ARE INDIVIDUALS WITH AUTISM SPECTRUM DISORDERS SENSITIVE TO TRAITS?

Rajani Ramachandran, B.A., M.A.

Thesis submitted to The University of Nottingham for the degree of Doctor of Philosophy

October 2007

Abstract

This thesis examined whether individuals with Autism Spectrum Disorders are sensitive to traits. The ability of individuals with Autism Spectrum Disorders to infer traits from descriptions of behaviour was investigated by asking participants to read trait implying sentences and then to chose one of two words that best related to the sentence. In experiment 1, individuals with Autism Spectrum Disorders performed similarly to matched controls in being faster at choosing the trait in comparison to the semantic associate of one of the words in the sentence. The results from experiments 1 and 2 provided converging evidence in suggesting that inferring traits from textual descriptions of behaviour occurs with relatively little effort. The results of experiment 3 suggested that making trait inferences took priority over inferring actions or making semantic connections between words. Experiment 4 investigated whether individuals with Autism Spectrum Disorders associated the inferred trait with the person carrying out the behaviour (actor). Participants were presented with a pair of faces and sentences followed by the same pair of faces being presented with a single word. Participants had to choose which actor is best described by the word. The results provided evidence that participants with Autism Spectrum Disorders were able to associate inferred traits with the actor easily, even when the actor was represented by his face. The experiments described in this thesis provide evidence for the possibility of trait inference as relating to behaviour being a spared socio-cognitive function in autism.

ACKNOWLEDGEMENTS

I would like to thank my supervisor, Peter Mitchell, for his fantastic guidance and encouragement which made being away from home and family worth while. I am also indebted to my second supervisor Danielle Ropar for her support and help over the last three years. I would like to thank The Commonwealth Scholarship Commission for funding my PhD and The British Council for their administrative support.

Special thanks to the staff and students of the participating schools which include: Monday club, Leicestershire; Potterspury Lodge School, Northamptonshire; Cruckton Hall School, Shropshire; Farleigh Further Education College, Somerset; Rosehill Special School, Nottingham High School and Long Eaton Comprehensive School, Nottinghamshire.

Finally, I would like to thank my family, especially my brother, Rajeev, for the discussions that made my thoughts and ideas clearer and my husband, Vijay, for always being there for me.

Table of Contents

List of Figures

Chapter Five

Chapter Six

List of Tables

Chapter One

General Background to Autism

1.1 Introduction

One of the most famous folklore characters in Kerala, a southern state of India, is Naranath Branthan (Naranath, the lunatic). Naranath supposedly spent his days pushing huge rocks up a steep hill only to send them rolling down from the top. He would laugh, jump and clap his hands in glee as he watched the rock tumble down. This he would repeat over and over again; hence being called a lunatic by some. Others, though, gave philosophical interpretations to this ritual and thought him to be a saint. Naranath supposedly lived about 1500 years ago. If he had been born in this century he quite possibly may have been diagnosed with autism. History has stood witness for many lives who probably were autistic. Brother Juniper, one of the first companions of Saint Francis who lived in twelfth century France, astonished everyone by his guileless and unpretentious behaviour and the descriptions of the 'Blessed fools of ancient Russia' match closely to how autism is portrayed in modern times (Frith, 2003). Houston and Frith (2000) systematically corroborated evidence archived in the Edinburgh court record dating from 1745 to arrive at a retrospective clinical diagnosis of autism for Hugh Blair. Blair's younger brother wanted the court to declare Blair mentally incapable with the intention of disinheriting him and Frith's diagnosis was based on the testimonials provided by friends and neighbours at the hearing. But, it was many years later, in 1943, that autism was clinically described for the first time by Leo Kanner as a disorder with symptomatology that clearly differentiated it from childhood schizophrenia and other psychoses. The term autism was coined by Eugen Bleuler for the active withdrawal from relationships seen in people with Schizophrenia and Kanner used this term to portray what he considered to be the essence of autism, "inability to relate themselves in the ordinary way to people and situations from the beginning of life".

Social impairment sits at the core of this syndrome which manifests a potpourri of other characteristics as well. A large amount of research has been carried out in an attempt to explain the social ineptness seen in individuals with autism, some of whom are otherwise highly successful. But the puzzle is yet to be solved. In order to better understand the enigma we must try and explain not only how individuals with autism are disabled by their social impairment but also how a few individuals with autism cope despite the impairment.

This thesis begins with a brief introduction to autism as we understand it today (Chapter One). Chapter Two discusses making inferences about others' personality traits as a socio-cognitive process that has not been investigated in individuals with autism. Arguments for and against expecting individuals with autism to infer traits from descriptions of behaviour are discussed concluding with the paradigm developed to investigate this ability. Chapter Three to Chapter Six describe the experiments carried out. The final chapter provides a summary of the experiments carried out, elaborates on the conclusions and discusses possible future research on the role played by traits in social cognition in autism.

1.2 What is autism?

Autism is a neuro-developmental disorder with an unknown aetiology and hence diagnosis is based on symptoms manifested behaviourally. Many epidemiological studies of autism have been carried out since the first one by Victor Lotter in 1966, who reported the prevalence rate to be 4.5/10,000. Recent studies suggest a much higher incidence of autism. In one of the latest studies, the incidence rate for autism was reported to be 38.9 per 10,000 children in the south Thames 9-10 year old population (Baird *et al.*, 2006). All epidemiological studies report a higher incidence in males than females, with a ratio of 4:1 on average (DSM-IV-TR, 2004).

1.2.1 Diagnosing autism

The first diagnostic criterion for autism was developed by Eisenberg and Kanner (1957). They set the two pathognomic features as extreme aloneness and a desire for preservation of sameness, both of which must be present within the first two years of life. The other features described by Kanner in the seminal writing on autism (delayed or deviant language development and a fascination for objects as opposed to people) were considered to be derivatives of these two core characteristics. Rutter (1978) included delayed and deviant language development as the third behavioural criterion and increased the age by which the features must be manifested from 24 months, as suggested by Eisenberg and Kanner (1957), to 30 months.

Autism was included as a distinct disorder for the first time in an official diagnostic system in the Diagnostic and Statistical Manual of Mental Disorders, third edition (DSM-III), published by the American Psychological Association in 1980. DSM-III used the label infantile autism which was changed in the revised version, DSM-III-R (1987), to autistic disorder in recognition of the fact that children with autism grow up to become autistic adults. DSM-III-R underwent two further revisions with the latest being DSM-IV-text revision (DSM-IV-TR, 2004).

The International Classification of Diseases (ICD) is the diagnostic system published by the World Health Organisation. Childhood autism was mentioned in the ICD for the first time as a disorder different from childhood schizophrenia in the tenth and latest edition, published in 1994. ICD 9 (1977) included autism but under the category 'Psychosis with origins in childhood'. The criteria for autism are identical in ICD-10 and DSM-IV-TR (see Appendix A), although they use different labels. ICD-10 uses the label 'childhood autism' and DSM-IV-TR uses the label 'autistic disorder'.

To arrive at a diagnosis, a detailed case history is taken, behavioural observations are made and neuro-psychological tests are administered. The information obtained from them is used to determine if the individual shows qualitative impairments with respect to his or her developmental age in the areas of social interaction and communication, and displays restricted range of interests and activities and whether these impairments were present before the age of three years. In addition, tools developed specifically for the purpose of identifying autism, including the Autism Diagnostic Interview-R (ADI-R, Le Couteur, Lord, & Rutter, 1994) and the Developmental, Dimensional and Diagnostic Interview

(3Di, Skuse *et al.*, 2004), to name a few, help to standardise the diagnostic procedure.

1.2.2 Clinical picture of autism

No two individuals with autism show identical clinical pictures. In fact as a child with autism develops, s/he may show different symptoms or variations in the intensity with which a particular symptom was manifested. In other words, being diagnosed as having autism means having a definite impairment in the three core areas of social interaction, communication and repertoire of interests and activities; but how the impairment is manifested behaviourally may vary between individuals as well as within the same individual overtime. The impairments, however, must be present before 3 years of age.

Qualitative impairment in social interaction

In the early years difficulties in social interaction are evident (though not necessarily recognised as a symptom at the time) in failure to cuddle, failure to raise hands in anticipation of being picked up, lack of imitation of speech and gestures, not finding enjoyment in reciprocal games like peek-a-boo and a deficit in joint attention (the phenomena when two people co-ordinate their attention to the same object or event). Those with autism may be indifferent to the presence or absence of their parents. They may approach strangers with the same uninhibited friendliness as they do with family and friends. But, some children with autism may cling to their parents and show extreme distress at separation. Many children with autism may not spontaneously seek to share enjoyment, interest or achievement. Neither do they seek comfort from parents or significant others when in distress. Those with autism may not develop mental age appropriate peer relations and may prefer solitary activities, showing relatively more interest in objects than people. As they grow, some may become interested in making friends but may not understand even basic conventions of social interaction, which their peers pick up with ease. People with autism may show difficulty initiating and maintaining conversation, selecting an appropriate topic, taking turns or keeping the conversation going. They may not be able to regulate social interactions based on information from non-verbal social cues like eye contact, facial expressions, body postures and gestures.

Wing and Gould (1979) identified three types of social interactions in children with autism. The aloof child is withdrawn, indifferent or upset by social overtures. The passive child accepts social interactions without a fight but not with any keenness or interest. The active but odd child likes to interact with others but the interaction is inappropriate, for example cuddling a stranger. A child may show all three types of interactions in different situations and the predominant type of interaction may change with age.

Qualitative impairment in communication

While the initial deficit in social interaction is often disregarded by parents as streaks of independence, contentment and self sufficiency, delay in language is often the symptom which rings definite alarm bells and leads the parents to seek professional advice.

Spoken language is either delayed or deviant and in many completely absent. Retrospectively parents often report that babbling was absent. Both non-verbal and verbal skills are affected in autism. Autistic children often do not use communicative gestures (for example, waving goodbye and nodding yes) or expressive gestures (for example, shrugging shoulder). They may not view the parent as a person who could fulfil their desires but use their parents' hand as a tool to get a desired object.

Deviations are observed in the form of immediate and delayed echolalia (parrot-like repetition of speech), pronominal reversal (using 'I' instead of 'you' and vice versa), neologisms, idiosyncratic use of words and literal understanding of language resulting in difficulty with understanding words having two meanings, puns, sarcasm and humour. The speech quality may be pedantic and uncolloquial. Prosody may be impaired. Difficulty with semantic and syntactic aspects of communication may vary in degree but pragmatic difficulty, using language for the purpose of communication, is universal in autism (Frith, 2003).

Markedly restricted repertoire of activities and interests

Individuals with autism may show interests that are abnormal either in intensity or focus, for example, an all pervading interest in bus timetables. They may show persistent fascination for ordinary objects or parts of objects like keys or buttons, or movements like the spinning of the washing machine. Those with autism may insist on a set routine for carrying out activities and strongly resist change; the same route may have to be taken to the supermarket every time, or Lego will be arranged in the same sequence and pattern every time. Often the route, sequence and pattern may be the one shown to the child the very first time. Change may lead to extreme distress in some individuals with autism. Stereotyped body movements (hand flapping and rocking) may be present.

Play may be stereotyped and repetitive, lacking in imagination. Children with autism may line up blocks or spin the wheels of a toy car rather than play constructively or symbolically with them. They may not show developmental age appropriate co-operative play with other children.

Associated features

A few features which are observed frequently in autism are not important for diagnosis per se, but help increase our understanding of the disorder. One of the features which led researchers to suspect a biological origin for autism is an increased frequency of seizures with the risk increasing at puberty (Tuchman & Rapin, 2002). Approximately seventy percent of children with autism have mental retardation (Fombonne, 2003). In intelligence tests most individuals with autism obtain a higher performance Intelligence Quotient (IQ) than verbal IQ. Some people with autism demonstrate islets of ability like hyperlexia, drawing skill or music ability that is well above what is expected based on their intellectual ability. Abnormal responses to sensory stimuli may be present in some children and adults with autism. Any of the sensory modalities, sound, vision, touch, smell or taste, may be affected. Temper tantrums, self injurious behaviour (like biting, pinching) and aggression towards others are sometimes exhibited by individuals with autism.

