.213, R = 0.462, B = -29.4, SE = 12.6, β = -.046), and neither the addition of strategy nor BADS score significantly improves the fit of the model. Likewise, strategy accounts for a significant proportion of the variance (R = 0.209) and neither group nor BADS score significantly improve the fit of the model.

7.7 Discussion

The results of this study show that many individuals with AS are able to use closed questions to correctly deduce a predetermined map route. They can do this equally competently either through text chat or via the telephone, though in general they take longer to do this than typically developing controls. However, this may be because some AS individuals have executive problems reflected in their inefficient route solving strategies. The main question of whether individuals with AS are more efficient at communication via text chat than through the telephone was not definitively answered by this study.

This may have been due to many factors, including the possible insensitivity of the map task itself at tapping into any potential media differences. It is equally possible that people with AS may be genuinely more effective at communicating on the telephone than via text chat. This in itself would be noteworthy and interesting.

7.7a Measuring competence using map scores

One issue regarding task sensitivity, which would need to be addressed in any future study, is the scoring procedure. Since many participants were scoring at ceiling on the map task this skewed the data, making statistical analysis inappropriate. The map task could be made more demanding by introducing more levels of choice, or the discrimination between landmarks could be made more difficult. The high scoring on the task, however, may reflect a high level of competence for both experimental groups. Even though this study did not generate enough variance, so preventing discrimination between groups, this was not known a priori. Therefore, it may be that the AS group are genuinely good at the task, and that making it more difficult may not reveal group differences.

Additionally, the AS group's success on the task suggests firstly that some people with AS can generate novel questions, and secondly that they can use the answers from those questions to infer the correct map route. The former ability suggests that problems of generativity may not be universal to all AS individuals, or on all tasks. The latter indicates that at least some individuals with AS can use their linguistic ability flexibly to make inferences. This is in contrast to some studies in which autistic individuals show problems in making inferences (Jolliffe & Baron-Cohen, 1999b; Norbury & Bishop, 2002).

7.7b Measuring competence using turns taken

A potential problem for measuring differences between two different media is that text chat is typed and telephone conversations are spoken. This non equivalence is especially problematic if time taken is used as an index of competence because the spoken word is much faster than written communication. Therefore, using turns taken to complete the task provided a useful measure of efficiency because it was independent of time. This suggests that in any future experiments the number of turns taken can be used as a time-independent index of communicative efficiency.

In this study, examining turns taken suggests that the AS group were not as efficient as the controls at working out routes, in either media. Furthermore, both groups improved at the map task, as shown by a reduction in turns taken. Both groups' peak performance was on trial three, but on trial four the number of turns taken increased. This suggests that practice and fatigue effects influenced performance. However, there is never any parity between the groups on any trial in terms of turns taken, intimating that the AS group were generally less efficient at working out the map route. The improvement with practice, in the autism group, does suggest that the task can be learned, with the AS group's learning curve mirroring that of the control group. This implies that people with AS can improve on this kind of task. This evidence suggests that teaching and training programmes for people with AS may be worthwhile. Although they may never attain clinically normal levels of performance, they may still show some learning.

7.7c Measuring competence using time taken

By focussing solely on the time taken to complete the task, it is possible to erroneously conclude that the AS group were performing poorer on text chat than via the telephone. However, by looking at the strategies individuals used to work out routes, it can be seen that participants using less efficient strategies were taking longer in both media. Moreover, because the time taken to type a question is longer than the time taken to ask a question, the strategy used had a greater influence on text chat times than on telephone times.

Related to this is that the individuals, in the AS group, who used left/right strategies were the ones who took the longest time and were the ones who had the lowest BADS scores. This indicates that executive ability had a bearing on the strategy used and is supported by the fact that group differences on time disappeared once BADS score was covaried. Looking at the detail of the communication on a qualitative level, and using this to inform quantitative analysis, shows that both levels of data description in combination provide a better idea of the processes involved.

Since the AS group took longer in both text chat and the telephone, this suggests that their speed of processing may be slower, but their high level of scoring indicates that they can complete the task. This may be important because it suggests that, with more time, people with AS may perform at levels close to, or comparable to those of clinically normal individuals. Therefore, typically developing individuals may need to exercise patience when communicating with individuals with AS.

7.7d The role of the experimenter

In this study the experimenter's responses were standardised so that they would not interfere with the task. However, even when the experimenter was simply answering yes or no, he still had to work out where on the map the participant was referring to. Therefore, to correctly use and interpret yes/no answers, there arguably had to be a meeting of minds. This suggests that even communication of this kind requires an understanding of mind, an understanding of communicational intention which goes beyond the surface meaning of the words.

Arguably, the AS participants who used left/right strategies may be showing a lack of appreciation for another's mental state, by making it hard for the experimenter to keep track of where on the map they were referring to. Landa (2000) states that children with autism have particular problems using forms of language that have no fixed referent, and shift in meaning depending on the contextual variable. Landa (2000) argues that this creates a particular challenge for the communicational partner to work out the child's intended referent and intended meaning. This challenge is evident in the difficulty the experimenter faced in working out which route the participant has taken based solely on left and right directions.

7.7e Time spent communicating

In addition to the main findings, this study revealed that despite individuals with AS spending a similar amount of time using the computer, they spent less of that time using it to communicate with others. They also spent less time speaking on the phone than the control group. These differences may have been because the AS group did not want as much social contact, or because they may have desired to be social, but did not have as many friends to contact as the controls. It may be that for some individuals with AS their lack of experience in communicating with others, for whatever reasons, leads them to have problems planning conversations, as borne out in this study. However, for others their high levels of executive ability may enable them to communicate relatively effectively despite a dearth of social contact. Future research is needed, though, to look at the reasons for social isolation and ascertain whether this is cause of, or the reasons for, autistic communicative impairments. In that the reason may a symptom of a more fundamental underlying cause.

7.7f Do the different strategies suggest different cognitive styles?: The Male brain hypothesis of autism and map reading

The different strategies used by participants show that map route instructions can be generated from two methods: either using the landmarks and or directions. Lawton (2001) states there is a consistent gender difference in giving and using directions, with females more likely than males to use a landmark-based navigational strategy, and men more likely than women to incorporate a survey or overview perspective into route directions, as indicated by frequency of referring to cardinal directions (North, East etc.). A speculation from the results of this study is that the use of non landmark-based strategies supports the extreme male brain hypothesis of autism (Baron-Cohen & Hammer, 1997b; Baron-Cohen, 2002).

7.7g The usage of computers and telephones by people with Asperger syndrome

It is often reported that engaging individuals with autism in any kind of interaction is difficult. Hence, the accomplishment of using both text chat and the telephone in this study, suggests that these two forms of communication are motivating for individuals with AS. An additional, though subsidiary, strength of this study is that the techniques reported here can be used and/or adapted for investigation and intervention in other areas of psychology. For example, examining if people negotiate differently with others depending on which media they are communicating through (e.g., Schliemann et al., 2001). However, a major contribution of this experiment is that it challenges the assumption that people with autism show the same communicative impairments across all media, and tests this through the development of a new experimental method. Designing a study comparing performance between two different media posed a considerable challenge. It was necessary to create a new methodology, both in terms of actually combining the hardware and software components, but also in trying to standardise the experimenter's responses.

Until now the implied assumption, in autism research, is that autistic individuals show the same communicative problems across all modalities. This implicit notion has now been tested experimentally for the first time. This is despite both real-life evidence, and theoretical grounds for suggesting that people with autism may be better at communicating via some media than others. Internet chat room have been created on the basis that people with AS find it easier to communicate through text chat (#aspergers, 2002). Moreover, communicating by text chat may act as a temporal buffer, slowing down the speed of communication and thereby mitigating the executive problems seen in the disorder. Therefore, evidence for a media-dependent competence would be of theoretical, as well as applied value. Hence, further research is required into media-dependent communicative performance in autism.

Chapter 8

General Discussion, Conclusions and Future Work

"Do you believe in computer dating? Only if the computers really love each other."

(Groucho Marx)

8.1 Thesis overview

The opening chapter of this thesis gave a brief historical perspective, along with Kanner's early clinical descriptions of autism. This was followed by an outline of the prevalence and risk factors associated with the disorder, along with a description of Asperger syndrome and its diagnostic controversies.

The second chapter described the developmental psychological perspective given to autism by the influential theory of mind deficit account. The problems of specificity, uniqueness and universality of this hypothesis were outlined. The latter part of Chapter two suggested how an early loss of a sensory modality (sight, hearing) could bring about mentalising problems arising from a deprivation of early joint-attention.

Chapter three described the Executive Function (EF) account of autism which suggests that autistic individuals share problems of initiating behaviour, sustaining behaviour, set shifting, and inhibition with patients with prefrontal cortex lesions. This chapter also described the possible relation between theory of mind and EF. Later in the chapter Weak Central Coherence (WCC) theory was elucidated. The chapter described WCC theory's strengths, that is accounting for autistic performance on a number of different levels, from the perceptual to the linguistic. It has been acknowledged, though, that the main weakness of the theory is the lack of a clear definition of central coherence. Plaisted's (2001) reduced generalisation interpretation is more specific, however, and suggests that in autism there is reduced processing of the similarities that are held between stimuli and situations. The chapter also described multiple deficit accounts which suggest that autism is a mélange of impaired theory of mind, WCC and EF.

Chapter four mainly described advanced tests of theory of mind, designed to sustain the theory of mind account of autism. In this chapter a case was made for the clearer distinction between theory of mind and its operationalisation, especially the test of false belief. An argument was also made for the use of computer-mediated role-play as a more ecologically valid tool for investigation which could enable participants to demonstrate 'on-line' competence, and thus we could tap into their working, rather than reflective, mentalistic ability. In this respect a demonstration of their nonliteral language comprehension, and social competence would be obtainable. Moreover, computer role-play rescinds the need for test questions because participants' responses could be rated. The absence of test questions avoids any possibility that participants do not understand what they are being asked, and that they are answering on the basis of what they think the experimenter wants to hear, rather than what they believe is correct.

Chapter five described the analysis of a corpus of computer-mediated dialogue, of two adults with AS, to investigate if a dearth of initiation questions is what makes autistic communication autistic; that is, do the communication and social problems seen in autism stem from a problem they have in asking questions. The results revealed that one of the two individuals with Asperger syndrome had problems asking questions. That is, part of what makes autistic communication autistic is an absence of reciprocal questioning, but this is not universal in all individuals. Moreover, this difficulty may stem from linguistic problems, not a lack of sociability, and may be the reason for, rather than the cause of, their social isolation. This chapter also debated whether it is preferable to analyse communication through conversational analysis or via blind ratings. Deciding which to use depends on the kinds of questions to be answered. In terms of investigating exchange structure, conversational analysis seems suitable. By contrast, when judging if someone has shown an understanding of nonliteral language, a rating scale utilised by blind raters is preferable.

Chapter six reported a study in which a computer program, Bubble Dialogue (Gray et al, 1991), was used to test the working understanding of nonliteral language and responses to inappropriate requests by individuals with AS. Blind raters served in this study, and their ratings were found to be sensitive to group membership, verbal and executive abilities. The AS/HFA group showed poorer understanding of figure of speech and were more likely to respond positively to a socially inappropriate request, compared with their typically developing peers. Verbal ability, however, accounted for approximately twice as much of the between participant variance as diagnosis. Additionally, a comparison group with Tourette syndrome showed better understanding of figure of speech and more socially appropriate responses than the AS/HFA group. However, differences between these groups were due to individual differences in executive ability. In contrast, understanding of sarcasm was predicted neither by verbal ability, executive ability nor clinical diagnosis. These results suggest that having AS/HFA does not inevitably dispose someone to having problems with communication and socialisation and that verbal ability protects the individual to a certain extent. Additionally, different types of nonliteral language may relate to tests of mentalistic understanding in different ways. The results also intimate that some individuals with Tourette syndrome may be at risk of autistic-like communicative and social problems, which may stem from their executive problems. This supports the possibility that developmental disorders differ from each other in terms of degree, rather than sharply defined non-overlapping boundaries.