1.2.3 Current issues relating to diagnosis: Autism as a spectrum of disorders

Lorna Wing (1981) reported a disorder similar to Kanner's autism which she referred to as Asperger's Syndrome after the person who first described it. Hans Asperger's paper was published in 1944, just a year after Kanner's influential article on autism. Though at first glance it is the similarities between the two descriptions which stand out (higher incidence in males than females, social isolation, impaired non-verbal communication and so forth), subtle differences are present between Asperger's Syndrome and Kanner's autism. The current classification systems (DSM-IV-TR and ICD-10) classify autistic disorder and Asperger's Syndrome separately under the category of Pervasive Developmental Disorders (PDD). Asperger's Syndrome is differentially diagnosed from autistic disorder in terms of cognitive and language skills. Individuals with Asperger's Syndrome do not show clinically significant delay in cognitive development, self help skills or adaptive behaviour. Early language development occurs at the normal pace. The nature of social impairment is different in autistic disorder and Asperger's Syndrome. Individuals with Asperger's Syndrome may not be indifferent to social approaches and in fact are often described as 'chatty'. However, their social interaction is characterised as odd due to failure to acknowledge conventional rules of conversation (like turn taking), limited understanding of non verbal cues and inadequate self monitoring capacity. Restricted repertoire of interests and activities are observed in both autism and Asperger's Syndrome. In autism this is characterised by fascination for objects, while in Asperger's Syndrome it is manifested in the form of the individual devoting an inordinate amount of time and energy gathering information about subjects that are often of little practical use (for example, actors and names and year of production of their movies).

Epidemiological studies on Asperger's Syndrome are few. Fombonne (2003) reported that the incidence of Asperger's Syndrome is lower than autism.

approximately 2.5/10,000. The gender ratio is found to increase with level of functioning. In the average intelligence group, Fombonne (2003) reported, the ratio to be 5.75:1 which decreased to 1.9:1 in the group with autism and moderate to severe learning difficulty.

It is debated whether the two syndromes are distinct nosological categories or whether Asperger's Syndrome is a milder, higher functioning variant of classical Kanner's autism. Some authors argue against the use of the term 'Asperger's Syndrome' without empirical evidence based distinction (*cf.* Ozonoff, Rogers, & Pennington, 1991) and the term Higher Functioning Autism is often used in preference by some. However, Ozonoff *et al.* (1991) found that it is possible to distinguish between Asperger's Syndrome and Higher Functioning Autism on neuropsychological measures. They found that participants with Asperger's Syndrome had fewer autistic characteristics on the Childhood Autism Rating Scale (CARS) and obtained a significantly higher verbal Intelligence Quotient (IQ) than participants with Higher Functioning Autism. The discrepancy between verbal and performance IQ found in the group with Higher Functioning Autism was not found in the group with Asperger's Syndrome. The group with Higher Functioning Autism showed deficits in Theory of Mind (discussed later) and verbal memory which were not observed in the group with Asperger's Syndrome.

The presence of other disorders characterised by social impairment, deviant communication, presence of narrow interests and repetitive behaviour but not fitting the diagnostic picture of classical autism has led to the use of the term Autism Spectrum Disorders (ASD). Autism Spectrum Disorders includes Autistic disorder, Asperger's syndrome, Rett's disorder (a rare disorder occurring exclusively in girls where autistic like symptoms develop after a period of normal development), Childhood disintegrative disorder (another rare disorder where there is regression in social and communication skills after a period of normal development) and Pervasive Developmental Disorders, Not Otherwise Specified (PDD-NOS, an umbrella term used when a child shows some but not all features of any of the conditions listed under Autism Spectrum Disorders).

Many epidemiological studies report an increase in the prevalence rate (total number of cases in the population divided by number of individuals in the population) of Autism Spectrum Disorders. The increased awareness about autism in the clinical set up along with the broadening of diagnostic criteria may be partly responsible for this trend. Baird *et al.* (2006) reported the prevalence rate for autistic disorder to be 38.9 cases per 10,000 in the south Thames 9-10 year old population. This rate however increased to 116.1/10,000 when the whole spectrum was considered.

1.2.4 Theories of causation

Highly intelligent but emotionally and behaviourally cold parent as the cause for autism was pondered by Kanner in his seminal work. However, he concluded that the symptoms are present very early in life which suggests that autism is an 'inborn autistic disturbance of affective contact'. The theory that autism is the result of parental rejection, especially by the mother, came to be known as the 'refrigerator mother hypothesis' and was propagated by Bruno Bettleheim (1959). But, the hypothesis was rejected, though not soon enough for some unfortunate parents, in favour of a biological explanation for autism thanks to the work of Bernard Rimland (1964). Our understanding of autism has progressed from the psychoanalytic explanation, and autism has now been established as a neuro-developmental disorder presenting distinctive deficits in cognition that are genetically influenced (Rutter, 2003).

Genetics of autism

The prevalence of Autism Spectrum Disorders among family members of individuals with autism is found to be higher than the prevalence in the general population, suggesting a high rate of heritability for autism. The prevalence of Pervasive Developmental Disorder subtypes amongst siblings of probands with autism was found to be seventy-eight percent for autism, six percent for Asperger's syndrome, and sixteen percent for atypical autism in one study (*cf.* Szatmari, Jones, Zwaigenbaum, & MacLean, 1998). Bailey *et al.* (1995) reported the concordance rate for autism to be sixty percent for monozygotic pairs and zero for dizygotic pairs.

The fact that males are at a higher risk of Autism Spectrum Disorders than females is suggestive of a genetic link, probably on the X chromosome (Skuse, 2003). However, identifying 'the gene' for Autism Spectrum Disorders has proved to be far more complicated than initially thought (Barnby & Monaco, 2003) particularly in terms of replicating evidence for the many candidate genes that have been identified in some studies (on chromosome 2, 7 and 14). This may be due to the complex nature of Autism Spectrum Disorders. How autism manifests in an individual varies dramatically in form and intensity, leading some researchers to suggest that multiple genes may be involved in Autism Spectrum

Disorders. Different sets of genes may be mutated in different individuals with autism (McIntosh, 1998).

Neural basis of autism

Neuropathological and imaging studies have identified structural and functional variations in the brains of individuals with Autism Spectrum Disorders. The most consistent structural abnormality reported is increased brain volume. This increase in brain volume is not evident at birth, but is a result of abnormal growth during infancy which slows down by adolescence (Courchesne *et al.*, 2001). The sudden increase in brain volume is speculated to be the result of abnormality in the pruning process which normally occurs in infancy. During pruning faulty connections are eliminated and the functioning of feedback control system is optimized (Frith, 2003). Structural abnormality in other brain regions, such as the amygdala and cerebellum, has also been implicated in Autism Spectrum Disorders. However the research findings are not always consistent (Frith, 2003).

Studying blood flow in the brains of individuals with Autism Spectrum Disorders 'at rest' reveals persistent abnormal perfusion in certain brain regions with consistent results found with respect to the medial temporal cortex in both hemispheres (*cf.* Hill & Frith, 2003).

Environmental factors in autism

The concordance rate for Autism Spectrum Disorders is not 100 percent even in monozygotic twins and hence non-genetic and environmental factors must also contribute to the development of autism. Environmental factors are seen as the culprit by researchers and the general public who support the claim that the increase in Autism Spectrum Disorders is real and not a result of increased awareness or improved diagnostic procedure. Some of the environmental factors considered are food allergy, particularly with respect to casein and gluten, gastric inflammation, viral infections and autoimmune disorders. Environmental factors, like mercury level in the environment, pre and perinatal complications, have also been implicated in some studies (*cf.* Rodier & Hyman, 1998).

Cognitive theories of autism

Explaining autism in terms of cognitive processes provides a vital interface between brain and behaviour (Hill & Frith, 2003). The three major cognitive theories of autism are the Theory of Mind hypothesis, the Weak Central Coherence hypothesis and the Executive Dysfunction hypothesis. These theories attempt to explain the behavioural symptoms exhibited by individuals with Autism Spectrum Disorders in terms of how the brain processes information.

1.2.5 The Theory of Mind hypothesis

Premack and Woodruff (1978) defined Theory of Mind as the ability to impute beliefs, desires, intentions and other mental states to self and to others. Children's knowledge about states of mind increases rapidly with development. Abilities that may be essential for learning about minds are observed in very young babies. Early in the first year of life babies can differentiate between people and objects and show preference for human faces, voices and movements (Flavell, 1999). Over the first two years, children rapidly learn about intentionality, desires and emotions. By 18 months they show a basic understanding about how simple mental states like intention (Meltzoff, 1995) and desire (Repacholi & Gopnik, 1997) influence action. Between three and four years of age children begin to understand more complex mental states like beliefs and knowledge as 'representations' of reality (Wimmer & Perner, 1983). Eventually an implicit theory, where mental states form an interacting coherent explanatory system for human action, develops. In other words, children progress from being desire psychologists to being belief-desire psychologists. Having a belief-desire psychology helps children to understand that people with the same desire may act differently if their beliefs are different or that individuals may even act contradictory to his desire because he holds a false belief (Wellman & Woolley, 1990). Thus, knowledge about mental states is essential for social interaction and communication as it helps us to understand and make predictions about others' behaviour.

Theory of Mind deficit as an explanation for social and communication difficulty in autism

Many of the social and communicative difficulties observed in individuals with Autism Spectrum Disorders could be explained in terms of a deficit in Theory of Mind. Joint attention refers to the phenomena when two people co-ordinate their attention to the same object or event. It involves more than mere following of gaze or gesture and reflects an interest in what the other person thinks, feels or knows about the shared event. Joint attention requires differentiating between what is in one's own mind from what is in the others' mind. While typically developing children show reliable evidence of joint attention by 18 months, it occurs with much lower frequency in children with autism (Sigman, Mundy, Sherman, & Ungerer, 1986). Absence of joint attention is often considered to be a sign of autism.

Individuals with Autism Spectrum Disorders struggle with regulating social interaction. They are unable to comprehend non-verbal cues and even simple social conventions. Non-verbal cues like facial expressions, body postures and gestures are subtle expressions of 'what is in one's mind'. And, conventions like choosing an appropriate topic for conversation and taking turns demand appreciation of others' states of mind in terms of their interests and emotions.

Individuals with Autism Spectrum Disorders show delayed and/or deviant language development. Language development depends on tracking a speaker's intention by using cues from the 'speaker's direction of gaze' and differentiating it from the 'listener's direction of gaze' (Baron-Cohen, Baldwin, & Crowson, 1997). Thus, children learn that the long, thin, colourful thing is a 'pencil' and not the eraser lying near by because father was 'looking' specifically at it when he 'said' pencil. Baron-Cohen *et al.* (1997) found that children with autism used the 'listener's direction of gaze' and hence assumed that a novel word referred to the object they themselves were looking at rather than the object the speaker was looking at. The idiosyncratic use of words, which is common in autism, may be the result of such errors. Indeed, anecdotal evidence from parental report suggests this to be the case (Kanner, 1943). Making inferences of other's point of view plays a vital role in understanding words like pronouns, which individuals with Autism Spectrum Disorders find difficult. The clinical picture of autism is also characterised by confusion with words that have multiple meanings, inability to comprehend puns, humour and sarcasm. These special categories of language require the listener to interpret the meaning 'behind the words'. The literal understanding of language exhibited by individuals with Autism Spectrum Disorders, thus, may be due to difficulty understanding the speaker's intention.

In summary, the Theory of Mind hypothesis explains the clinical features of Autism Spectrum Disorders, particularly in the realm of social interaction and communication, in terms of cognitive difficulty in imputing mental states.

Experimental studies on Theory of Mind in autism

Baron-Cohen, Leslie and Frith (1985) suggested that children with autism have difficulty imputing false belief. In order to test this Baron-Cohen *et al.* (1985) developed the 'Sally-Ann task' which was a shortened and simplified version of the 'unexpected transfer' technique used by Wimmer and Perner (1983). Two puppets, Sally and Ann, were used to enact a scene. Sally has a marble which she places in a basket. In Sally's absence, Ann removes the marble from the basket and puts it in a box. The final scene shows Sally returning and children were asked where she would look for her marble. Baron-Cohen *et al.* (1985) administered this task to children with autism, children with Down's syndrome and typically developing children. They found that all children passed the reality (Where is the marble really?) and memory (Where was the marble in the beginning?) questions, suggesting good comprehension of the story. With respect to the belief question (Where will Sally look for the marble?), 86 percent of the children with Down's syndrome and 85 percent of the typically developing children passed, but 80 percent of the children with autism failed, even though they had a higher mental age than the children with Down's syndrome. They pointed to where the marble really was rather than where Sally falsely believed the marble to be. Since the participants with Down's syndrome, who had a lower verbal and non verbal mental age, were able to appreciate Sally's false belief the authors concluded that individuals with autism have a deficit in representing mental states of others which is independent of mental retardation.