The precise role of executive function and how it relates to communication is not known. Though, in Chapter seven, it was suggested that people with autism have a preference for internet-based communication, and it was argued that this may be due to the slower rate of informational exchange through text chat/email. To test this hypothesis, a route solving task was used to compare the communicative performance of individuals with AS using different media: text chat and the telephone. A first impression of the results suggested that AS performance may in fact have been better via the telephone. However, a detailed look at the strategies employed by some AS individuals revealed that their executive problems may have resulted in a less than ideal approach to the task in both media. The results of this study also indicated a relation between executive and mentalising ability because both are required to solve the task. Additionally, many of the AS participants generated novel closed questions to successfully solve the map task in both media, though they were slower than controls. Whether autistic communication is more effective across text chat than either the telephone or face-to-face conversations is still not entirely clear and the merits of including a face-to-face condition are discussed in Section 8.6 (p.214).

8.2 A picture of autistic communication and socialization

From Happé's (1994) and Jolliffe and Baron-Cohen's (1999) studies, the picture is that people with autism cannot understand nonliteral language. Moreover, this lack of understanding has supposedly no relation to their verbal and executive abilities, but is related to their performance on a test of belief attribution. According to these researchers, even autistic individuals who pass second-order theory of mind tasks have problems with nonliteral language comprehension. Furthermore, this problem is unique to autism and stems from a domain-specific problem in mentalising. By contrast, the results from this thesis suggest that this portrait reflects neither the complexity nor the reality of autism.

Happé (1994) and Jolliffe and Baron-Cohen's (1999) studies can be criticised on different levels and for various reasons, with both theoretical and methodological short-comings leading to an erroneous view of autism. Firstly, their vignette-based tasks assess reflective rather than working understanding, and hence might tap into a level of functioning that is beyond what is needed to perform effectively in the real world. That is, the demands of the tasks may be so great as to go beyond nonliteral language comprehension, and so render the tests insensitive to working communicative abilities in autism. By contrast, in this thesis, participants demonstrated 'on-line' competence through computer mediated role-play. They did not have to read a long passage of prose, nor did they have to answer any test questions. They simply role-played characters in a computer-generated comic strip environment.

Secondly, in Happé's (1994) methodology, participants' understanding of nonliteral language was based on the judgements of only two raters, one of whom was the experimenter and so not blind to the experimental hypothesis. Despite showing a high level of agreement between the two raters, Happé's methodology can be criticised for relying too heavily on the subjective judgements of just two people. Additionally, these dichotomous, right-or-wrong judgements are arguably too conservative, and offer no room for people showing the emergence of an understanding. Moreover, right/wrong judgements do not generate enough variance to sensitively relate performance with other measures like verbal and executive ability. This is especially important because of the heterogeneity in autism, which is not adequately addressed by matching groups on verbal ability or other criteria.

In the study reported in Chapter six, 62 blind raters rated all the participants' scripts on ratings scales. This generated between as well as within-participant variance, which enabled group and individual differences to be investigated at the same time. Furthermore, the HLM analysis not only allowed clinical status group, verbal and executive abilities to be examined, but also gave proportions of how much variance they accounted for in predicting rated performance. This permitted me to ascertain not only the variables which contributed to understanding nonliteral language, but also the relative influence of these factors.

By contrast, Happé's methodology does not tell us about the relative importance or weighting of various factors like verbal and executive ability. This is related to another problem with Happé's methodology: No measures were taken of non theory of mind domains, like executive function. Hence, we do not know if problems of understanding nonliteral language stem from or are related to other domains. However, using the Behavioural Assessment of the Dyexecutive Syndrome (BADS) as a measure of executive ability, enabled the influence of executive function, in addition to verbal ability, to be considered in investigating peculiarities in the understanding of nonliteral language[10]. Thirdly, Happé, and Jolliffe and Baron-Cohen's studies compared autistic groups with clinically normal groups. The absence of clinical comparison groups meant that they could not demonstrate that problems of nonliteral language comprehension were unique to the autistic population. Furthermore, if abnormal comparison groups had been included, they could have used their

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[10]Gillberg and Coleman (2000) argue that research is required to find out if there are specific executive deficits in autism. Additionally, Ozonoff, Strayer, McMahon & Filloux (1994) assert that a profile of executive abilities, for the autistic population as a whole, would be useful because different profiles may be associated with different developmental disorders. The BADS test used in this thesis could be used to create a profile associated with autism and/or Asperger syndrome in much the same way as Evans et al. (1997) did for schizophrenia. The BADS test is composed of six subtests, in which participants can score between zero and four for each one. As such, the variance it generates requires more participants than were tested in this thesis in order to detect a significant difference between groups on the BADS profile score. A power calculation reveals that for a power of 0.5, a group of 38 autistic and 38 normal participants would be needed to identify a significant group difference (however 50 percent of the time a type II error would be made). For a more conservative power of 0.8, groups of 77 participants would be required.

results to tease out different factors, depending on the differences and similarities between the clinical and autistic groups. For example, two recent studies by Bishop and Norbury (under review-a & b) found that a group of children with Pragmatic Language Impairment (PLI) and another with autism both had problems with two aspects of executive function: generativity (Turner, 1999) and response inhibition. Thus, from their results there seems to be a relation between executive ability and language that is independent of social problems and restricted interests/behaviours, but related to the third diagnostic axis: communication impairments. In this thesis, individuals with Tourette syndrome comprised the clinical comparison group because they shared the repetitive behaviours of individuals with AS, but not the other two axes of communication and socialisation. The inclusion of the Tourette group revealed that problems of understanding nonliteral language are neither unique to autism, nor specific to the domain of mentalising, but instead seem related to executive function (see Burack, Iarocci, Bowler & Mottron, 2002, for a discussion on matching and comparison groups in developmental psychopathology research).

8.3 Theoretical problems with the Strange Stories test

As well as methodological limitations with the Strange Stories test, it, and other advanced tests of theory of mind, may be criticised on principled grounds. Fundamentally, these studies were designed to look for failure within the autistic population. They were created with the aim of supporting the theory of mind deficit hypothesis of autism, in the face of autistic successes in second-order belief attribution tasks. Nonliteral language comprehension was viewed by Happé as an area in which, a priori, autistic problems would be expected because of their suspected inability to mentalise. Therefore, any relative failure on this task would show, in Happé eyes, a theory of mind deficit.

The Strange Stories test was not designed to further our knowledge of autistic understanding of nonliteral language because many different types of nonliteral language were grouped and investigated together: sarcasm, metaphor, lies and so on. Happé did not differentiate types of figurative language, or use the study to find out if there were particular types of nonliteral language that were more or less problematic for people with autism. Additionally, Happé used neither measures of verbal ability, nor executive ability to see if they 'explained' nonliteral language comprehension. The results from this thesis suggest that a figure of speech and sarcasm should not be considered as equivalent tests of mentalistic understanding, and that nonliteral language comprehension is influenced by verbal and executive ability

Happé's investigation of autistic communicative problems, as a test of relevance theory (Sperber & Wilson, 1996), could be an example of a researcher using broad concepts (like figurative language) without taking account of the controversies, or using the experiments already developed within that area. A major problem of using figurative language as a test of mentalising ability is that psycholinguists have found no empirical evidence suggesting that figurative language requires special mental processes (Gibbs, 1994). Gibbs cites many studies which refute the traditional view of figurative language: that the literal meaning of a sentence has to be coded, before the nonliteral. Gibbs reports research showing that, in typically developing people, nonliteral language is processed at the same speed as literal language. Additionally, Gibbs argues that the idea of literal language is not as obvious as it may first seem. He states there is no comprehensive account of what literal meaning is, and that we do not really know what it means when we say we speak and think literally. He argues that what we think of as literal depends on a variety of factors, including the culture, the individual, the context and the task.

Arguably Gibbs' (1994) treatise of nonliteral language highlights the pitfalls for researchers, coming from a developmental perspective, who move away from the neat operationalisation of first and second-order belief attribution tasks. In the special case of using understanding of nonliteral language as a test of higher order theory of mind, they risk moving into the area of psycholinguistic research which in itself questions the notion of a difference in processing between nonliteral and literal language.

As a future direction autism researchers could use some of the existing methodologies from nonliteral language research developed by psycholinguists, to help identify the character of autistic thought and language in more detail. In turn such research could help psycholinguists in their attempts to identify the boundaries between different types of nonliteral language in shaping everyday thought.

8.4 Problems with socially-based tests of mentalising ability

Social tests, like The Awkward Moments Test (Heavey et al., 2000), can be criticised on similar grounds as language-based tests, essentially because they used the same methodology as the Strange Stories test. The only fundamental difference is that participants watched a film clip instead of reading a vignette. After viewing, they were asked test questions which were then rated for 'correctness' based on the judgements of only two people. In the Awkward Moments Test there was no inclusion of a clinical comparison group, no measures of executive ability, and the test tapped into reflective rather than working understanding. Arguably, it looked for autistic failure.

In Chapter six, participants role-played a social situation in a comic-strip environment and were not asked any test questions. Additionally, responses were rated by many blind raters, and were judged on a scale which is congruent with Klin's (2000) suggestion that in real life settings there is a continuum of social dysfunction, and that 'all or nothing' tests may not be sensitive to theory of mind delays in autistic individuals. Furthermore, participants with Tourette syndrome were included as a clinical comparison group.

Furthermore, the study reported in this thesis shows that the same methodology can be used to investigate both the social and the linguistic aspects of autism. This is important because the results show that not only does verbal and executive ability influence social appropriateness, as well as non literal language comprehension, but they have approximately the same influence given the similar proportions of between-participant variance they account for.

8.5 The Picture of autism now

The results reported in this thesis suggest that we have to challenge our current understanding of autistic communication, which is such a central feature of the condition itself. A question like, " What makes autistic communication autistic? " is one that can be answered in different ways now. Firstly, some, but not all, people with autism have problems asking questions. This may make their communication style appear cold and may give the impression that they are not interested in others. However, this problem may be the reason for, rather than the cause of, their social isolation. Secondly, some individuals with autism may have problems understanding some, but not all, forms of nonliteral language. Thirdly, clinical status, executive ability and verbal ability all seem to interact in predicting both social and communicative performance, and with approximately the same degree of importance. Fourthly, the results from this thesis highlight the relation between linguistic and social understanding.

A further contribution made by this thesis is that it has challenged the assumption that autistic individuals have communicative problems which are universal. This assumption has been made despite both real-life evidence, and theoretical grounds for suggesting that people with autism may be better at communicating via some media than others. Moreover, this has been tested through the development of a new experimental methodology detailed in Chapter seven.

Although Chapter seven did not find any evidence for media-dependent differences in autistic performance, further research is required: Was the task insensitive to genuine differences between text chat and telephone communication? A face-to-face condition would have been a valuable addition because the temporal aspects of communication may vary between face-to-face and telephone media. This is because even though both are synchronous, face-to-face communication has, additionally, extra-linguistic and non verbal cues (e.g., gesture, eye contact, facial expression) which alter the nature of communication. Individuals with AS may have been found to be most effective at communicating via text chat, or telephone compared to speaking face-to-face. If so, then, this would suggest that the additional information processed during face-to-face communication is a potential source of difficulty. However, because no face-to-face condition was included in the study the nature of any interaction between extra-linguistic and non-verbal cues and synchronous forms of communication remain speculative.

The results from Chapter seven do, nevertheless, give us greater insight into autism. Firstly, some individuals with AS can generate novel questions, and use the answers from those questions to infer a correct map route. This suggests that problems of generativity (Turner, 1999) may not be universal to all AS individuals, or on all tasks. It also indicates that at least some individuals with AS can make linguistic inferences. This stands in contrast to some studies in which autistic individuals show problems in this area (Jolliffe & Baron-Cohen, 1999b; Norbury & Bishop, in press). Furthermore, the results suggest that individuals with AS are able to communicate in at least two forms of media.

Secondly, individuals with AS who had the greatest success, in planning and carrying out a strategy to deduce the map routes, were those with the highest levels of executive ability. The poorer performance of the autistic individuals, with lowest executive ability, may be associated with their problems of appreciating another's mental state because they were using left/right directions rather than using landmarks or descriptions. This made it hard for the experimenter to keep track of where on the map they were referring to. This indicates not only a relation between executive function and theory of mind, but also that it is hard to tease these two domains apart because this task, along with many others, simultaneously makes demands on both.

Thirdly, the use of left/right procedures, in individuals with AS, might implicate a male brain-type of navigational strategy because it is generally used more by men than women (Lawton, 2001). A speculation, from the results of this study, is that the use of non landmark-based strategies supports Baron-Cohen's (2002) extreme male brain hypothesis of autism. Future work, focusing on autistic performance on tasks where there are gender differences, may shed more light on a possible bias that people with autism have towards an extreme male type of cognitive processes.

Fourthly, since the AS group took longer in both text chat and the telephone, this suggests that their speed of processing may be slower than that of typically developing individuals. However, the AS group's high level of scoring indicates that they can nevertheless complete the task successfully. This suggests that with more time, people with AS may perform at levels close to those of clinically normal individuals. Therefore, typically developing people may need to exercise patience, rather than individuals with AS having to 'step up' to normal levels.

Fifthly, although both the AS and control groups improved at the map task, at no point was there any parity between them. The improvement with practice does suggest that the task can be learned (with the AS group's learning curve mirroring that of the control group). This implies that people with AS can improve on this kind of task. Such evidence emphasises that teaching and training programmes for people with AS can be, and are, worthwhile. Although, they may never attain clinically normal levels of performance, individuals with AS may still show some learning.

8.6 Methodological considerations

The aim of the study reported in chapter 7 was to investigate if slowing the tempo of communication would result in more effective communication (this would explain an autistic preference for the use of asynchronous media, like text chat). In this way the computer may be considered as an executive or temporal buffer, because it slows down the speed of communication and responses. Thus the computer medium may be the optimal mode of communication for individuals with autism because interacting with them in real-time is likened to conversing with someone who is calculating his next move, or someone who is working out a complicated maths problem (Bruner & Feldman, 1993).

In this study, the telephone shares the same quality of distance as computer-mediated communication, but crucially requires real-time responses. Thus, communicating via the telephone requires immediate responses, unlike the computer condition, which was the point of comparison. The ideal comparison condition would have been a telephone condition in which speech was converted into text, in real-time. Unfortunately, this technology is currently in its infancy. Interestingly, the performance of individuals with AS in the study shows their relative competence in two media forms. It would be valuable to find out if their performance is task dependent. Thus, for example, would individuals with AS be as proficient a task in which they had to communicate abstract ideas, especially given their problems in using imagination.

The inclusion of a face-to-face condition would have allowed the comparison between two form of synchronous communication in the study reported. It may be that even though both telephone communication and face-to-face communication are synchronous, face-to-face communication has additional processing demands from it associated extra-linguistic cues and non-verbal cues. However, a different methodology might have more appropriate because it may have appeared an unusual task to ask participants to work out a map route when the person who had the solution was sitting directly in front of them.

If another methodology had been used, such as a scene description; for example Ellis, Miller and Sin's (1983) scout camp picture and/or the cookie theft picture (Goodglass & Kaplin, 1972) then it may have revealed how extra-linguistic and non-verbal cues affect the communication in individuals with Asperger syndrome, as in a study by Doherty-Sneddon, McAuley, Bruce, Langdon, Blokland and Anderson (2000). They found that face-to-face communication interfered with rather than facilitated communication in children. In their study, Doherty-Sneddon et al. (2000) used two modes of communication to test their hypothesis. They used audio and face-to-face conditions to investigate the impact of visual signals on children's ability to describe abstract stimuli. Specifically, 6 and 10 year old children were asked to describe shapes when they could see each other (though not the shape) and when they could only hear each other. This shape description task was a variation of Glucksberg, Krauss and Weisberg's (1966) referential communication task (Doherty-Sneddon et al., 2000). Children were given multiple scores reflecting the accuracy of their descriptions, and both age groups were found to be most accurate in the audio condition.

By including a face-to-face condition, the affect of the visual signals on communication in Asperger syndrome could have been able to be investigated. Autistic individuals are known to have sensory and perceptual abnormalities (O'Neill & Jones, 1997), and the heavy visual processing accompanied with face-to-face interaction could be at the cost of the processing needed to conduct a conversation. It may be that individuals with Asperger syndrome have the greatest difficulty in communicating and responding quickly to combined visual and auditory cues, as indexed by a face-to-face condition. This may be one of the reasons why individuals with Asperger syndrome seem to show a particular affinity with computer-mediated communication (#aspergers, 2002), because communication via text chat does not have verbal or extra-linguistic cues associated with it. Any evidence showing an elevation in performance in a computer condition, over and above a face-to-face condition, would strengthen the case for using computers as a medium for interacting with individuals with Asperger syndrome. This would in turn strengthen the case for using programs, like Bubble Dialogue (Gray et al, 1991), which may be used to tap into a level of autistic linguistic performance that is closer to their 'true' understanding than any 'paper and pencil' measure (as in the experiment described in chapter 6).

In future, it would be useful to conduct a study in which all three forms of media are compared directly. Thus, the affects of extra-linguistic cues, synchronous and asynchronous communication could be teased apart. Furthermore, it may be useful to conduct research into more lower level processing before investigating of the relative processing demands of different media. Then researchers may be able to specify more precisely why individuals with Asperger syndrome find face-to-face communication most difficult of all, if indeed that is the case.

8.7 Can the current theories of autism account for the results from the studies reported in this thesis?

8.7a The theory of mind deficit hypothesis of autism

The theories of autism, outlined in the opening chapters, seem to be able to account for different aspects of the results from the thesis. Although no one theory seems to be to able account for all the results. In this respect the weakest theory, arguably, is the theory of mind deficit account (Baron-Cohen et al., 1985). The theory of mind deficit hypothesis of autism can explain Wing and Gould's (1979) triad of impairments as secondary to a more primary cognitive impairment. It can also account for the relation between mentalising ability and non-literal language comprehension. That is, similes can be understood without having a first-order metarepresentational ability; metaphoric understanding requires a first-order metaprepresentational ability and understanding irony needs second-order metarepresentational ability (Happé, 1993).

However, the theory cannot account for differences in autistic communication, in terms of exchange structure, because it cannot account for why different individuals with the same diagnosis (of Asperger syndrome) show individual differences in whether they ask questions or not. The theory of mind hypothesis cannot account for differences in understanding nonliteral language and responses to inappropriate requests based on individual verbal ability and executive ability in both the autistic and Tourette syndrome groups.

In short, the theory of mind deficit hypothesis should be credited for taking autism research clearly into the cognitive age. However, the theory seems unable to account for the great range of autistic performance, seen in results in this thesis and in many other studies. Therefore, Baron-Cohen and Swettenham's (1997) multiple deficit account (see Section 3.8, p.70) may be ultimately the only way to keep the theory alive.

8.7b The executive dysfunction hypothesis of autism

The executive dysfunction hypothesis of autism (Ozonoff et al., 1991a) can account for many of the features of autism which fall outside Wing and Gould's (1979) triad of impairments, such as the autistic individual's need for sameness, difficulty switching attention, a tendency to perseverate and a lack of impulse control.

This hypothesis of autism arguably offers the greatest possibility of integrating the findings from this thesis. However, it too cannot explain any differences in initiating questions in the autistic population. For the structural aspects of autistic language a different theory may be required, perhaps one which has its roots in specific language impairment research.

A more general problem with executive function is that it is a very global term that includes many cognitive functions. Thus, it may not be surprising that the theory is so all embracing and can account for so much. A way forward though has been through the use of the BADS (Wilson et al., 1996) which tests a broad range of executive abilities and thus is arguably one of the better tests of executive function currently available. Hence, profile scores on the BADS do seem to indicate a general problem of executive function.

The role of executive function in socialisation and communication is just starting to be investigated. The results from chapter 6 suggest that executive ability does play a role in both language comprehension and social functioning. However, exactly what that role is requires further investigation. Two recent studies (Bishop & Norbury, under review-a & b) may shed some light about the role of two aspects of executive ability in language structure: inhibition and generativity. In one these studies, Bishop and Norbury (under review-b) used two subtests from the Test of Everyday Attention for Children (TEA-Ch; Manly, Anderson, Nimmo-Smith, Turner, Watson & Roberson, 1998; Manly, Robertson, Anderson & Nimmo-Smith, 2000). The Sameworld/Opposite world tasks, and the Walk Don't Walk subtests assess inhibitory control (both verbal and nonverbal) and were used with children with autism, pragmatic language impairment, specific language impairment and a typically developing group. The rationale behind the experiment was that through the inclusion of different groups, which share different features of the autistic phenotype, problems of inhibition can be attributed to either autism, pragmatic language difficulties, or general language impairment. The results were that all three clinical groups show poor performance on both inhibition tasks, thus suggesting that verbal skills may play an important role in executive functions (Bishop & Norbury, under review-b).

In their companion study, Bishop & Norbury (under review-a) asked children with autism, pragmatic language impairment, specific language impairment and a typically developing group to generate uses for various everyday objects (e.g., a mug), and generate meanings for line drawings which had no specific prior meaning attached to them. Bishop and Norbury found that both the pragmatic language impaired and children with autism produced a lower percentage of correct responses than the control children. Thus they concluded that difficulty in generating relevant ideas can be another cause of autistic-like communicative abnormalities.

The map task study, reported in chapter 7, alludes to another role of executive ability in communication, that of planning. Arguably, in order to succeed on the map task, one needs to devise, plan, and carry out an effective strategy in order to work out the route. Thus, executive ability might be required in order to plan a conversation in order to attain a goal, as in Gillberg and Coleman's (2000) definition of executive function: faculties needed to work, in a motivated fashion, towards a goal that may not be reached instantly.

8.7c The Weak Central Coherence Theory hypothesis of autism

Weak Central Coherence theory's (Frith, 1989) strength is that it can account for both the perceptual and linguistic aspects of autism. An additional boon is that autism is often considered an impairment, but this theory can explain why in some instances individuals with autism show superior performance than individuals without autism, due to their cognitive style. However, the exact mechanism for central coherence has not been specified and it has been left to others (e.g, Plaisted, 2001) to detail the exact mechanism; for example through the reduced processing of similarities that are held between stimuli and situations.

Furthermore, some researchers have argued that weak central coherence is evident only in certain circumstances. Specifically, López and Leekam (2003) argue for contextual processing in weak central coherence. They found that evidence for weak central coherence depends on the nature of the task itself, for example whether the task is verbal or visual. López and Leekam (1993) used both visual and verbal tasks in their study and replicated Frith and Snowling's (1983) homograph test and findings, but did not find any evidence for weak central coherence in their visual tasks. Hence, López and Leekam (2003) argue that weak central coherence is not a general deficit in autism, but specific to complex verbal stimuli and especially with using sentence context to disambiguate meaning.

Although Weak Central Coherence has been thought to underlie an autistic inability to read for meaning (see Section 3.7c, p.69), the results of the study reported in chapter 6 suggest that some individuals with autism can integrate the story context and respond appropriately to nonliteral language. However, this ability seems meditated both by executive and verbal ability. Thus, a more fine grained analysis may be required to find out if there is evidence that processing styles between people with autism and typical development are different on a lower level.

8.8 Is a new theory of autism required?

Can current theories of autism be stretched to account for the findings reported in thesis and recent other work, or is it time to seek a different kind of theory? Any new theory of autism would have to be applicable to individuals across the entire spectrum; it would need to apply to both individuals with autism who had severe learning disabilities, as well as those who are higher-functioning. Any new theory would additionally have to integrate the socio-linguistic, perceptual, and sensorimotor aspects of the disorder. It would also need to encompass the movement disordered aspect of the condition (see Green et al., 2002, for a summary for the motor problems associated with autism).