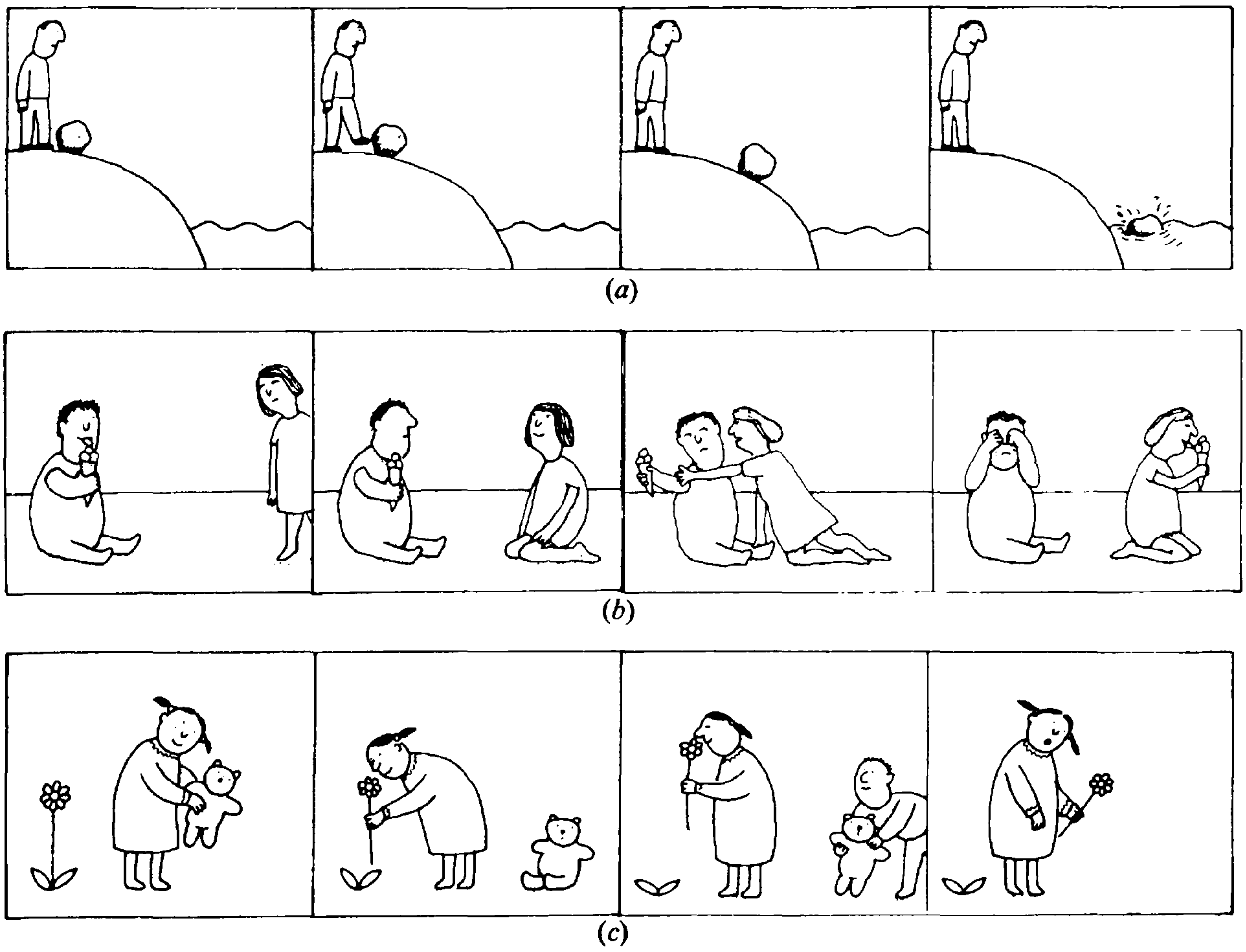
Difficulty with attributing mental states was observed even when real-life-like scenarios were used (Leslie & Frith, 1988; Perner, Frith, Leslie, & Leekam, 1989). Perner *et al.* (1989) used a 'deceptive-appearance paradigm'. Participants were shown a 'Smarties' tube and asked about its contents. All answered 'Smarties', and were surprised when the tube was opened to reveal a pencil instead. After replacing the pencil participants were asked about what another child, who was about to come in to be tested for the first time, would think was in the box. Results indicated that a majority of the participants with autism (whose mental age was well above 3 years) did not make a correct belief attribution. In contrast, control children with specific language impairment attributed false belief to the other child without difficulty. One might expect this task to be easier than the 'Sally-Ann task' as participants can use their own recent experience with false belief to make similar attributions to another person. However, children with autism continued to be severely impaired in 'mentalizing' even on this comparatively easier task.

Since the ability to represent mental states is crucial for predicting others' behaviour, impairments in social interaction observed in autism were suggested to be due to lack of Theory of Mind.

Is the difficulty with representation specific to mental concepts?

Baron-Cohen, Leslie and Frith (1986) compared children with autism, Down's syndrome and clinically normal children on a picture sequencing task. The mental age (verbal and non-verbal) of the group with autism was higher than the mental age (verbal and non-verbal) of the group with Down's syndrome and the chronological age of the clinically normal group. The picture sequences illustrated stories that were mechanical, behavioural or intentional in nature. The mechanical stories depicted objects interacting or people and objects interacting causally. Both the behavioural and intentional stories showed people involved in interactive activities, but comprehending the former did not require an understanding of mental states, whereas comprehending the latter did. See figure 1.1.

Figure 1.1: Mechanical (a), behavioural (b) and intentional (c) picture sequence used in Baron-Cohen, Leslie and Frith (1986).



Participants were awarded points for correctly sequencing the cards. Results indicated that the children with autism were far superior to the children with Down's syndrome and as good as the typically developing children on mechanical and behavioural stories respectively. However, on intentional stories they were the worst performing group, scoring less than the group with Down's syndrome who had a lower mental age. From the narration given by the children, it was observed that all children used descriptive utterances for the behavioural stories, but the typically developing children used comparatively more mental state expressions. In the intentional stories, the clinically normal children and the children with Down's syndrome used significantly more mental state utterances than the children with autism. But, the children with autism used causal utterances to a greater degree than the other two groups for the mechanical stories. The authors concluded that while individuals with autism have a greater understanding of physical interaction, they show specific impairment with regards to interactions requiring an understanding of mental states.

Leslie and Thaiss (1992) compared children's performance on two tasks requiring comprehending representation, one mental and the other non-mental. In the false photograph (non-mental representation) task, a puppet (a horse) was shown photographing another 'model' puppet (a cat) placed in location A. Though puppets were used, an actual photograph was taken using a Polaroid camera. After the photograph was placed face down on a table, the 'model' was moved from location A to B. In the unexpected transfer task and false photograph task, the respective belief and scene represented were rendered false as both were out dated representation of reality. In another version of the false photograph task, the model cat was replaced by a mouse puppet but the location remained the same. The photograph is a non-mental representation of reality, comparable to the mental representation in the deceptive appearance task. The participants, who were not shown the photograph, were asked three questions similar to the ones used in the false belief task: a memory question ('When Polly, the horse, took the photograph, where was the cat sitting?' or 'Who was sitting on the toy-box when the cat took the photograph?'); a belief question ('In the photograph where is the cat sitting?' or 'In this photograph, who is sitting on the toy-box?') and a reality question ('Where is the cat now?' or 'Who is sitting on the toy-box now?').

Results showed that the typically developing participants performed similarly in the false belief and false photograph tasks unlike the participants with autism, who were significantly worse on the mental representation (false belief) tasks than the non-mental representation (false photograph) tasks. The participants with autism, in fact performed better than the typical participants on the false photograph tasks. The authors concluded that individuals with autism do not show a general impairment in handling representations, but have a specific difficulty with mental representations.

Limitations and criticisms of the Theory of Mind hypothesis of autism

Baron-Cohen (1995) suggested that a cognitive mechanism or domain specific module is dedicated to the understanding of others' mind. Children with autism showed no difficulty sequencing behavioural and mechanical stories, but their performance on intentional stories was poorer than children with Down's syndrome who had a lower mental age (Baron-Cohen *et al.*, 1986). In the false photograph task children with autism showed superior performance to typical controls though they were significantly worse on the false belief task (Leslie & Thaiss, 1992).

Bowler, Briskman, Gurvidi and Fornella-Ambrojo (2005) questioned the specificity of the representational deficit demonstrated by the false photograph task. They contended that the false belief task was more complex than the false photo task in terms of the number of elements and episodes. Possibly, individuals with autism find complex events, not mental states, difficult to interpret. The same criticism holds for the picture sequences used by Baron-Cohen *et al.* (1986). The mechanical and behavioural sequences were intrinsically easier than the intentional sequences (Zelazo, Jacques, Burack, & Frye, 2002). Bowler *et al.* (2005) developed a mechanical analogue of the Sally-Ann task which they suggested was a better control task of similar complexity but not requiring the participants to infer mental states. The scenario was a model airport where planes could land on either a blue or a yellow landing pad. The location of the plane was signalled by a blue or yellow light, as appropriate, to an automatic, driverless train which conveyed goods from the plane to the terminus. Once the children understood the sequence of events, the test trial was presented. In the test trial, a bird lands on a particular pad (say the blue one) before the plane. The plane is then forced to land on the other (yellow) pad, but not before the blue (false) signal was triggered by the bird. Participants were asked to predict to which pad the train would go. Participants (children with autism, children with learning difficulty and children developing typically) who passed the Sally-Ann task predicted that the train would go to the signalled pad, where as children who failed the Sally-Ann task predicted that the train would go to the pad on which the plane actually landed. The authors concluded that the result is a reflection of difficulty understanding complex events by individuals with autism of which mental states may be one. Thus, there is no strong evidence for individuals with autism having a specific deficit in representing mental states.