The only theory which might accommodate most of those characteristics is the executive function account. Perner (1997) argues that since actions are based on intention, some higher order desire/want/need antecedes the planning and organisation required for that goal to be attained. Consequently, Perner states that a theory of mind is prerequisite to executive function (see Perner, Lang & Kloo, 2002, for a summary of the possible different relations between theory of find executive function). However, Perner (1997) does not acknowledge the link between cognitive and sensorimotor expressions of executive function. Denkla (1996a, 1999b) suggests that executive function may be considered metacognitive, but she adds that it ought to remain close to its clinical neurology roots of motor praxis or "execution" in, for example, motor sequencing tasks.

Furthermore, O'Neill and Jones (1997) counsel against attempts to systematically investigate one aspect of autism in isolation because that approach does not reflect the complexity and multi-dimensionality of human behaviour. Hence Perner's (1997) narrow view of executive function fails to integrate other non-cognitive characteristics, like the movement disorders associated with autism (Green et al., 2002).

The same criticism cannot be made against Russell (1996), who proposes that success in theory of mind tests depends on executive function abilities. Russell's position both accommodates and is compatible with the theoretical integration of the motor features of autism with its cognitive characteristics; it is possible to suggest that stereotypic perseverations, in movement (such as hand flapping, rocking etc.) and cognition, stem from the same basic damage to the supervisory attentional system (Norman & Shallice, 1986).

8.9 What kind of qualities would a new theory need in order to account for the results from this thesis?

It is unlikely that any new theory of autism can explain all the different aspects of the disorder because of the many 'types' of autism. That is, individuals with the same diagnosis may develop the same core symptoms of autism but with different etiologies. Because autism is a syndrome, a collection of symptoms, this leaves the label open for a broad range individuals to have the same basic characteristics in common. The fact that there are some similarities between individuals with acquired frontal lobe head injury and autism, suggests that there may even be an acquired root into autistic-like problems. Therefore, mutliple-deficit accounts of autism (e.g, Baron-Cohen & Swettenham, 1997) may be the only ones that can account for the diversity of autism. However, such theories do not posit a basic core cognitive deficit which is responsible for the broad range of autistic symptomatology. Arguably, a new theory of autism will require psychology as a whole to move beyond the cognitive époque, to a new era.

8.10 The borderlands of autism and other disorders

The results from this thesis suggest that the boundaries between different developmental disorders may be more fluid, overlapping and less sharply delineated than the current diagnostic classification systems portray. Results like the ones reported in this thesis may eventually lead to a new way of thinking about diagnosis, that is a move away from diagnostic systems based on à la carte menu-style heuristics. Support for the results reported in this thesis comes from other studies, notably Bishop and Norbury (2002) who looked at the borderlands of autistic disorder and Specific Language Impairment (SLI). They specifically tested the claim that all children with PLI would meet diagnostic criteria for autism. Standardised diagnostic measures of autism were used to assess children with PLI and children with more typical specific language impairments(SLI-T). The researchers found that a small proportion of children with PLI did meet the criteria for autism, but many did not. Bishop and Norbury argue their results suggest that although the presence of PLI should prompt clinicians to investigate the possibility of autism, it is incorrect to assume that all children with pragmatic difficulties are autistic.

Furthermore, Bishop (1989) argues that the blurred boundaries of autism are not just a consequence of the subjective and elusive nature of its symptoms. Instead it may be that autism is a disorder that has no clear boundaries (Green et al., 2002). Green et al. (2002) state that this fuzziness could equally be applied to all developmental disorders and may be viewed by some 'as a reflection of the supposed wooliness of psychology...or as an indication that developmental disorders cannot be proper diseases'(Rutter, 1998, p.12). According to Rutter, however, such assumptions are misguided because 'even single gene Mendelian disorders show amazing variability' (Rutter, 1998, p.12). Presumably, because autism may involve between 2 and 10 genes (Pickles et al.,1995), this increases the likelihood of variability and in turn makes the disorder even harder to delineate.

Difficulties in knowing where one disorder ends and another begins may simply reflect the reality of developmental disorders. This need not be a problem, however, provided that the heterogeneity of individuals is taken into account in the experimental method and/or analysis, along with multiple measures from different domains, as in the experiments in this thesis.

8.11 Final summary

This thesis has shown that information and communication technology (ICT) can be a useful tool to the developmental scientist. Moreover, computers may have a special significance for the developmental psychopathologist because of their value as an interface between the researcher and the participant. They also seem highly engaging for higher-functioning people with autism, and motivation factors should not be ignored in this population. Additionally, computer-mediated role-play may have greater ecological validity than traditional paper and pencil tests of linguistic and social understanding. Moreover, as ICT improves, and software becomes increasingly sophisticated, ever-more elegant experiments can be devised to investigate autism and child development in general.

Many views have been challenged in this thesis, through the use of ICT. Arguably, this use of technology coupled with the new methodologies and analyses reported in the thesis has changed our view of autism. We have now moved away from a simplistic picture of autism to a more complex, and realistic, portrait of this enigmatic disorder.

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Appendix

DSM-IV (1994) criteria for Asperger disorder

A. Qualitative impairment in social interaction, as manifested by at least two of the following:

(1) marked impairment in the use of multiple nonverbal behaviors such as eye-to-eye gaze, facial expression, body postures, and gestures to regulate social interaction

(2) failure to develop peer relationships appropriate to developmental level

(3) a lack of spontaneous seeking to share enjoyment, interests, or achievements with other people (e.g., by a lack of showing, bringing, or pointing out objects of interest to other people)

(4) lack of social or emotional reciprocity

B. Restricted repetitive and stereotyped patterns of behavior, interests, and activities, as manifested by at least one of the following:

(1) encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus

(2) apparently inflexible adherence to specific, nonfunctional routines or rituals

(3) stereotyped and repetitive motor mannerisms (e.g., hand or finger flapping or twisting, or complex whole-body movements)

(4) persistent preoccupation with parts of objects

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 used 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 behavior (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.

ICD-10 (1992) research criteria (WHO) for Asperger syndrome

A There is no significant general delay in spoken or receptive language or development. Diagnosis requires that single words should have developed by 2 years of age or earlier and that communicative phrases be used by 3 years of age or earlier. Self-help skills, adaptive behaviour, and curiosity about the environment during the first 3 years should be at level consistent with normal intellectual development. However, motor milestones may be somewhat delayed and motor clumsiness is usual (although not a necessary diagnostic feature). Isolated special skills, often related to abnormal preoccupations, are common, but not required for this diagnosis.

B There are qualitative abnormalities in reciprocal social interaction (criteria as for autism):

(a) failure adequately to use eye-to-eye gaze, facial expression, body posture, and gesture to regulate social interaction

(b) failure to develop (in a manner appropriate to mental age, and despite ample opportunities) peer relationships that involve mutual sharing of interest, activities and emotions

(c) lack of social-emotional reciprocity as shown by an impaired or deviant response to other people's emotions, or lack of modulation of behavior according to social context; or a weak integration of social, emotional, and communicative behaviors

(d) lack of spontaneous seeking to share enjoyment, interests, or achievements with other people (e.g., a lack of showing, bringing, or pointing out to other people objects of interest to the individual)

C The individual exhibits an unusually intense, circumscribed interest or restricted, repetitive, and stereotyped patterns of behaviour, interests and activities (criteria as for autism; however it would be less usual for these to include either motor mannerisms or preoccupations with part-objects or non functional elements of play materials).

D The disorder is not attributable to the other varieties of pervasive developmental disorder; simple schizophrenia; schizotypal disorder; obsessive-compulsive disorder; anankastic personality disorder; reactive and disinhibited attachment disorders of childhood, respectively.

Gillberg and Gillberg's (1989) diagnostic criteria for Asperger syndrome, elaborated (Gillberg, 1991) which includes motor clumsiness

1 Social impairment (extreme egocentricity) (at least two of the following):

(a) Inability to interact with peers

(b) Lack of desire to interact with peers

(c) Lack of appreciation of social cues

(d) Socially and emotionally inappropriate behavior

2 Narrow interests (at least one of the following):

(a) Exclusion of other activities)

(b) Repetitive adherence

(c) More rote than meaning

3 Repetitive routines (at least on of the following):

(a) on self, in aspects of life

(b) on others

4 Speech and language peculiarities (at least three of the following):

(a) Delayed development

(b) Superficially perfect expressive language

(c) Formal pedantic language

(d) Odd prosody, peculiar voice characteristics

(e) Impairment of comprehension including misinterpretation of literal/implied meanings

5 Non-verbal communication problems (at least one of the following):

(a) Limited use of gestures

(b) Clumsy/gauche body language

(c) Limited facial expression

(d) Inappropriate expression

(e) Peculiar, stiff gaze

6 Motor clumsiness

Poor performance on neuro-developmental examination

Codes used to classify conversational behaviour, devised by Adams and Bishop (1989)

1. Exchange structure	
Initiation	
Question/command	IQ
Statement	IS
Response	
Minimal, non-verbal	RMn
Minimal. verbal	RMv
Extended	RE
Continuation statement	CS
Follow-up	F
Unintelligible	Un
Incomplete	X
2. Turntaking	
Gap	<G>
Inadvertent overlap	<I>
Violating overlap	<V>

Adult repairs	<A>

3. Repairs

Appropriate response to request for clarification	<R1>
Inadequate response to request for clarification	<R2>
Child request for clarification	<R3>

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Computer mediated interaction in Asperger's syndrome: the Bubble Dialogue program

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Abstract

This paper reports the use of a computer application, Bubble Dialogue, with two primary aims: (1) to assess the experience of computer-mediated role-taking on the interpersonal understanding, executive abilities and verbal abilities of two young male adults with Asperger's syndrome (a diagnosis given to higher functioning individuals with autism); (2) to investigate whether blind raters judged differently between Bubble Dialogue scripts produced by individuals with Asperger's syndrome and scripts produced by individuals with emotional and behavioural difficulties. The results show that there was no detectable improvement in the interpersonal understanding of the participants with Asperger's syndrome, but there was an improvement in their executive function scores. Additionally, the blind ratings revealed that only one of the 'Asperger' Bubble Dialogue scripts was different from the scripts generated by individuals with emotional and behavioural difficulties. Conceivably, Bubble Dialogue helps to regulate interaction, such that the social impairments characteristics of Asperger's syndrome are less conspicuous. © 2000 Published by Elsevier Science Ltd.

Keywords: Adult learning; Cooperative/collaborative learning; Computer-mediated communication; Human-computer interface

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1. Introduction

1.1. Overview

The purpose of this study was to investigate the educational value of computer-mediated Dialogue in individuals with Asperger's syndrome. The application is potentially useful in at least two respects. First, practising Dialogue in a computer-assisted simulation might confer measurable benefits in social functioning and certain aspects of cognitive performance. Second, the dialogues generated in the computer-assisted simulation might allow an opportunity to assess the quality of communication by individuals with Asperger's syndrome. Such assessments could contribute usefully in building up a profile of skills on which to base a programme of education for individuals with Asperger's syndrome.

1.2. Computers and autism

Moore, McGrath and Thorpe (2000) argue that despite good evidence for the value of computer assisted learning in individuals with autism, this area remains relatively unexplored. Swettenham (1996) states various reasons why computers are ideal as educational tools for individuals with autism and Asperger's syndrome. First, computers provide social and emotional distancing by acting as an interface between interactants. Second, the computer accommodates the autistic need for sameness. Third, it allows the individual to take control and work at his or her own speed.

With the aim of assessing and improving interpersonal understanding in individuals with Asperger's syndrome, we utilized the Bubble Dialogue program (Gray, Creighton, McMahon & Cunningham, 1991). The application creates the experience of role-play in a comic strip world, in which two users each role-play a character (see Fig. 1). The users have opportunity, by clicking on icons, to insert text into a speech Bubble above the head of their character and then to insert text into a thought Bubble which subsequently replaces the speech bubble. The Dialogue thus alternates between the users and each has access to the speech and thoughts generated by the other.

1.3. Autism and Asperger's syndrome

Autism is a neurodevelopmental disorder characterised by a triad of impairments: communication, social understanding and imagination (Wing & Gould, 1979) as well as sensory and perceptual abnormalities (Happé, 1996; O'Neill & Jones, 1997; Ropar & Mitchell, 1999). Asperger's syndrome is a diagnosis given to high-functioning individuals with autism who lie at the end of the autistic spectrum which shades into normality. It is a label given to individuals who have subtle manifestations of autism but without severe language problems or mental retardation (Rutter & Schopler, 1987).

1.4. Can the understanding of mental states be taught?

Many studies show that individuals with autism have problems in understanding their own and other people's mental states (Baron-Cohen, Leslie & Frith, 1985; Perner, Frith, Leslie & Leekam, 1989). A failure to develop a 'theory of mind' may therefore underpin the social and cognitive deficits in autism (see Baron-Cohen 1995; Frith, 1989; Happé, 1994; Mitchell, 1997, for reviews). Accordingly, Swettenham (1996) and Hadwin, Baron-Cohen, Howlin and Hill (1996, 1997) tried to teach rules to children with autism for working out the underlying mental states of others. Hadwin et al.'s (1996, 1997) results showed that children with autism could be taught to pass tests of belief and emotion and these improvements were still apparent two

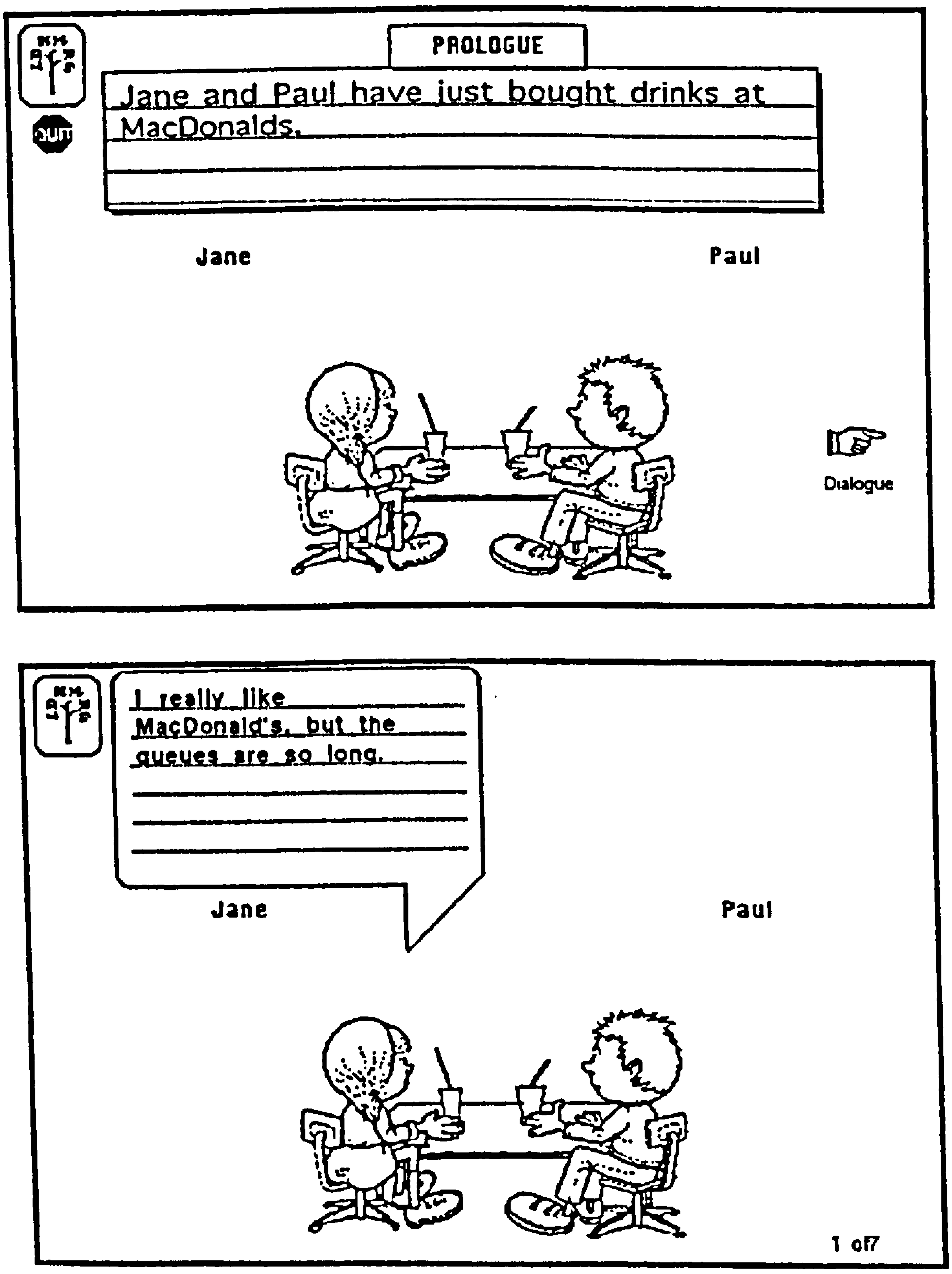

Fig. 1. Prologue from the first Bubble Dialogue scenario: simple perspective taking.

months later. Participants had to infer another person's mental state on the basis of that person's experiences, and thus needed to resist reporting their own beliefs and emotions.

The success of Hadwin et al.'s (1996, 1997) study was limited by the finding that benefits did not generalize to untutored areas. For example, tutoring about belief did not help participants to make more accurate judgements about another person's emotion. Moreover, the approach adopted in Hadwin et al.'s study is questionable in principle because solely teaching some rules to pass tests may be considered very crude. Children "may have learned to pass the tasks rather than understanding the concepts underlying the rules" (Hadwin et al., 1996, p.359). Indeed, learning rules does not necessarily mean that the children will understand and apply what they have been taught in the context of real life situations. As Frith (1989) wrote, "In order to develop a theory of mind one needs not only the ability to mentalize, but also experience. One needs experience with people who have different relationships to each other, and different personal interests" (p. 166).

1.5. Can an understanding of mental states be learned through experience?

In this study, we aim to introduce a computer-mediated intervention to participants while honouring the fact that clinically normal children acquire an understanding of the mind in the absence of any explicit tutoring. Presumably, their understanding develops through the experience of interacting with other people, perhaps along the lines that Frith (1989) envisioned. Individuals with autism and Asperger's syndrome are conspicuously impaired in their ability to interact, which could be a symptom of their difficulty in understanding other minds but which also could be an impediment to development in their understanding of the mind (Mitchell, 1996).

The Bubble Dialogue application allows users to reflect on speech as Dialogue and also alerts them to thought content as something distinct from speech. The program regulates turn-taking and serves as an interface between the two users. In this way Bubble Dialogue might allow the meeting of minds to occur as an explicit, engaging and experiential process.

Jones and Selby (1997) used Bubble Dialogue to explore communication in children with emotional and behavioural difficulties. They suggest that Bubble Dialogue can help children to communicate and express their feelings and views when they find it difficult to communicate directly. This virtue of Bubble Dialogue might also apply to individuals with Asperger's syndrome. Jones and Selby also state that the role-playing element provides an emotional 'distance' which allows specific issues in the child's life to be raised without direct reference. Hence, participants could play characters without having to identify closely with them.

Bubble Dialogue involves a prologue which introduces a particular social situation. Six theory of mind-inspired scenarios were developed for this study, showing an exchange of utterances made by two characters (Fig. 1 shows the prologue of the first scenario). The participant and researcher then assume the roles of these characters and take the Dialogue forward in an entirely open-ended way. The scenarios were developed to give an initial structure to the dialogues, yet are unconstrained and there are no correct or incorrect ways of doing the dialogues.

If participants benefit from Bubble Dialogue, this might be reflected in improvements in their every day social behaviour. To find out, supplementary items devised for the Vineland

Adaptive Behavior Scales by Frith, Happé and Siddons (1994) were administered, prior and post Bubble Dialogue, along with the Wisconsin Card Sorting Test (which tests executive function) and the British Picture Vocabulary Scale (which gives an assessment of receptive verbal comprehension).

The Card Sorting Test taps into aspects of autism which are not easily explained by the theory of mind account. Individuals with autism show a need for sameness, have difficulty switching attention, have a tendency to perseverate and lack impulse control. These symptoms are similar to those shown by individuals with frontal lobe brain injury in a condition known as Dysexcutive Syndrome (Baddeley & Wilson, 1988). Ozonoff, Pennington and Rogers (1991) define executive function "as the ability to maintain an appropriate problem-solving set for attainment of a future goal; it includes behaviors such as planning, impulse control, inhibition of prepotent but irrelevant responses, set maintenance, organized search, and flexibility of thought and action." (p. 1083). Using tests of executive function, including the Card Sorting Test, Ozonoff et al. (1991) found that high functioning autistic participants showed specific deficits. In the current study, a change in scores in Vineland Adaptive Behavior Scales, but not in the card sort or verbal ability was anticipated because the intervention was conceived specifically to improve interpersonal understanding.

1.6. Measuring the character of Dialogue in Asperger's syndrome

With the aim of constructing a detailed profile of speech and thought in Asperger's syndrome, blind raters were asked to rate Bubble Dialogue transcripts. This might give further insight into the peculiarities of interpersonal interaction in Asperger's syndrome and as a point of comparison, we included participants with emotional and behavioural difficulties.

We identified three dimensions on the assumption that they would best elicit the polarities of autism and characteristics associated with emotional and behavioural difficulties. Would the blind ratings reflect differences in the clinical classification of participants involved in the study?

1. Emotionally flat–emotionally charged: this dimension was chosen to access the lack of affect which Hobson (1990) proposes in his socio-affective account of autism. Hobson argues that individuals with autism have specific impairments in understanding people as sentient beings. His argument relates to Kanner's (1943) original clinical observations by postulating a primary impairment in the ability to form emotional contact with people.
2. Polite–coarse: the participants with emotional and behavioural difficulties attend a residential school almost exclusively for adolescents who had been excluded from mainstream state education because of antisocial and/or criminal disorderly conduct. In contrast, those with Asperger's syndrome live in residential care homes and attend mainstream colleges of further education. Hence, it was anticipated that the characters played by the individuals with Asperger's syndrome would be more polite than the characters played by individuals with emotional and behavioural difficulties.
3. Pursuing a topic too little–pursuing topic too much: this dimension was selected to adduce ratings reflecting the autistic tendency for perseveration. For example, individuals with

Asperger's syndrome are well known for incessantly talking about a single narrow topic (Ghaziuddin & Gerstein, 1996).

It was anticipated that the individuals with Asperger's syndrome would be rated as emotionally flat, polite and pursuing a topic too much. The reverse was expected for the individuals with emotional and behavioural difficulties.

2. Method

2.1. Participants

Two young adult males with Asperger's syndrome (D. and N.) and two adolescent males (P. and W.) took part in this study. Both males with Asperger's syndrome had been diagnosed by experienced clinicians according to standard criteria (DSM-IV, American Psychiatric Association, 1994) and lived in residential care homes. Both adolescents attended a residential school for children with emotional and behavioural difficulties. At the start of testing, D. and N. were aged 23 years 4 months and 23 years and 2 months, respectively; P. and W. were aged 14 years 9 months and 14 years 10 months, respectively.

The form of investigation used in this study lends itself to a case study approach. Hence, a small number of participants were tested over many sessions and a large quantity of data was gathered for each person. A detailed profile of each individual could thus be constructed.

2.2. Materials

The principal piece of hardware was an Apple Macintosh Classic computer installed with Bubble Dialogue (Gray et al., 1991) and Hypercard. Fig. 2, shows the complete scenario 'Tricia and Sue', for Bubble Dialogue session 3.

In this scenario, Tricia has a lighter which she keeps in her handbag. While Tricia was away from her bag (in the toilet), Sue takes the lighter from Tricia's bag (to use it) and then returns it. Crucially Sue puts the lighter in Tricia's coat pocket, instead of returning it to Tricia's bag. When Tricia returns from the toilet, both protagonists resume their conversation and Sue asks for a light for her cigarette, whereupon Tricia offers Sue the use of her lighter. When she goes to her bag, Tricia cannot find her lighter. Tricia has a false belief about the location of her lighter because it has been unexpectedly transferred. Tricia's belief about the lighter has not been updated in accordance with the current state of reality (i.e., the current location of her lighter).