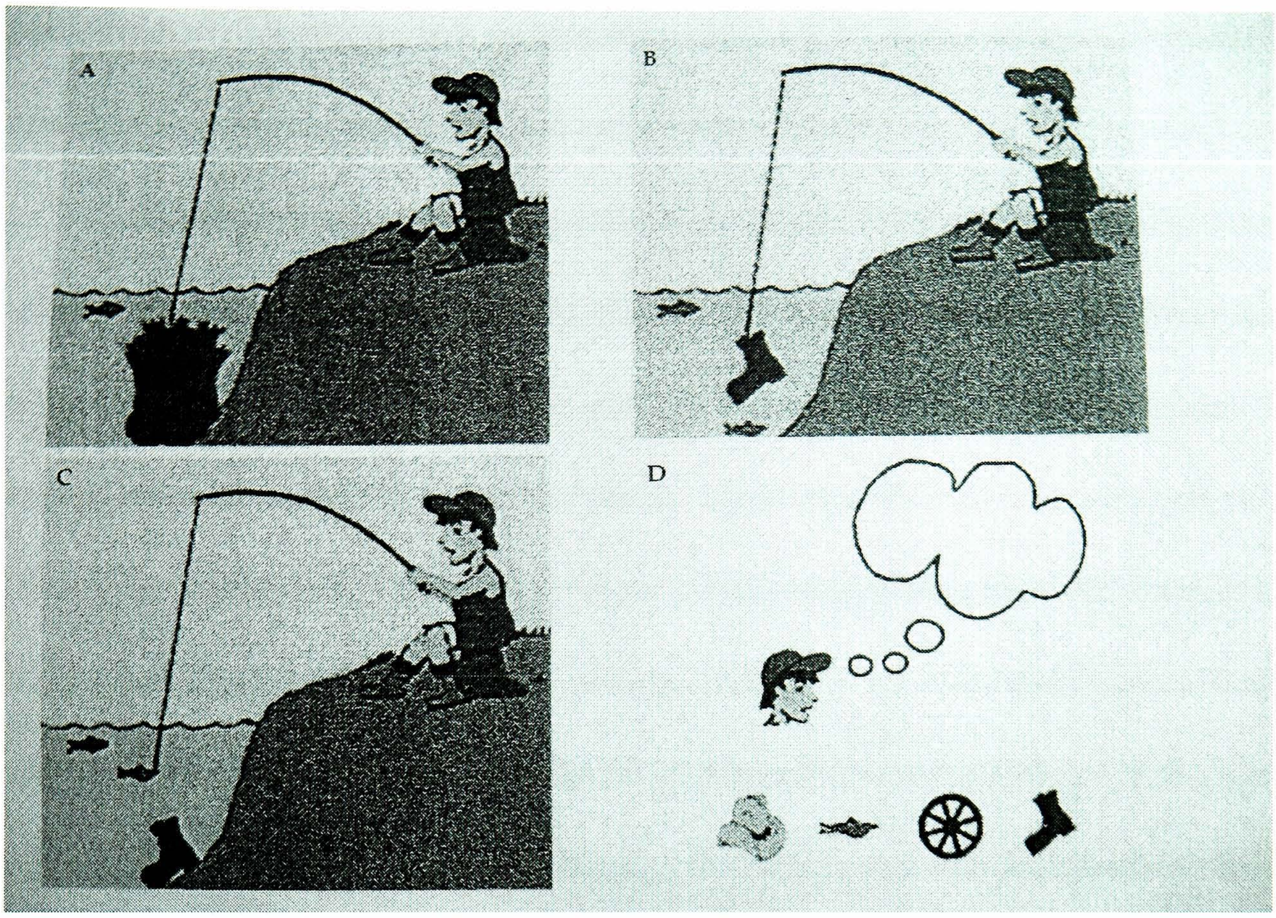
When Baron-Cohen *et al.*'s (1985) article was published it was argued that autism is the result of a single core cognitive impairment, namely a lack of Theory of Mind. However, the current view is that it is not so much a total deficit in Theory of Mind, but a delay that is observed in autism. Happe (1995) reviewed a large set of data on performance by children with autism and typically developing children on the Sally-Ann task and the Smarties task. They reported that the performance of typically developing children aged four years was comparable to the performance of children with autism who had a mental age of nine years and two months.

Though Theory of Mind hypothesis is one of the most influential theories of autism, having impairment in Theory of Mind is not currently accepted as a primary and sufficient explanation for autism. In order for a theory to provide a sufficient explanation for autism it must, according to Rajendran and Mitchell (2007), fulfil the conditions of universality and uniqueness. Uniqueness and universality refer to whether the causal factor identified is observed only in individuals with a diagnosis of autism and in all individuals with a diagnosis of autism respectively.

In every 'mentalizing ability' study, there were a few participants with autism who passed the test. Across studies, the percentage of children who pass the Theory of Mind task varies from 15 percent to 60 percent (Happe, 1995). Indeed, in some studies a majority of individuals with High Functioning Autism and Asperger's Syndrome passed both first order (Prior, Dahlstrom, & Squires, 1990) and second order (Bowler, 1992; Ozonoff *et al.*, 1991) false belief tasks. The explanation suggested by Frith, Morton and Leslie (1999) for some individuals with autism being able to pass the Theory of Mind task is that unlike typically developing children who solve the task intuitively, children with autism use rules. Rules may help them pass simple structured tasks in the laboratory but continue to show difficulty in real life scenarios. Indeed, tougher and presumably more age appropriate Theory of Mind tasks were more sensitive and tapped deficits which were not tapped by first order (Where does she think the marble is?) and second order (Where does Mary think John thinks the van is?) Theory of Mind tasks (Baron-Cohen, Jolliffe, Mortimore, & Robertson, 1997). Happe (1994) developed stories where one character says something intended as a joke, sarcasm, irony and other utterances which were not literally true. After hearing each story, participants were asked to provide explanations for why the character said something. Relatively able individuals with autism passed both the first and second order false belief tasks, but many performed poorly on the stories task, which presumably depicted more natural interactions. They often gave context inappropriate reasons. However, a small subset of the participants with autism performed well on this tougher and arguably more naturalistic task too. Thus, the Theory of Mind hypothesis of autism fails to satisfy the condition of universality.

Another challenge to the Theory of Mind hypothesis of autism is that failure on mentalizing tasks has been reported in children with other disability who do not show features of autism. Woolfe, Want and Siegel (2002) used thought pictures (see figure 1.2) that minimized receptive and expressive language ability and found that late signing children (deaf children of hearing parents who acquire sign language mainly outside the family) showed deficits in Theory of Mind ability.

Figure 1.2: Though bubble paradigm used in Woolfe, Want and Siegel (2002).



Minter, Hobson and Bishop (1998) tested Theory of Mind ability in congenitally blind children using tactile versions of the false belief tasks. In the tactile version of the deceptive appearance task, children were presented with a hot teapot and asked about it contents. A majority of the children answered either tea or coffee. The contents were then poured into an empty cup to reveal that the pot actually contained sand. After replacing the sand children were asked the representational change and false belief questions as in the 'smarties tube' task. In the tactile version of the unexpected transfer task, one experimenter places a pencil in one of three boxes which had a lid made of sandpaper (rough box), cotton (soft box) or foil (smooth box) and leaves the room. In his absence a second experimenter transfered the pencil to one of the other boxes.

Subsequently, the memory, reality and belief questions were presented as on the Sally-Ann task. Results indicated that the visually impaired children's performance on both the tasks was poorer than the control children who were matched for chronological age and verbal mental age.

These findings, which suggest that difficulty with 'mentalizing' is not unique to autism, do not support uniqueness of a Theory of Mind deficit in autism as an explanation for the triad of impairments in social interaction, communication and imagination (Wing & Gould, 1979).

In addition to having problems with universality and uniqueness, the Theory of Mind hypothesis is also problematic in that it does not explain all the features of autism. It falls short when it comes to explaining features like restricted repertoire of interests and activities, abnormal responses to sensory stimuli and savant abilities. These features are better explained by the other two cognitive theories, namely the Executive Dysfunction hypothesis and the Weak Central Coherence hypothesis, which suggest a domain general deficit in autism.

1.2.6 The Executive Dysfunction hypothesis

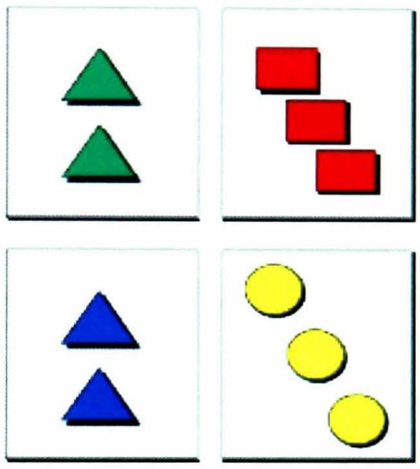
Executive function is often defined by a list of functions regarding the ability to maintain an appropriate problem solving set for the attainment of a future goal. It includes behaviours such as planning, impulse control, inhibition of pre-potent but irrelevant responses, set maintenance, organised search and flexibility of thought and action (Ozonoff, Penington & Rogers., 1991). These functions are associated with the pre-frontal area of the brain. The possibility of executive dysfunction in autism dates back to a 1978 paper by Damasio and

Maurer who found many behavioural and neurological similarities between individuals with autism and individuals with frontal lobe damage (*cf.* Griffith, Pennington, Wehner, & Rogers, 1999). Some features of Autism Spectrum Disorders suggest an executive dysfunction that is not explained by a deficit in Theory of Mind. Individuals with Autism Spectrum Disorders resist change and show extreme distress over even trivial variation in their environment or routine. Perseverative behaviour is common in the form of extremely narrow interests or repetitive stereotypical activities. They are impulsive, poor in self monitoring, inflexible and find it difficult to anticipate consequences of behaviour in the long run.

Empirical assessment carried out using a variety of neuropsychological tests report that individuals with Autism Spectrum Disorders have difficulty with planning, mental flexibility and inhibition (Hill, 2004). Planning involves establishing sequences of actions that is constantly monitored, re-evaluated and updated for attaining a goal. Tasks like the Tower of Hanoi or the Tower of London assess planning ability. In these tasks participants have to move discs prearranged on three different pegs to match an arrangement determined by the examiner. This must be achieved using few moves and as quickly as possible. Several specific rules may also have to be followed. For example, in the tower of Hanoi task, the pegs vary in size and participants are not allowed to place a larger disc on a smaller one. Studies suggest that participants with autism are less efficient and require more moves to solve the problem, compared to matched controls without autism (Bennetto, Pennington, & Rogers, 1996).

Mental flexibility or set shifting refers to the ability to modify strategies based on changed situation. Mental flexibility is assessed using tasks like the Wisconsin Card Sorting Task (WCST). As the name suggests participants are required to sort cards based on one of three possible dimensions (colour, number or shape). See Figure 1.3.

Figure1.3: Sample cards from Wisconsin Card Sorting Task taken from Hill (2004).



However, the rule for sorting is not explicitly stated to participants. Instead, they are given feedback on whether or not the card was placed correctly in each trial. The participant learns the rule through trial and error. Once the rule is learned and the participants consistently use the correct dimension to sort, the rule is changed. Again, the change is not explicitly stated but is implied through feedback. Many studies (Bennetto *et al.,* 1996; Ozonoff, Pennington, & Rogers, 1991) report that while the typical participants shift to the new rule with ease, the participants with autism tend to perseverate and continue to use the old, and now incorrect, rule despite feedback.

The ability to inhibit pre-potent but undesirable responses was assessed by Russell, Mauthner, Sharpe and Tidswell (1991) using the 'windows task' that they devised. This task involved a participant and a 'competitor'. The participant's task was to point at one of two boxes, one of which contained a chocolate. The participant won the chocolate if s/he pointed at the empty box but if s/he pointed at the box containing the chocolate then the participant lost the chocolate to the competitor. In the initial phase, neither the participant nor the competitor was aware about which of the boxes contained the chocolate. Hence, the participant was essentially guessing. Thus, the participant learned that to get the chocolate s/he had to point at the empty box without being reinforced for the behaviour (of pointing at the empty box). In the next phase, the same box was used but with windows such that the participant could see which of the two boxes contained the chocolate. If the participant now points at the empty box, this suggests that s/he is deliberately misdirecting the competitor. Results indicated that significantly fewer children with autism pointed to the empty box in the first trial of the second phase, which consisted of 20 trials, compared to children with Down's syndrome. The children with autism continued to perseverate pointing at the box that contained the chocolate in the rest of the trials despite the fact that they lost the chocolate as a consequence. Russell *et al.* (1991) suggested that, for the children with autism, the knowledge of the physical reality was more salient than the knowledge of mental states. They were unable to inhibit a pre-potent response even though they were maladaptive.

Russell *et al.* (1991) further argued that poor performance on the false belief tasks may also be explained by the relatively greater salience of 'the current location of the object'. According to this explanation children with autism do not lack Theory of Mind but have an inability to disengage from the more salient knowledge of the physical reality.

Limitations and criticisms of the Executive Dysfunction hypothesis of autism

Based on the perseverative behaviour of individuals with autism on the windows task, Russell *et al.* (1991) argued, the Executive Dysfunction hypothesis may be able to explain not only the restricted repertoire of interests and repetitive behaviour observed in autism, but also the social and communication impairment which are thought to arise from an impaired Theory of Mind ability. For example, impairment in disengaging and shifting attention may lead to problems in interpersonal sharing (Bowler, 2006).

Jarrold, Boucher and Smith (1994) investigated whether children with autism fail to engage in pretend play as a result of a deficit in executive functioning characterised by an inability to use internally generated representation setting aside the schemas evoked by the external object. They asked participants to select a prop to stand as substitute for a target object (for example, toothbrush). Specifically they wanted to know whether children with autism would have difficulty choosing an object with a clear alternate function (for example, pencil), to perform the pretend function (of brushing teeth), from amongst other, non-functional props. However, it was observed that children with autism were as likely as control participants to select a prop with an alternate function. Hence, diminished pretend play in autism cannot readily be explained by executive function deficits. A few researchers have investigated whether executive functioning is co-related to the severity of autistic symptomatology and the acquisition of adaptive functioning using measures like the Vineland Adaptive behaviour Scales and Childhood Autism Rating Scale. However, the results are equivocal (Fine *et al.,* 2001). Thus, evidence for an executive dysfunction explanation for the social and communication difficulties observed in individuals with Autism Spectrum Disorders is not sufficient.