2.3. Measures

The carers most familiar with D. and N. were interviewed using the Vineland Adaptive Behavior Scales supplementary items (Frith et al., 1994). These additional items are composed of two sets: one set of 16 items relating to social behaviours which do not require a theory of mind and the other 16 relating to behaviours which reputedly do. Scores are obtained by

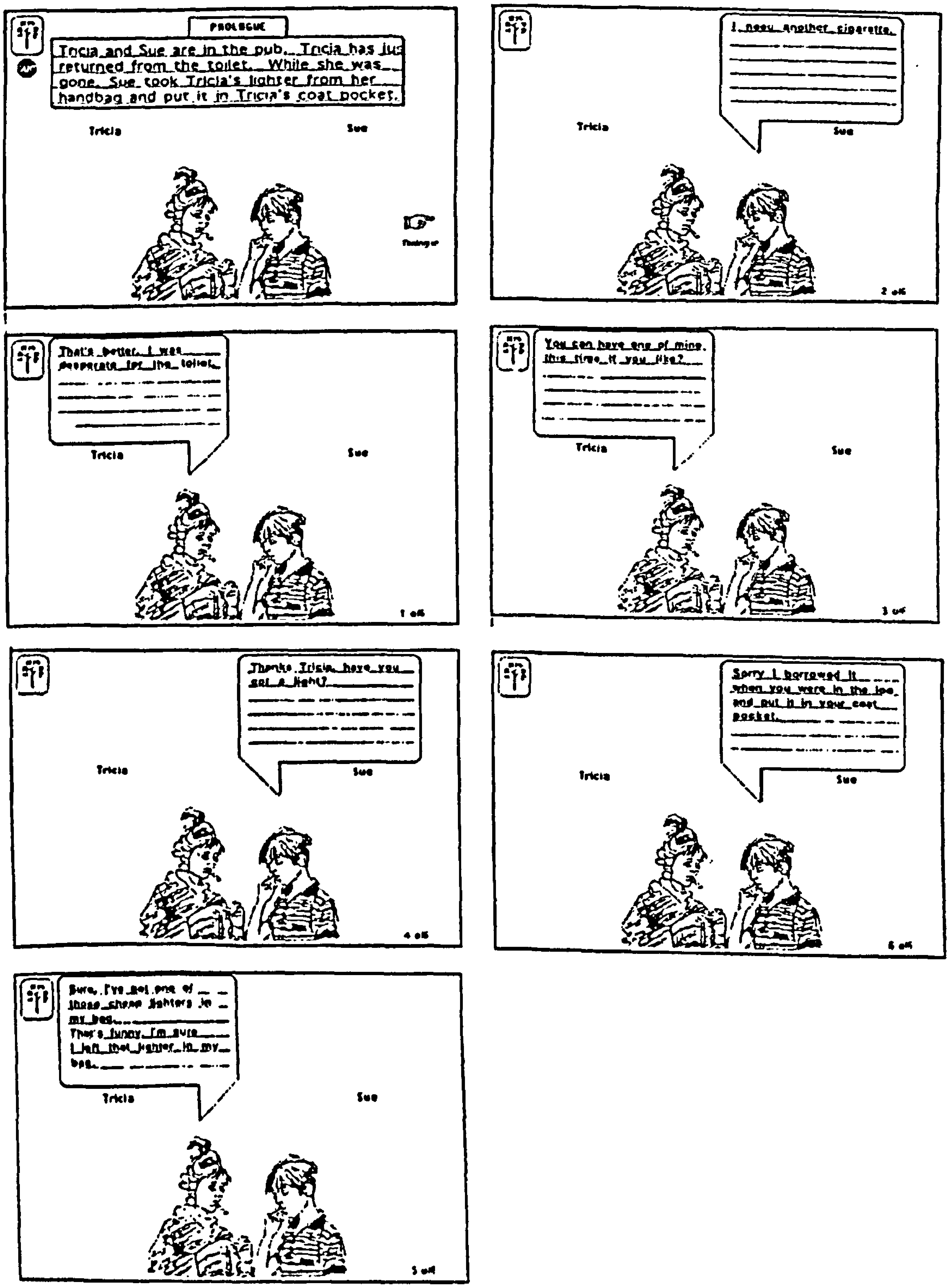

Fig. 2. Complete scenario for the third Bubble Dialogue scenario: false belief.

interviewing carers and grading the items 2, 1 or 0 if the behaviours are done habitually, occasionally or never, respectively. Therefore, total scores reflect usage of theory of mind in everyday life.

The Wisconsin Card Sorting Test (Grant & Berg, 1948) is a widely used measure that assesses an aspect of inhibitory control (Baddeley, 1990), which is a defining feature of executive function. In the task, four cards are placed in front of a participant. They vary across three dimensions: colour, geometrical shape and number (e.g., a card may have two blue stars). The participants are asked to sort a deck of cards according to the target cards, but are not informed explicitly of the criterion for sorting. Feedback regarding each attempted match is given. The initial unstated sorting criterion is colour and after ten consecutive correct responses, the criterion is changed to shape, but without informing the participant.

For accurate performance, a recently learned response rule has to be inhibited. Individuals with autism show similarities to those who have frontal lobe damage because they tend to persevere sorting the cards using the previous rule, even when told their responses are incorrect (Ozonoff et al., 1991). Additionally, we used the British Picture Vocabulary Scale (Dunn, Dunn, Whetton & Pintilie, 1982), which provided an assessment of receptive verbal ability.

All three measures were administered to D. and N., both before and after the six Bubble Dialogue sessions. D., N. and their carers were debriefed about the tests after the second administration. P. and W. were not tested and participated in the Bubble Dialogue sessions only.

2.4. Bubble Dialogue sessions

The Bubble Dialogue sessions took about 1 h each with the frequency of approximately 1 per week for 6 weeks. D. and N. were tested and had the Bubble Dialogue sessions in their own homes. P. and W. had the sessions in their school library.

The theory of mind-inspired scenarios (1)–(6) below, were given the folowing sequence (see Fig. 2 for an example of a scenario for 'False Belief'). These scenarios incorporate the principles taught to children with autism in Hadwin et al.'s (1996) study.

1. Simple perspective taking
   Understanding sources of informational access: "seeing leads to knowing"
2. Complex perspective taking
   Understanding implications of physical disability
3. False belief
   Communicating with someone who holds a false belief
4. Deception–Lie
   Lying to a parent about your whereabouts
5. Deception–"White" lie
   Organising a surprise birthday party
6. Making a friend
   Introducing yourself to a stranger

2.5. Procedure

Each participant was shown the scenario for that session and read it as often as he wanted. Once ready, the experimenter clicked on the speech icon for the character he played. The experimenter always played the character whose turn it was to speak next (see Fig. 2). Once the experimenter had inserted into the speech Bubble what he wanted his character to say, he clicked on the thought icon. The speech Bubble disappeared and was replaced by a thought bubble. The experimenter proceeded to type in what his character thought and then clicked on the participant's character's speech icon. When the empty speech Bubble for the participant's character appeared, the previous speech of the experimenter's character reappeared. When the participant had typed what he wanted to say, the experimenter clicked on the thought icon for the participant and a thought Bubble replaced the speech bubble. Once the participant understood the procedure of clicking on the icons to bring up the thought and speech bubbles, that task was left entirely to him. The participant and experimenter continued the Dialogue until they either ran out of time or had exhausted all the avenues to progress further with the dialogue.

The participant was asked if he wanted to review what he had written. If he did, the experimenter clicked the review icon and both users had an opportunity to go back through the entire Dialogue and change whatever they wanted.

2.6. Rating Bubble Dialogue scripts

The speech and thought Bubble Dialogues for all four participants were transcribed. The scripts resemble play scripts or screen plays (see Appendix A, for example). Additionally, thoughts were italicized, so that raters could easily discriminate them from speech.

Thirty-three 'blind' raters were recruited to assess the Dialogue scripts. The raters were psychology third/final year undergraduates following a course in theory of mind. They knew, in advance, that some of the scripts were produced by participants with Asperger's syndrome, but did not know which. They were randomly assigned to one of three teams (11 in each). Eleven raters rated all the four sets of six scripts (four participants, six scenarios), along one of three dimensions:

1. Emotionally flat–emotionally charged
2. Polite–coarse
3. Pursuing a topic too little–pursuing a topic too much

The raters were asked to rate the dialogues of both characters (one of which was played by the participant and the other played by the experimenter) by circling one line on a six point bipolar scale. The raters were deliberately not given any examples of what constitutes "emotionally flat or charged" and the same was true for the other two dimensions. The basis of interpretation was left to their own judgement and so a large number of raters (relative to the number of participants) were employed to ensure that even small effects would surface.

Since the discourse was between two people, the participants' scripts should not be rated in isolation. Therefore, the raters were asked to rate the experimenter's scripts as well. There were two scales, one for each character. The experimenter's rated scores were then subtracted from the participant's. This gave a number which reflected the interaction between both Bubble Dialogue users and was subsequently analysed quantitatively. It reflected, for example, how emotionally flat or emotionally charged the participant's character was relative to the experimenter's. A negative value would indicate that the participant was rated emotionally flat relative to the experimenter. The subtracted ratings were then summed across the scenarios.

3. Results

As Table 1 shows, there was no difference before and after the Bubble Dialogue sessions, in the Vineland Adaptive Behavior Scales for D. and only a slight difference for N. Similarly, there was very little difference in the British picture vocabulary scales before and after the Bubble Dialogue sessions for D. and N. However, D. and N. show a striking improvement in Wisconsin Card Sorting Test, in terms of reduced perseverations and an increase in categories they managed to sort correctly.

After the experimenter's Bubble Dialogue rated scores had been subtracted from the participants' rated scores, these subtracted ratings were then summed across five scenarios (rather than all six). The scores for scenario number 5, for all four participants, were not included in the aggregation and subsequent analysis because D. only produced one sentence for the entire scenario.

Table 1
Test scores for young adult men with Asperger's syndrome

Test	Score: Pre Bubble Dialogue	Score: Post Bubble Dialogue
	For D.	For D.
Vineland Adaptive behavior scales		
Active score (Max. 32)	20	20
Interactive score (Max. 32)	14	14
Executive function		
WCST[a] perseverations	105	28
WCST[a] categories	2	3
Verbal mental age:	14-9	12-5
Verbal IQ: (standardised score)	76	74
	For N.	For N.
Vineland adaptive behavior scales		
Active Score (Max 32)	19	21
Interactive Score (Max 32)	11	9
Executive function		
WCST[a] perseverations	65	9
WCST[a] categories	2	6
Verbal mental age:	12-8	14-7
Verbal IQ: (standardised score)	64	75

[a] WCST: Wisconsin Card Sorting Test.

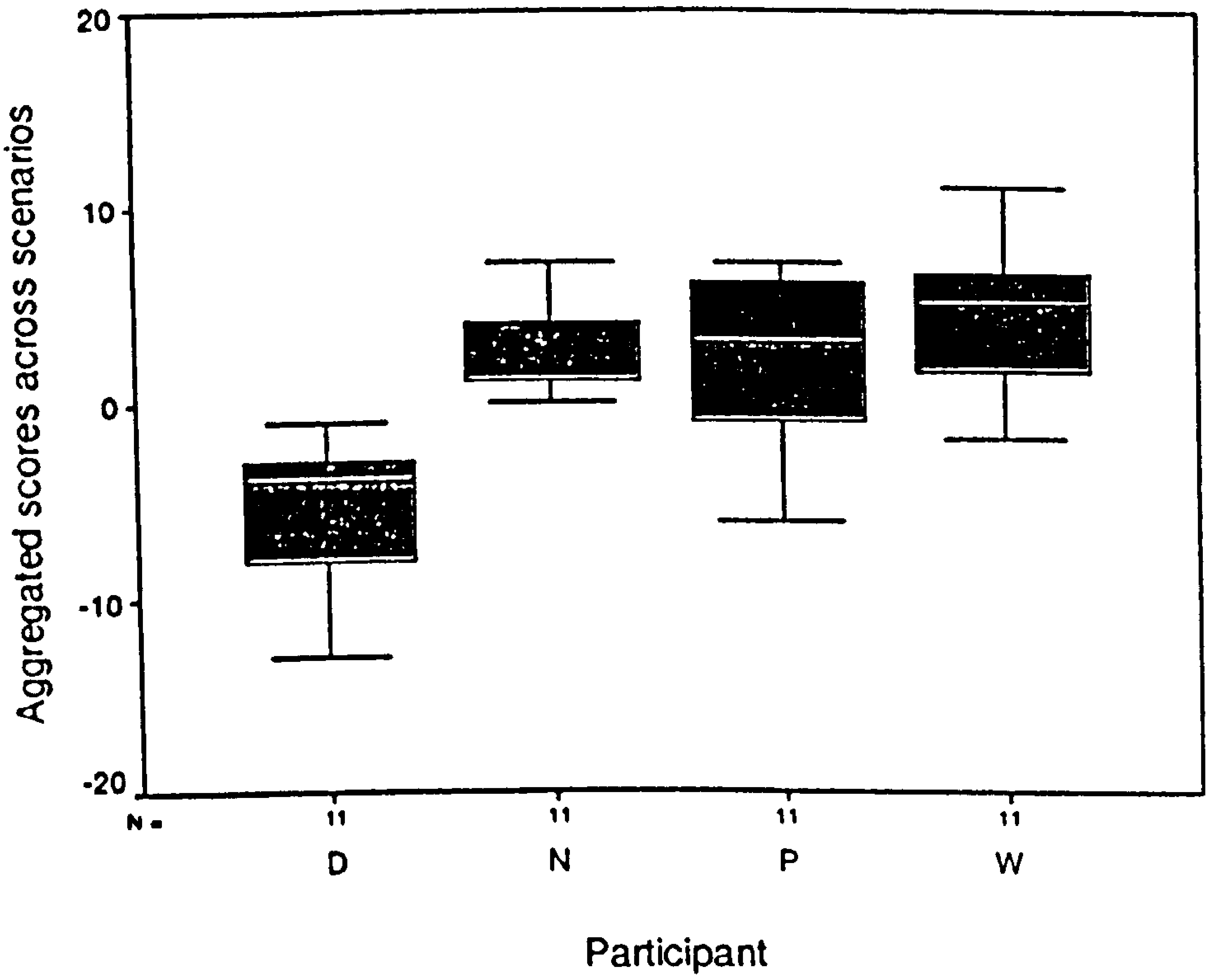

Fig. 3. Graphical representation for the blind ratings of the dimension emotionally flat to emotionally charged. D. and N. have Asperger's syndrome and P. and W. have emotional and behavioural difficulties. The top and bottom whiskers show the largest and smallest values which are not extreme scores (i.e., scores which are within 1.5 box lengths above or below the box). The top of the box shows the 75th percentile, the horizontal line shows the median (50th percentile) and the bottom of the box shows the 25th percentile.

Fig. 3 shows a graphical representation of the blind ratings for the dimension emotionally flat to emotionally charged. The data were analysed using a one-way within subjects analysis of variance, with four levels: $F(3, 30) = 14.8$, $p < 0.001$. In order to identify the locus of significance, we conducted a series of t-tests, which are summarized in Table 2. For effects to count as significant, they had to reach the 0.008 level of

Table 2
Results of the paired-sample t-tests, for the dimension "emotionally flat–emotionally charged"

		$t(df = 10)$	Significance (2-tailed)
Pair 1	D.–N.	−5.000	0.001
Pair 2	D.–P.	−3.454	0.006
Pair 3	D.–W.	−4.805	0.001
Pair 4	N.–P.	0.361	0.726
Pair 5	N.–W.	−1.741	0.112
Pair 6	P.–W.	−2.119	0.060

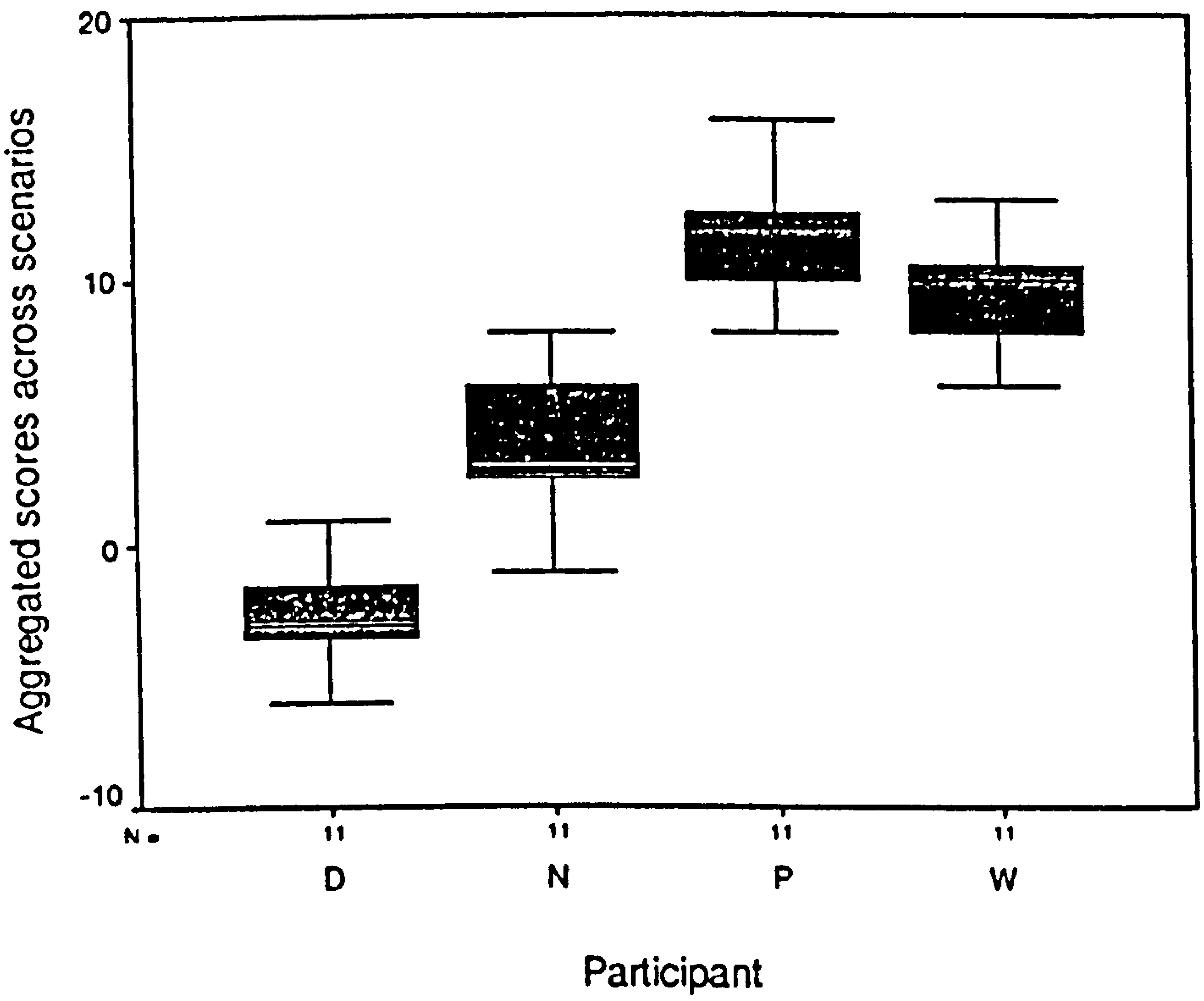

Fig. 4. Graphical representation of the blind ratings for the dimension polite to coarse. D. and N. have Asperger's syndrome and P. and W. have emotional and behavioural difficulties.

probability according to the Bonferoni adjustment (significance level divided by number of paired comparisons, i.e., 0.05 ÷ 6). D.'s scripts were rated as emotionally flat relative to the three other participants. N.'s scripts were not rated differently from the two individuals with emotional and behavioural difficulties.

Fig. 4 shows a graphical representation of the blind ratings for the dimension polite to coarse. Rater 5 omitted to rate scenario 3 for one of the participants with emotional and behavioural difficulties. His/her score was estimated by dividing the sum of the other five

Table 3
Results of the paired-sample t-tests, for the dimension "Polite–coarse"

		$t(df = 10)$	Significance (2-tailed)
Pair 1	D.–N.	−4.963	0.001
Pair 2	D.–P.	−13.668	< 0.001
Pair 3	D.–W.	−12.000	< 0.001
Pair 4	N.–P.	−5.682	< 0.001
Pair 5	N.–W.	−5.391	< 0.001
Pair 6	P.–W.	2.101	0.062

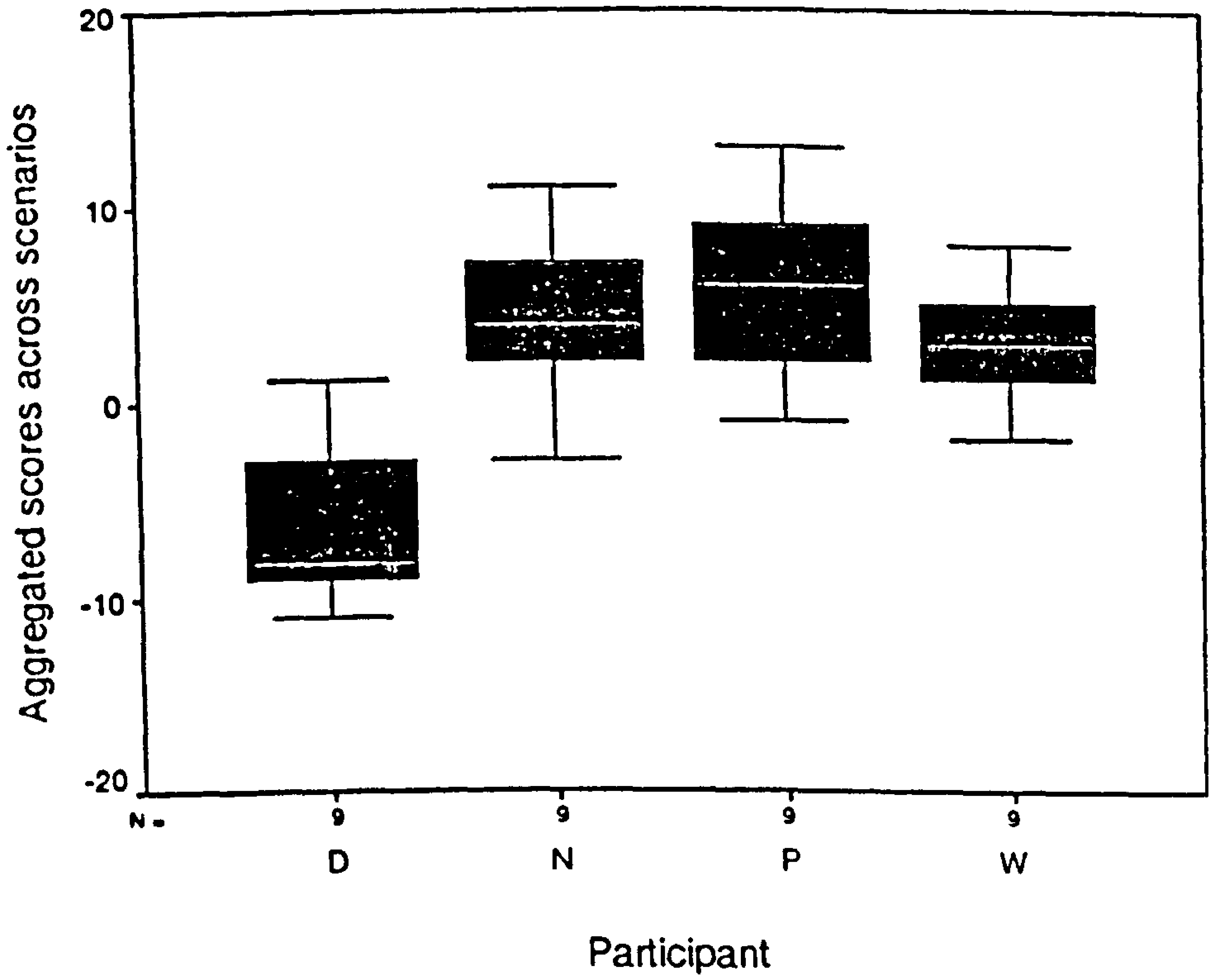

Fig. 5. Graphical representation of the blind ratings for the dimension pursuing a topic too little–pursuing a topic too much. D. and N. have Asperger's syndrome and P. and W. have emotional and behavioural difficulties.

scenarios by five. Significantly different ratings were made for the four participants: $F(3, 30) = 63.1, p < 0.001$. The t-tests summarized in Table 3 reveal that D. and N. are rated as more polite than both participants with emotional and behavioural difficulties. Additionally, D. was rated as more polite than N.