Most research on Executive Dysfunction reports group differences but not individual differences in terms of the percentage of participants who pass the task. This makes it difficult to ascertain the prevalence of executive dysfunction in autism (*cf.* Rajendran & Mitchell, 2007). The prevalence rate of Executive Dysfunction in the sample with autism ranged between 50 and 96 percent in the three studies reviewed by Rajendran and Mitchell (2007). More studies are required before conclusions can be drawn about the universality of executive dysfunction in autism.

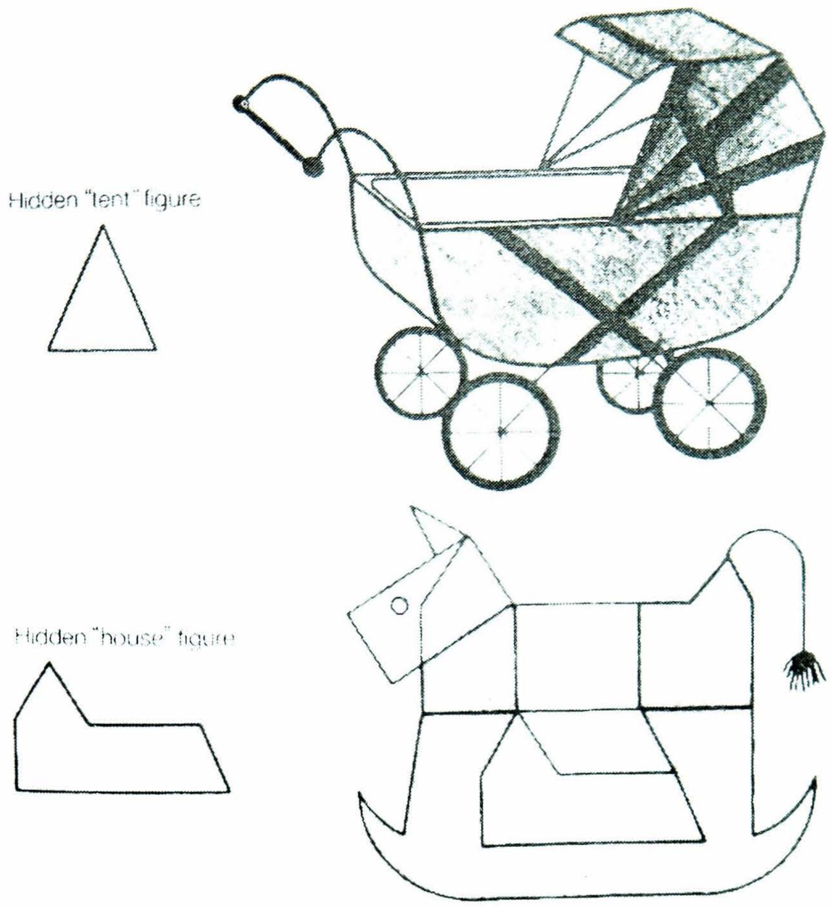
The Executive dysfunction hypothesis definitely does not fulfil the criteria of uniqueness. It is observed in a large number of varied clinical groups like Attention Deficit Hyperactivity Disorder (ADHD), Tourrett's disorder, Schizophrenia and Obsessive-Compulsive Disorder, none of who show the social difficulties observed in Autism Spectrum Disorders. However, Ozonoff and Jensen (1999) reported that individuals with autism demonstrated difficulties on tasks that demanded flexibility and planning but not inhibition. Conversely, individuals with ADHD demonstrated difficulties with inhibition but not flexibility and planning. Thus, it is not sufficient to explain the features of autism in terms of a general impairment in executive functioning. The executive function profile in autism requires further clarification in terms of which functions are spared and which impaired and how the autism profile of executive functioning can be differentiated from that of other disorders.

1.2.7 The Weak Central Coherence hypothesis

The Theory of Mind hypothesis and the Executive Dysfunction hypothesis focus on deficits observed in autism. Individuals with autism, however, show relative strength in associative memory, rule based tasks, and visuo-spatial organisation (Minshew, Goldstein, Muenz, & Payton, 1992). Frith (1989) suggested that a single cognitive processing mechanism could explain both the deficits as well as the assets exhibited by individuals with autism. Typically, information processing is characterised by extracting the overall meaning or gist rather than focusing on individual features that make up the whole. Frith (1989) suggested that a deficit in global-level processing results in a tendency to process information in terms of local features in autism. This could explain the uneven cognitive profile observed in autism. In other words, autism is characterised by weak central coherence.

Shah and Frith (1983) observed that participants with autism were significantly quicker in the Embedded Figures Test which involved locating a target hidden within a more complex figure. See figure 1.4.

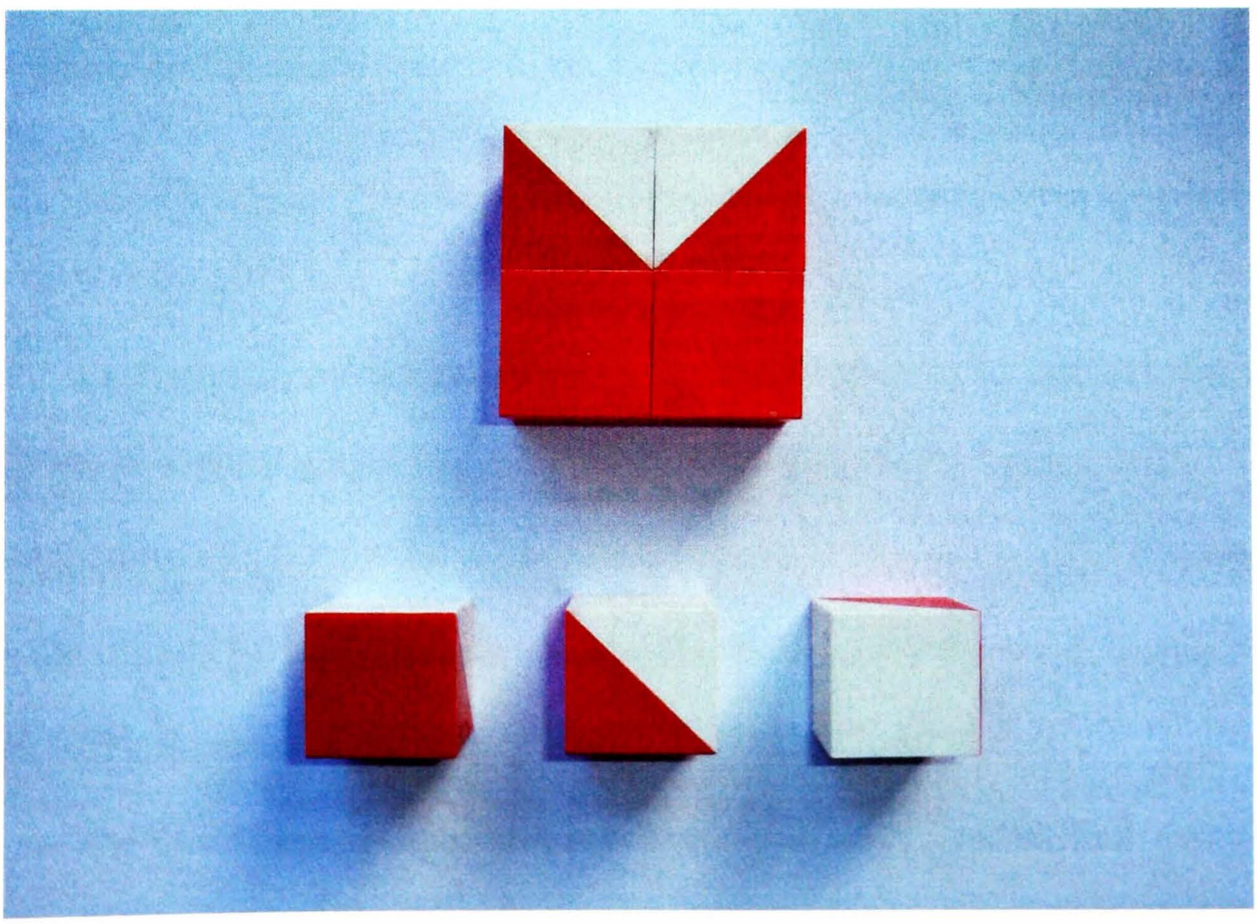
Figure 1.4: Examples of the Embedded figures test' material used in Shah and Frith (1983).



The authors suggested that the participants with autism did perceive the meaning of the complex figure as they were able to name them. However, they might not have been 'captured by the overall meaning' to the same extent as the control group of participants, thus allowing them to perceive the embedded figure quickly and accurately. Hence, for the typical population the meaning conveyed by the complex figure (pram) is so compelling that it interferes with the task of locating the target (triangle). In individuals with autism central coherence is suggested to be much weaker, and hence they are able to dissociate the parts from the whole. Thus, they do not experience severe interference from the global figure.

Shah and Frith (1993) suggested that this ability to view local elements as distinct from the global picture may be responsible for individuals with Autism Spectrum Disorders gaining higher scores on the performance subscales (block design subtest in particular) than the verbal subscales of Wechsler's intelligence scales. In the block design test participants are shown abstract two dimensional geometrical designs on a card and are required to use cubical wooden blocks with two sides coloured red, two sides coloured white and two sides coloured red and white to make the patterns shown on the cards. See figure 1.5.

Figure 1.5: Individual blocks (below) and an example of pattern (above) used in the block design test.



Efficient performance requires participants to inhibit perceiving the design as a whole and identifying the constituent parts in terms of the block faces. Shah and Frith (1993) hypothesised that the process of segmentation is easier for participants with autism because of Weak Central Coherence. But, in typical participants the central coherence is so strong that the process of segmentation takes time and effort. If so, the performance of typical participants should increase to the level of participants with autism if the design were pre-segmented (as shown in figure 1.6).

Figure 1.6: Original and pre-segmented designs used in Shah and Frith (1993).

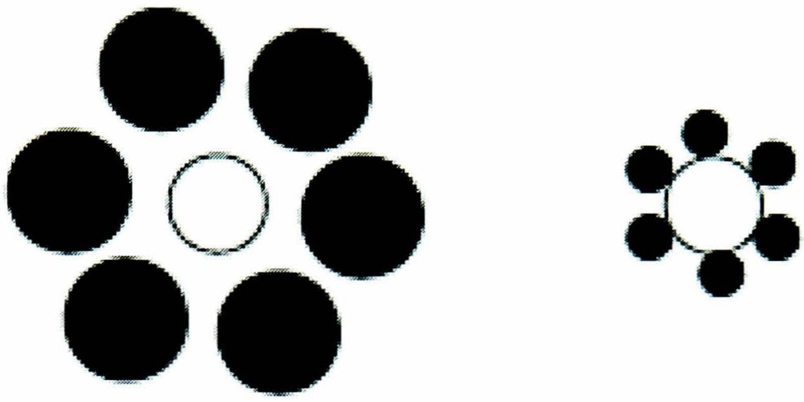
As predicted, pre-segmentation significantly improved the performance of participants without autism (typically developing children and children with learning difficulty) but not the performance of participants with autism. This was taken as support for the hypothesis that while coherence is very strong in typical participants, autism is characterised by Weak Central Coherence.

The Weak Central Coherence hypothesis provides a possible explanation for abnormal and often enhanced perceptual processing found in many higher functioning individuals with Autism Spectrum Disorders. Comprehending the gist of written language at the level of sentences or longer requires a global strategy. This may explain the difficulty faced by individuals with autism on sentence processing tasks (Hermelin & O'Connor, 1967; Romondo & Milech, 1984). Ordinary conversation too requires separating out the meaningful from the meaningless and taking account of the context in which the interaction takes place. Difficulty processing the information globally may thus explain the social impairments in autism.

Limitations and criticisms of the Weak Central Coherence Hypothesis of autism

Frith and Happe (1994) suggested that weak central coherence is a 'cognitive style' rather than a deficit. Having weak central coherence is disadvantageous in tasks requiring global level contextual processing but advantageous when detailed local level processing is required. This impact of weak central coherence is observed in both higher level tasks like extracting meaning from sentences and lower level perceptual tasks. Happe (1996) reported that participants with autism were less likely than typical participants to succumb to visual illusions created by immediate visual context. For example, in the Ebbinghaus illusion (see figure 1.7) participants with autism do not see one inner circle as larger than the other inner circle. In order to be susceptible to the illusion the inner circle should be perceived in the context of surrounding circles. Weak central coherence would impair such integrative processes which influences perception in typical individuals.

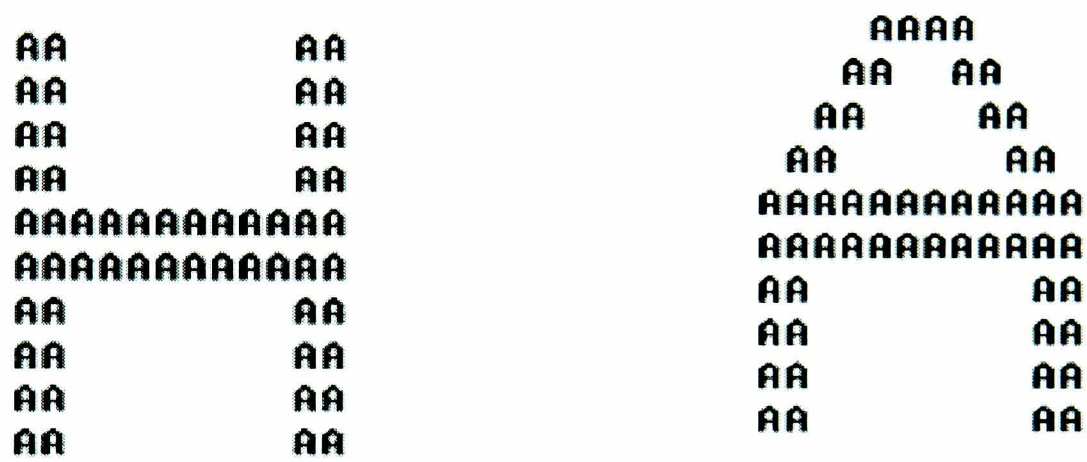
Figure 1.7: Ebbinghaus illusion.



However, using a computerised procedure where participants had to adjust the circles so that they were the same size (as opposed to saying whether the size of the circles were the same or different) Ropar and Mitchell (1999; Ropar & Mitchell, 2001) failed to replicate Happe's (1996) finding. They found that individuals with Autism Spectrum Disorders were just as susceptible to illusions as matched typically developing controls. Ropar and Mitchell (2001) did not find the visuo-spatial abilities tests thought to measure weak central coherence (block design and embedded figures tasks) to correlate with or predict non-susceptibility to illusions in individuals with and without Autism Spectrum Disorders. This suggests different mechanisms may be involved in the perception of illusions and performance on visuo-spatial tasks.

Other researchers have reported that individuals with Autism Spectrum Disorders can process global aspects of information using the Navon task. The Navon task consists of hierarchical stimuli – a large figure made up of smaller identical figures (See Figure 1.8). Participants were required to identify whether the target letter (for example A) was present or absent. The target could be presented either at the global level (as in the figure on the right) or at the local level (as in the figure on the left). In the congruent condition the letters in the local and global level are the same. In the incongruent condition, the two are different.

Figure 1.8: Example of stimuli used in the Navon task.



Both participants with Autism Spectrum Disorders and participants developing typically showed global advantage and global interference on Navon tasks. They are faster and more accurate when the target was presented at the global level than at the local level (global advantage) and when the target was presented at the local level in the congruent condition than the incongruent condition (global interference). However, participants with Autism Spectrum Disorders also showed local interference; incongruent local stimuli disrupted the processing of the global stimuli (Plaisted, Swettenham, & Rees, 1999; Rinehart, Bradshaw, Moss, Brereton, & Tonge, 2000)

Weak Central Coherence hypothesis suggests that enhanced visuo-spatial ability in autism is a result of preference for local level processing as a result of weak central coherence. However, in some studies (Plaisted *et al.*, 1999; Ropar & Mitchell, 2001) individuals with autism demonstrated intact global processing, given appropriate testing conditions. This has led to an attempt to find alternative explanations. Enhanced Perceptual Functioning (EPF) model proposed by Mottron and colleagues (1993, 2006), suggests that individuals with Autism Spectrum Disorders have a hierarchical organisation defect – an imbalance between complex high level and simple low level processes. Hence, while they process information at the global level and local level normally, they do not show a global precedence which typically developing individuals show. Another rival theory of Weak Central Coherence posits that individuals with Autism Spectrum Disorders process unique features of stimuli better than typical individuals and common features of stimuli worse than typical individuals (Plaisted, O'Riordan, & Baron-Cohen, 1998). This could explain enhanced performance on tasks like embedded figures where participants have to focus on features that are unique between the target figure and the complex figure. However, categorization tasks, on which individuals with autism perform less well (Klinger & Dawson, 2001), require participants to focus on the common features between stimuli and make generalisations.

A further problem for the Weak Central Coherence hypothesis comes from a large scale study by Pellicano, Maybery and Durkin (2005). They administered four visuo-spatial coherence tasks (the Preschool Embedded Figures Test, the Pattern Construction Task from the Differential Abilities Scale, the Figure

Ground Task from the Developmental Test of Visual Perception and the Developmental Test of Visual Integration) to typically developing four and five old children. Contrary to what was expected by the Weak Central Coherence hypothesis inter-correlations between the four measures were not substantial or in the direction that would have been predicted if central coherence had been a unitary construct. Furthermore, a principal components analysis carried out to assess whether the four measures were driven by the same underlying mechanism for central coherence yielded two factors, one corresponding to integrative or visuo-spatial construction ability while the second factor was ambiguous. These results question the validity of central coherence as a unitary construct.

Information about the uniqueness and universality of Weak Central Coherence are rarely reported in research articles. Furthermore, although local precedence could explains the perceptual characteristics of Autism Spectrum Disorders, its ability to explain the social features remains to be tested.

1.2.8 Mapping the theories to areas in the brain

With the advent of neuro-imaging techniques like fMRI scientist have began attempts to identify functional differences in brain regions of typical individuals and individuals with Autism Spectrum Disorders. Neuro-imaging studies involve recording brain activity while individuals carry out tasks, inside a scanner, which supposedly depend on cognitive process in which the investigator is interested.

When the task concerns Theory of Mind, the medial prefrontal region (paracingulate cortex) and the temporo-parietal junction in the superior temporal sulcus, have been consistently identified (Frith & Frith, 2005). The medial frontal region appears to be involved in reflecting on one's own and other's mental states while the temproral-parietal junction seems to play a special role in recognizing actions and intentions of others. Differences in brain activation between individuals with Autism Spectrum Disorders and individuals of typical development have been reported in many studies when different social tasks were being carried out. For example, Baron-Cohen *et al.* (1991) conducted an fMRI study on individuals with High Functioning Autism or Asperger's Syndrome and typically developing participants while they were shown photographs (of the eye region alone) and asked to identify the mental state expressed in the same photographs. Results showed increased activation of the superior temporal gyrus, amygdale and parts of the pre-frontal cortex in typical participants. However, participants with High Functioning Autism and Asperger's Syndrome showed activation of fronto-temporal regions but not in the amygdale.

Executive functioning has been historically related to the frontal lobe of the brain, the pre-frontal cortex in particular. In fact, the possibility of individuals with Autism Spectrum Disorders having executive dysfunction was based on the similarities observed in behaviour exhibited by individuals with acquired frontal lobe damage. Lesion studies have identified medial and dorsolateral frontal structures as mediating performance on Wisconsin Card Sorting Task. Very few fMRI studies on Autism Spectrum Disorders have used executive function tasks. But significantly lower task-related activation of the dorsolateral frontal structures and the posterior cingulated cortex have been observed in individuals with autism when carrying out spatial working memory tasks and a visually guided saccade task (*cf.* Hill, 2004a).

Just and colleagues' underconnectivity theory (2004) is related to Weak Central Coherence hypothesis but at the neural rather than the cognitive level. They suggest that Autism Spectrum Disorders is caused by reduced integrative functioning in the brain. The coordination and communication between relevant cortical areas appears to be lower in participants with autism than typical participants when they were scanned carrying out various tasks like sentence comprehension (Just, Cherkassky, Keller, & Minshew, 2004), face processing (Koshino, et al., 2007), planning (Just, Cherkassky, Keller, Kana, & Minshew, 2007) and inhibition tasks (Kana, Keller, Minshew & Just, 2007).

1.2.9 Treatment options for autism

The intervention options for individuals with Autism Spectrum Disorders can also be classified as biological, cognitive and behavioural. Sometimes medications which fall under the category of major tranquilisers are prescribed, not as a cure but as a means to control behaviour that may cause a threat to the child or interfere with education.

A few researchers have attempted to teach children with autism Theory of Mind (Hadwin, Baron-Cohen, Howlin & Hill, 1997; Ozonoff & Miller, 1995). They reported that children with autism were able to succeed in Theory of Mind tasks following training. Hadwin *et al.* (1997) investigated whether formal training on theory of mind tasks in children with autism improved their ability to initiate and maintain conversation and increased the frequency of mental state terms used in conversation. The participants in the study were randomly assigned to one of three groups and were trained in the areas of emotion, belief or play. The results showed that the children through training did learn to pass tasks concerning emotion and belief understanding, but, no corresponding advance in social communication was seen – either in terms of development of communication or use of mental state terms in speech.

Many therapies which use behavioural modification techniques, like Applied Behaviour Analysis or ABA and Treatment and Education of Autistic and related Communication Handicapped CHildren or TEACCH, have been developed and are proving to be highly successful. However, early identification and intervention is crucial to help the child achieve his/her potential to the maximum, possibly learning some coping strategies for dealing with the world as well as themselves (for example, their own sensory issues). Best intervention option, as of now, is a combination of behavioural therapy, speech and language therapy and special education.

A few of the other therapies include nutritional therapy (for example gluten and casein free diet based on the theory that children with autism often suffer from allergy to gluten and casein which aggravate symptoms), sensory integration which involves exposing the child to various sensory stimulations in a controlled manner, thus regulating their hyper and hypo active sensory systems. However, further controlled studies are required before claims about their efficacy can be accepted.

1.3 Chapter summary

Autism Spectrum Disorder is a complex neuro-developmental disorder of unknown aetiology; it is complex at the biological, cognitive and behavioural level. It is diagnosed behaviourally and the core features of autism can be categorised under impairment in social interaction, impairment in communication and restricted repertoire of interests and activities. At the cognitive level no single unifying theory has been identified so far. Three main theories have been described: the Theory of mind hypothesis, the Executive dysfunction hypothesis and the Weak central coherence hypothesis. The cognitive impairments identified by these theories, which are obvious in their names, explain a different subset of features. Structural and functional brain imaging studies hold the promise of identifying which features of Autism Spectrum Disorders have similar origins in the brain, and hence a common cause. Frith (2003) suggested that autism affects development and development affects autism. Hence, results from imaging studies should be interpreted with caution as we cannot be clear which of the observed differences are causal and which are compensatory. As of now the best rehabilitation option for children with Autism Spectrum Disorders involves a combination of behaviour therapy, speech and language therapy and special education.

Chapter Two

Social impairment in Autism Spectrum Disorders

2.1 Introduction

As discussed in Chapter One, no two individuals with Autism Spectrum Disorders present identical clinical pictures. However, a pervasive social impairment is observed across the spectrum, even in individuals who have high intelligence and lead a successful professional life. Temple Grandin is a remarkable person who despite her autism holds a PhD and is Professor of animal sciences at Colorado State University, U.S.A. She also runs a successful business as a consultant and designer of livestock-handling facilities. But, she refers to herself as an anthropologist on mars 'stumped by the games people play' (Sacks, 1995). Williams (2004) carried out an interpretative phenomenological analysis (a qualitative method analysing how people understand the experiences they have lived through) of ten published autobiographical accounts written by individuals diagnosed with either High Functioning Autism or Asperger's Syndrome. A main theme common to the autobiographies was the difficulty understanding the social world around them, a feeling of being an alien onlooker unable to access the social and emotional cues for interaction.