Fig. 5 shows a graphical representation of the blind ratings for the dimension pursuing a topic too little or pursuing a topic too much. Raters 3 and 4 did not completely rate all the scripts, so their entire ratings for the dimension were discounted. The main analysis revealed

Table 4
Results of the paired-sample t-tests, for the dimension "Pursuing a topic too little–too much"

		$t(df = 8)$	Significance (2-tailed)
Pair 1	D.–N.	−3.625	0.007
Pair 2	D.–P.	−5.433	0.001
Pair 3	D.–W.	−4.839	0.001
Pair 4	N.–P.	−0.652	0.532
Pair 5	N.–W.	0.216	0.834
Pair 6	P.–W.	3.468	0.008

that raters judged the four participants differently: $F(3, 24) = 11.3$, $p < 0.001$. The t-tests summarized in Table 4 indicate that D. was rated as significantly pursuing a topic too little compared with the three other participants. The script ratings for the two participants with emotional and behavioural difficulties were on the cusp of being significantly different.

4. Discussion

4.1. Did the Bubble Dialogue experience facilitate interpersonal understanding?

It seems the experience of Bubble Dialogue, presented through six theory of mind-inspired scenarios, did not induce a detectable change in interpersonal understanding as measured by Frith et al.'s (1994) supplementary items for the Vineland Adaptive Behavior Scales. These results could be interpreted in four ways:

1. The experience of Bubble Dialogue induced an improvement in interpersonal understanding, but was too weak to be detected by any readily available test.
2. The Vineland Adaptive Behavior Scales in particular is not a sensitive enough measure to detect any such change, despite being a widely used clinical tool.
3. D. and N. do not have the ability to mentalize and the experience of Bubble Dialogue could not help to improve their interpersonal understanding.
4. D. and N. already possessed the ability to mentalize and the Bubble Dialogue experience was of no further benefit to them.

The Vineland Adaptive Behavior Scales scores, for both D. and N., were very similar to those of the children with autism who passed both first and second order theory of mind tests in Frith et al.'s (1994) study. Therefore, D. and N. may be amongst those individuals Happé (1993) calls the 'talented minority', and hence were able to mentalize in everyday life prior to the experience of Bubble Dialogue. In that case, interpretation 4 would appear plausible.

Irrespective of any measurable benefits, N., P., and W. often commented how engaging and enjoyable they found Bubble Dialogue. Therefore, as well as being interactive, Bubble Dialogue provides a humanistic and socially non-threatening way to engage in role-play and experience other people's perspectives. D., in contrast, saw the sessions as a piece of creative English language work. At first he articulated a hope that Bubble Dialogue would provide him with a creative imagination, but as he progressed through the sessions he became increasingly disillusioned when he realised this was not going to happen.

4.2. Does Bubble Dialogue provide a link between theory of mind and executive function?

The control measures in the study were the British Picture Vocabulary Scale and the Wisconsin Card Sorting Test. The results, relating to the former, show very little difference in verbal ability before and after the Bubble Dialogues sessions (see Table 1). However, D. and N. show a striking improvement in the Wisconsin Card Sorting Test in terms of reduced perseverations and an increase in the number of categories they managed to sort correctly.

It seems unlikely that there was general improvement in overall functioning because the verbal ability scores are similar for D. and N. before and after the Bubble Dialogue experience. This suggests that there was no 'across-the-board' increase in cognitive function arising from either experiencing Bubble Dialogue or developmental changes.

Ferland, Ramsay, Engeland and O'Hara (1998) found that clinically normal male participants showed little evidence of gaining in performance after repeated administrations of the Wisconsin Card Sorting Test. Ferland et al.'s (1998) normal male group ($n = 22$) scored a mean of 11.0 perseverative responses on the first administration of the test and 6.6 on the second. These results suggest that the scores are consistent over repeated testings. Additionally, Ozonoff (1995) found that the Card Sorting Test was extremely reliable in eliciting stable scores, when individuals with autism were re-tested after two years.

Prior to the Bubble Dialogue intervention, D. and N.'s scores (see Table 1) were remarkably like those of Ferland et al.'s (1998) brain injured group. D. and N.'s scores improved on re-test after Bubble Dialogue and notably N.'s scres became almost identical to Ferland et al.'s (1998) normal group.

Interestingly, perseveration may not be characteristic of individuals with Asperger's syndrome who show normal scores on the Wisconsin Card Sorting Test (as D. and N. do on post-test), because according to Shallice (1988) individuals who do not perform like frontal lobe damaged patients on the Card Sorting Test have an intact Supervisory Attentional System. This is a device which allows a person to switch attention. Norman and Shallice (1986) state that a particular response may be thought of as the outcome of a computer program working through its algorithm, where the Supervisory Attentional System allows that program to change once it has started running. Shallice (1988) uses this computational analogy to explain that once an internal program has been set (e.g., sort by colour) it cannot be changed if there is damage to the supervisory attentional system.

It could be argued that aspects of Bubble Dialogue require executive function because the, "Supervisory attentional system is construed as being necessary for effective control of action in a number of situations: Situations that involve planning or decision making; situations that involve error correction or troubleshooting; situations where responses are not well learned or contain novel sequences of actions; situations judged to be dangerous or technically difficult; and finally situations that require the overcoming of strong habitual response or resisting temptation" (Evans, Chua, McKenna, & Wilson, 1997, p. 636).

When using Bubble Dialogue, thoughts (which are normally private and hidden) become public and visible and so the users have access to the thoughts of each other's character. The users are literally able to mindread. If a user plays 'correctly', then their character will not act upon the knowledge that resides in the private thoughts of the other user's character. This ability requires the inhibition/impulse control of actions that might stem from knowledge acquired from the other character's thoughts. Additionally, using Bubble Dialogue requires flexibility of thought and action, along with planning in how next to progress in the dialogue. Hence, it may be the practice of these executive processes, engendered by Bubble Dialogue, which brought about the reduction of perseveration on the Card Sorting Test.

It could be that development in executive function precedes changes in mentalizing and that is why D. and N. showed improved scores in the test of executive function without concomitant improvements in verbal ability. Indeed, there might be a time lag before we see parallel improvements in measures of verbal ability. Another possibility is that since scores of verbal ability were commensurate with an ability to mentalize, there would be no remaining scope for improvements in executive function to facilitate mentalizing any further.

4.3. Blind ratings of Bubble Dialogue transcripts

The blind rating of transcripts provides a third-party perspective on the formulation of speech and thought by people with Asperger's syndrome. The Bubble Dialogues D. and N. produced were rated as the most emotionally flat of the four participants. These results support Hobson's socio-affective theory and Kanner's original clinical observations that individuals with autism are impaired in their social and emotional connectedness. D. and N.'s Bubble Dialogues were also rated as the most polite of the four participants. These results show that despite their lack of affect, some individuals with Asperger's syndrome can be viewed as polite.

D.'s characters were rated as pursuing a topic too little relative to the experimenter's. This dimension may have been picking up the lack of social reciprocity in D.'s characters, rather than perseveration. The raters might have viewed D.'s characters as not being sensitive or responsive enough, which they characterised as 'pursuing a topic too little'.

The blind rating analyses of the three dimensions, show that although D. and N. have the same diagnostic label of Asperger's syndrome, the Bubble Dialogue scripts they produced were sometimes rated differently from each other. Indeed, N.'s adduced ratings were not significantly different from the adolescents with emotional and behavioural difficulties, along the emotionally flat-charged and pursing a topic dimensions.

Does this mean N. was incorrectly diagnosed? This seems unlikely. The rating differences perhaps highlight that even individuals with the specific label of Asperger's syndrome can vary. It may also be that for some individuals with Asperger's syndrome, Bubble Dialogue elicits social interactions indistinguishable from other populations. The implication is that computers can be used to elicit more 'normal' social interactions in individuals with Asperger's syndrome (cf., Swettenham, 1996).

4.4. The future role of computers in dialogue

Speaking to someone in person requires an enormous amount of information to be processed. We have to attend not only to the words themselves, but also to the person's intonation, their facial expression and so on. A lot of information is, therefore, processed rapidly and seemingly effortlessly by clinically normal people. In contrast, individuals with Asperger's syndrome and autism are known to have sensory-perceptual abnormalities (O'Neill & Jones, 1997) which may result in overload by too much multi-sensory information. Computers slow down the experience of communication, by offering individuals more time to compose a response. Additionally, Bubble Dialogue allows the chance to 'go back' (in review mode) and change what was said; something we cannot (sadly) do in everyday conversations.

Arguably the greatest benefit of computers to individuals with Asperger's syndrome, is that they offer a radically different mode of social engagement. The way people communicate is already changing and potentially this is very beneficial to individuals with autism. Computer-mediated communication through e-mail, chat rooms and virtual reality environments may allow individuals with Asperger's syndrome to overcome some of their social problems. Therefore, it would be somewhat ironic if individuals with autism, who are stereotypically thought of as unemotional logic-driven machines, become more integrated into society through information technology.

The results from this study suggest that future research needs to be directed at developing experiential interventions, and investigating their efficacy in improving social understanding in individuals with Asperger's syndrome. Furthermore, the use of computer software, like Bubble Dialogue, provides an engaging and humanistic way of facilitating this. The methodology of using blind raters is a technique that can be applied to other investigations. It is suitable for experiments where it would be valuable to obtain third party measures of scripts produced by participants from any source. Additionally, more research needs to be carried out detailing the cognitive neuropsychology of autism and using the theory of mind and executive function paradigms to provide a comprehensive theoretical picture of autism.

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Appendix A

Scenario	Tricia and Sue are in the pub. Tricia has just returned from the toilet. While she was gone, Sue took Tricia's lighter from her handbag and put it in Tricia's coat pocket.
Tricia says	"That's better I was desperate for the toilet."
Sue says	"I need another cigarette."
Tricia says	"You can have one of mine this time if you like?"
Sue says	"Thanks Tricia, have you got a lighter?"
Tricia says	"Sure I've got one of those cheap lighters in my bag. That's funny. I'm sure I left that lighter in my bag."
Sue says	"Sorry, I borrowed it when you were in the loo and put it in your coat."(Rate from here onwards)
Tricia says	"I could have sworn that lighter was in my bag."
Tricia thinks	*"I wonder if Sue played a trick on me?"*

Sue says	"No, I put it in your pocket or maybe you've put it in my pocket? Well, wherever it is I'm not responsible, and you should have seen were you have put it in the first place."
Sue thinks	"*Boy I feel strange today*!"
Tricia says	"Sorry there's no need to get upset. I was just certain the lighter was in my bag and when I looked, it wasn't there anymore."
Tricia thinks	"*Sue is certainly very moody today. I wonder why she is so touchy*?"
Sue says	"Are you trying to make me feel guilty for what I've done?"
Sue thinks	"*What is she implying*?"

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