Of the three core cognitive theories of autism, the Theory of Mind hypothesis focuses on the social features. A deficit in attributing mental states like beliefs, desires and intentions is intuitively compatible with features like poor imitation and impaired understanding of non-verbal social cues. Experimentally however, the results are not clear-cut and the Theory of Mind hypothesis has many shortcomings as explained in the previous chapter. One criticism is the over-emphasis on false-belief tasks. The majority of the studies that report specific impairment in mentalizing in autism investigated belief attribution in particular. Comparatively fewer studies look at other mental states like intention, desire, knowledge and thinking. Understanding of false belief is considered to be the hallmark test for possessing a Theory of Mind. It requires an understanding that the other person has beliefs different from one's own and hence provides the strongest evidence for the capacity to conceive others' mental states (Baron-Cohen *et al.*, 1985). However, difficulties in social and communication behaviour are observed in Autism Spectrum Disorders even before the age at which typical children pass the classical theory of mind tasks of 'unexpected transfer' and 'deceptive appearance'. Since intentions and desires occur earlier in ontology than beliefs and knowledge, investigating understanding of these simpler mental states by children with autism would provide important information about how far back Theory of Mind deficits extend in autism (Carpenter, Pennington, & Rogers, 2001). In the few studies which investigated understanding of intentions and desires by individuals with autism, some found impaired performance (Intentions: Phillips, Baron-Cohen, & Rutter, 1998. Desires: Baron-Cohen, Campbell, Karmiloff-Smith, Grant, & Walker, 1995; Tager-Flusberg & Sullivan, 1994) though the majority did not (Intentions: Carpenter*et al.,* 2001; Russell & Hill, 2001. Desire: Baron-Cohen, 1991; Tager-Flusberg, 1992; Tan and Harris, 1991). Since some studies report that children with Autism Spectrum Disorders do not show impaired understanding of mental states like intentions and desires, a general difficulty in attributing mental states as an explanation for autism is questionable. Possibly there may be something special about mental states like beliefs (Carpenter *et al.,* 2001). According to Bloom and German (2000), the false-belief task is ingenious but taps only one aspect of peoples' understanding of others' minds.

2.1.1 Traits and Theory of Mind

Theory of Mind is a crucial aspect of social understanding as it is used to understand and predict others' behaviour. Even though it is not widely acknowledged by researchers into Theory of Mind today, how we understand and predict others' behaviour is also the area of study of attribution research. An important component of attribution research involves understanding 'traits', a characteristic of a person that is associated with a particular type of behaviour.

Initial research in the area of attribution and Theory of Mind conceives of both traits and mental states as causing behaviour. The seminal work in attribution carried out by Heider (1958) describes how in common-sense psychology, the result of an action is felt to depend on factors within the person (which included mental states like desires and intentions as well as traits) and factors within the environment (luck and difficulty). Research on Theory of Mind began in the late 1970's with experiments investigating whether chimpanzees possess a Theory of Mind (Premack & Woodruff, 1978; Woodruff & Premack, 1979). In attempting to study intentional communication in chimpanzees, Woodruff and Premack (1979) developed a paradigm that required taking into account the behavioural disposition of the "sender" or "receiver" of the information as being "cooperative" or "competitive". The researchers wanted to know whether the chimpanzees were sensitive to these traits when evaluating information. More recently, other researchers have suggested that traits and mental states are inter-related in being part of Theory of Mind. According to Wellman (1990) specific desires and beliefs arise from traits. For example, the desire to do skydiving may stem from an adventurous disposition. Rosati *et al.* (2001) suggested that children may develop the notion of stable and enduring traits to explain regularities in intentional action. Thus, mental states can be viewed as the proximal cause and traits as the distal cause of an action.

2.1.2 Can individuals with Autism Spectrum Disorders infer traits?

One could argue for and against the possibility that people with Autism Spectrum Disorders can infer traits. The debate concerns the point in development at which children begin to comprehend traits. Some researchers believe that trait reasoning develops after belief-desire reasoning has already been established. While understanding of false beliefs is achieved between the age of 3 and 4 years (Wellman, Cross, & Watson, 2001), comprehending traits as causing thoughts, feelings and desires develops after four years (Gnepp & Chilamkurti, 1988; Yuill & Perason, 1998).

Gnepp and Chilamkurti (1988) examined the ability of Kindergarten (mean age: 6;1 years), second grade (mean age: 8;2 years), fourth grade (mean age: 10;2 years) and university students to take account of traits when predicting future emotional reactions of the protagonist. The traits were implied in stories that depicted three examples of a child's past behaviour. For example, "This is a story about a boy named Tommy. He helps old people walk down the stairs. He shows new kids around the school. Tommy sets the table for his mom whenever he can. One day Tommy's mom asked him to help his little sister clean her room. Do you think Tommy felt happy or sad when his mom asked him to do that?" Having to clean up would under most circumstances result in unhappiness. However, given Tommy's helpful disposition we might assume that he would in fact be happy to help. Thus, only by taking Tommy's disposition into account (based on his previous behaviour) can participants correctly predict his emotional response to the new situation. Control stories presented only the first and the last two sentences. Results indicated that only the university students and the fourth graders, to a lesser extent, demonstrated understanding of traits as implying internal events such as thoughts, feelings, intentions and motivations.

Yuill and Pearson (1998) adapted Gnepp and Chilamkurti's (1988) task to make it clear and simple for younger children. In the first experiment, they used stories implying opposing pairs of traits (for example, selfish-generous) rather than the no information control stories so that the same behaviour (for example. sharing cake) results in different emotions (sadness in the selfish person and happiness in the generous person). It was expected that the stronger contrast would yield a sharper distinction between predictions. Using this task, children as young as five years (but not four year olds) made different emotional predictions about the same situation depending on the actor's (inferred) traits.

In a further experiment, Yuill and Pearson (1998) found direct evidence for subjective understanding of desires and causal understanding of traits to be related. The participants were divided into two groups based on their conception of desires as subjective or objective. This was assessed from the children's response regarding the emotion of a protagonist to an unpleasant outcome (for example, hitting someone with a ball) when it was desired and when undesired. Objective children would predict that the protagonist would be sad because the desire and the outcome were objectively bad, whereas subjective children would predict the protagonist to be happy on achieving a desired outcome despite it being objectively bad. The performance of the two groups of children on a task similar to the first experiment revealed that the subjective children were taking the actor's disposition into account and thus making different emotional predictions about the same situation to a greater extent than the objective children. The mean age of the subjective group was 5 years 6 months and that of the objective children was 4 years 11 months. Hence, the developing understanding of traits, desires and emotions can be seen as part of general development, with children moving towards theory based understanding of traits with increased understanding of desires as subjective.

If belief-desire reasoning and awareness of the subjective nature of these mental states is required in order to understand traits as psychological entities, any deficit in belief-desire reasoning may lead to difficulty with trait inferences, amongst other things. Therefore, because individuals with Autism Spectrum Disorders reputedly do have difficulty with belief-desire reasoning, so they should have difficulty inferring traits.

Notwithstanding, even preschoolers who have not yet acquired belief-desire reasoning understand trait in terms of behavioural regularity; a person having a particular trait would behave in a way consistent to the trait across situations. They can use this information to make predictions about others' future behaviour. Dozier (1991) presented children from kindergarten (mean age: 5;7 years), second grade (mean age: 7;7 years) and fourth grade (mean age: 10;1 years) with two pieces of information about a peer who helped (just a little or a lot) and shared (just a little or a lot). They were then required to indicate how much they liked the peer on a rating scale and to predict how many pennies (of a total of 10 pennies) they thought the peer would give them. It was reported that children from all age groups used the knowledge about how the peer had behaved previously (helped and shared just a little or a lot) to make their judgements about the peer's future behaviour (how many pennies they would give). In Gnepp and Chilamkurti (1988) and Yuill and Pearson (1998) children as young as four years, including the objective children, were able to infer dispositions from past behaviours and use this information to predict future behaviour (though not emotional response) in a different situation.

Research suggests that children make these predictions using rules. They use simple frequency rules about how often a particular behaviour occurs as well as more complex rules like Kelly's covariation principle. According to Kelly (1973), causal attribution involves identifying which of the causes (person, entity or circumstance) the effect (behaviour) covaries with. Individuals use three types of information to identify the cause of behaviour. One, they observe the degree to which the person's behaviour (for example, John sleeps in Mr. Andy's class) is consistent across time and situation. Consistency would be high if John always sleeps in Mr. Andy's class. Two, how distinct the behaviour is across stimuli is observed. Distinctiveness would be high if John does not sleep in any other lecturer's class and only in Mr. Andy's class. Three, the degree of consensus across other individuals is considered. Consensus would be high if not only John but other students too sleep in Mr. Andy's class. Based on the covariation pattern the event is attributed to one of the three classes of causes, person (John), entity (Mr. Andy) or circumstances (for example, Mr. Andy takes a boring subject or Mr. Andy's class is always the first one on Monday morning) using the rules outlined in table 2.1.

Table 2.1: Causal attribution based on Kelly's covariation principle.

Attribution	Information		
	Consensus	Distinctiveness	Consistency
Person	Low	Low	High
Entity	High	High	High
Circumstances	Low	High	Low

Ferguson, Olthof and Luiten (1984) investigated whether there is a decreased use of frequency and an increased use of covariation information with age. They presented five to thirteen year old children with (aggressive) behavioural information about a boy. The information varied in frequency and covariation pattern. In the first condition, consistency was low, distinctiveness was high and frequency was low. In the second condition, consistency was high, distinctiveness was low and frequency was high. In the third condition consistency was low, distinctiveness was high and frequency was high. Later, participants were required to rate the protagonist on a list of adjectives as well as infer the cause of his behaviour in a number of stories. A frequency-based rule would result in stronger dispositional attribution of aggressiveness in the second and third condition. On the other hand, a covariation-based rule would result in stronger dispositional attribution only in the second condition. In the story task kindergarten children (mean age: 5;9 years) attributed aggressiveness to a greater degree in conditions two and three, whereas first (mean age: 7;3 years), third (mean age: 8;9 years) and fifth graders (mean age: 9;4 years) showed stronger dispositional attribution in condition two alone. This suggests a developmental decrease in the use of the frequency rule and an increase in the use of the covariation rule. However in the rating task, even the youngest children showed an ability to use covariation principle.

Considering that people with Autism Spectrum Disorders sometimes successfully learn and apply rules (Hermelin & O'Connor, 1986; Klinger & Dawson, 2001; Minshew, Goldstein, Muenz, & Payton, 1992), they might draw on this ability to good effect when inferring traits. A particular incident narrated by Temple Grandin, (Sacks, 1995) neatly illustrates this possibility. The machinery in one of the plants designed by Temple Grandin suffered repeated breakdown and she observed that these occurred when a particular man was in the room. Thus, she inferred that this man was sabotaging the machinery by "putting two and two together" and "correlating" the incidents though she "...couldn't see the jealous look on his face".

Hermelin and O'Connor (1986) found that individuals who have below average intelligence but show superior calendarical skills (referred to as savants), being able to name the day of the week of any given date of any year with speed, used rule-based strategy and not rote memory or arithmetic procedures to do their calculations. Furthermore, some of the participants were able to transfer the rule, with varying degree of success which depended on their cognitive ability, to a non-calendarical task.

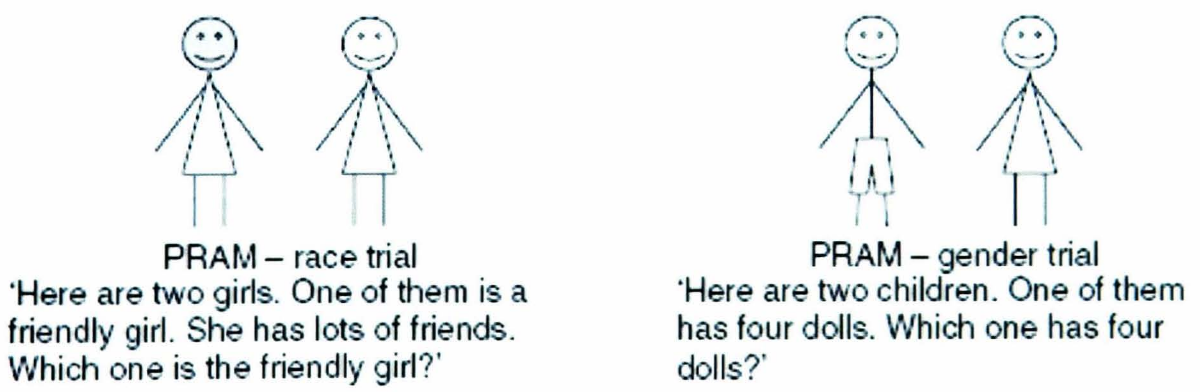
Minshew, Goldstein, Muenz and Payton (1992) administered several neuropsychological tests to a group of individuals with autism (without learning difficulty) between the ages of 15 and 40 years. Results indicated that the participants with autism were not significantly different from control typically developed individuals matched on age, gender, intelligence quotient and race on rule learning aspects of abstract thinking.

Klinger and Dawson (2001) investigated the use of a rule-based strategy and a prototype-based strategy by individuals with autism when learning about categories. The performance of participants (with autism, with Down's syndrome and developing typically) was compared on two categorization tasks: one where there was an explicit rule and the other where there was no rule and hence required that a prototype be formed. The results indicated that although participants with autism and participants with Down's syndrome showed difficulty forming prototypes, all three diagnostic groups could use a rule-based strategy to determine category membership, often being able to infer implicit rules as well.

Thus, rule acquisition in autism appears to be intact which could mean that they may be able to infer traits using logic and rules. Moreover, any difficulty with belief-desire reasoning in autism should not be an impediment given that making predictions on the basis of behavioural regularity is something that preschoolers seem able to do at a point in development well before they can demonstrate mastery of belief-desire reasoning.

Recently, Hirschfeld, Bartmess, White and Frith (2007) reported that children with autism were able to use gender and race stereotypes to predict behaviour. Preschool Racial Attitudes Measure (PRAM II) was used to assess knowledge about gender and racial stereotype. Preschool Racial Attitudes Measure uses a forced-choice format and presents scenarios using line drawings as shown in figure 2.1. The child is shown life-like coloured drawings of people with brown or pink skin and hears a short vignette following which s/he has to choose which of the two people the vignette best describes.

Figure 2.1: The PRAM task used in Hirschfeld, Bartmess, White and Frith (2007)



On the Preschool Racial Attitudes Measure eight year old children with autism (mental age of seven), irrespective of whether they passed Theory of Mind task, used gender and race stereotype to make predictions.

Hirschfeld *et al.* (2007) also presented a conflict task (Figure 2.2) where the response would differ depending on whether the predictions were made based on information about current mental states, habitual preference or social group (race and gender) membership.

Figure 2.2: The conflict task used in Hirschfeld, Bartmess, White and Frith (2007)

Conflict task – race trial
'Here are two women. This is Georgina (left) and this is Chloe. Georgina likes to help people. One of these women walked an old lady across the road. Which woman was it?'

Conflict task – gender trial
'Here are two people. This is James and this is Grace. Grace doesn't like to cook for people. One of these people has baked biscuits. Which person baked biscuits?'

Taking the example illustrated in figure 2.2, if participants base their predictions on race stereotypy then they would predict that Chloe walked the old lady across the road despite the information that Georgina likes to help people. But, if they use the given mental state information, then they would predict that it was Georgina who helped the old lady. On the conflict task children with autism who passed the Theory of Mind task were similar to typically developing seven year olds, preferring mental state explanation of behaviour as opposed to stereotype-based explanation. But, children with autism who did not pass the Theory of Mind task, like typically developing three year olds, continued to use stereotype-based explanation for behaviour. In the conflict task, children with autism who pass and who do not pass the Theory of Mind task were able to attribute characteristics to people. The difference was that the former used mental state information while the latter used stereotype-based information.

Stereotyping involves attributing traits and preferences to a person based solely because he or she belongs to a particular social group. Stereotypes are not explicitly taught to children. Hence, it has a strong albeit implicit cultural and social learning component. This study suggests that individuals with Autism Spectrum Disorders are able to grasp subtle, cultural cues regarding the assumed characteristics of individuals belonging to different social categories. They use this information to predict future behaviour. This study, thus, indirectly supports the ability of individuals with Autism Spectrum Disorders to infer and use traits to predict behaviour.

2.1.3 Why study knowledge about traits in Autism Spectrum Disorders?

The well established equation of causal attribution assumes that behaviour is a joint product of disposition and situation. Dispositional attribution places the cause of an action within the individual, on some lasting characteristic, whereas situational attribution places the cause outside the individual on environmental circumstances that can be transient. Most early models of attribution posit that ordinary people will examine the possible causes of behaviour in terms of stable internal mental states and transitory external situational forces before making a causal attribution. In other words, when confronted with a behaviour, ordinary people consider whether the behaviour was the result of the kind of person the actor is or the kind of situation the actor was in. For example, if someone refuses to give you directions, is it because he is an unhelpful person or because he is late for an important appointment and is in a hurry? If the behaviour can be explained by situational demands then the observer does not attribute the cause to dispositions (Jones & Davis, 1965; Kelly, 1973).

As early as 1943, Ichheiser suggested that people are prone to believe that a person behaved in a certain way because s/he possessed certain personal qualities rather than as a result of situational pressures to act in a particular manner. In 1967, the classic study carried out by Jones and Harris provided empirical evidence that this was indeed the case. They presented university students with essays, allegedly written by another student, which either supported or opposed the Cuban president Fidel Castro. Some of the participants were told that the essayist was given freedom to choose whether to write pro-Castro or anti-Castro essays. The other participants were told that the essayist was instructed by his debate coach to defend a particular point of view. Based on the attribution equation, participants were expected to attribute pro or anti-Castro attitude when the essayist were free to choose their stance but not when the debate coach dictated which stance to take. Jones and Harris (1967) reported that participants did attribute the appropriate attitude when the essayist had the freedom of choice. Surprisingly, though weaker, similar attributions were made by the participants even when the essayist, presumably, took the position suggested by the debate coach. This Observer bias, to use Jones and Harris' (1967) term, has been replicated many times in Western culture by different researchers (for example, Fein, Hilton, & Miller, 1990). The tendency to attribute the cause of behaviour to the actor's disposition even when it is possible to provide a situational explanation for the action is predominant in Western culture. It is also referred to as the fundamental attributional error (Ross, 1977) or correspondence bias (Gilbert & Malone, 1995) and illustrates the influential role played by traits in social cognition.

From the extensive Theory of Mind research we know that people with Autism Spectrum Disorders have difficulty using situational information to impute mental states to the protagonist which putatively explains why they make errors in predicting behaviour. Tasks used to test Theory of Mind can be considered as a special kind of attribution task where only the situation needs to be considered and where the disposition of the protagonist need not be taken into account for arriving at the correct answer. To predict Sally's behaviour participants need to understand that the situation constrains Sally's knowledge which then influences her behaviour. What kind of person Sally is (a forgetful person, for example) is not relevant, and neither is Sally's ability to infer that Ann has moved the marble. Because the participant is not required to consider traits, one might argue that the task tests only part of the mentalistic understanding involved in predicting other peoples' behaviour.

Furthermore, Theory of Mind investigations into Autism Spectrum Disorders have been restricted to very few propositional mental states like beliefs, desires and intentions. Hence, our understanding of social cognition in Autism Spectrum Disorders is restricted to their inability to attribute these few mental states to others. William's (2004) interpretative phenomenological analysis revealed that individuals with autism often compensate for their lack of intuition by using explicitly generated rules and logical strategies to deal with social situations. Oliver Sack's (1995) description of Temple Grandin, is suggestive of a person who has used her autistic strengths of logic and visual memory to teach herself social conventions, even though she feels she cannot *understand* them. In fact, elsewhere Grandin (1995) does compare herself to Mr. Spock of the 'The Star Trek' series and writes, "I have always used visualization and logic to work out how people will react". Gaining a comprehensive understanding of social cognition in autism requires investigating not only the deficits but also the possible compensatory processes by which they use information in the social environment to yield causal explanations. Anecdotal evidence clearly points to the use of explicit logical strategies. Propositional mental states partly explain an individual's action in a particular situation. Traits, on the other hand are conceived as stable and enduring across situations. Thus, traits may be relatively more amendable to interpretation based on formal logical rules. Investigating how individuals with autism conceptualize traits may provide scope for directly investigating possible strategies used by some higher functioning individuals with autism when navigating social situations.

Thus, traits are an important, hitherto ignored, socio-cognitive construct in autism research. The aim of the experiments described in this thesis was to investigate whether individuals with Autism Spectrum Disorders infer traits from descriptions of behaviour and if they do so, are they especially sensitive to traits?

2.2 How to study trait inference in autism: The paradigm

How humans perceive their social world and especially the other individuals who live in that world, has been the focus of research for decades.

Many experimental paradigms have been developed for this purpose. Task performance on these paradigms often depends on other skills like verbal ability, memory and imagination to a great extent. However, when developing a paradigm to test a special population like those with Autism Spectrum Disorders, one has to consider whether difficulty doing the task is the result of difficulty in the area of investigation (social inferences in this case) and not task demands specific to the paradigm.

2.2.1 Drawing trait inference from textual behavioural descriptions

Studies on Spontaneous Trait Inference, which is an unintentional trait inference that occurs when one attends to trait implying behaviour for any reason other than inferring a trait has been studied extensively by Uleman and colleagues. These experiments use textual descriptions of behaviour (for example, 'He smiled and said hello to everyone at the party.'), which participants are instructed to read under a variety of conditions, although they are never told explicitly to form impressions or infer traits. Studying inferences drawn from text as the preferred method of investigation is done under the assumption that the findings are informative about the way people function in real life situations (Uleman, Newman, & Moskowitz, 1996). Sentence comprehension involves selecting among the many meanings of each word and combining them to arrive at an emergent meaning of the sentence. According to Uleman *et al.* (1996) this process can be considered to be analogous to parsing the stream of behaviour and disambiguating its parts to extract meaning.

One possible drawback of using sentences as stimuli to test people with Autism Spectrum Disorders comes from studies on the Weak Central Coherence hypothesis (Frith, 2003). The theory suggests that individuals with Autism Spectrum Disorders have a deficit in processing information at a global level which includes sentence processing. The evidence for difficulty with extracting meaning from sentences comes from two main lines of research. In one, researchers have reported that individuals with Autism Spectrum Disorders are not aided by structure when sentences were presented as opposed to random word strings in free recall tasks (Hermelin & O'Connor, 1967; Romondo & Milech, 1984). In the second, research has consistently found that individuals with Autism Spectrum Disorders do not use sentence context to disambiguate homographs (for example, 'tear') that have different meanings and pronunciations but are spelt the same (Frith & Snowling, 1983; Happe, 1997; Jolliffe & Baron-Cohen 1999).

If indeed individuals with Autism Spectrum Disorders do have difficulty extracting meaning from text, then using a paradigm that uses sentences as stimuli would not be suitable for studying trait inference in this population. The (global) meaning conveyed in the sentence must be processed for the traits to be inferred. The trait *clumsy* is implied in the behaviour described in the sentence 'He tripped on the rug and twisted his ankle' and cannot be inferred from any single part of the sentence. Hence, in case we do find that individuals with Autism Spectrum Disorders are unable to infer traits from textual descriptions of behaviour, we cannot to be certain whether the difficulty arises from inability to infer traits or having what Frith and Snowling (1983) termed "sentence blindness" caused by weak central coherence.

2.2.2 Sentence processing in Autism Spectrum Disorders

In this section the literature on sentence processing in autism is reviewed in order to assess the feasibility of using textual stimuli to investigate whether individuals with Autism Spectrum Disorders infer traits.

Memory for sentence vs. memory for phrase

A much replicated study tapping into language deficits in autism was carried out by Hermelin and O'Connor (1967). They compared children with autism and children with learning difficulty on the recall of structured and unstructured material. The two groups, matched on vocabulary and digit span, were orally presented with sequences of one syllable words three to eight words long. Immediately after a sequence was presented participants were required to recall them in an unpaced manner. There were three kinds of sequences, simple English sentences (for example, 'He went to town'), random order sequences matched for frequency with the simple English sentences (for example, 'Some that a went') and contextual sequences made of less frequent words (for example, 'Shade this young plant'). Results indicated that frequency did not affect recall and that the children with autism had a higher immediate recall score than the children with learning difficulty. But, while the children with learning difficulty performed significantly better with sentences than with random sequences, no significant difference was found in the children with autism. The authors concluded that this pattern of recall is an indication that children with autism are unable to use structure and meaning to code linguistic material, unlike their vocabulary and digit span matched controls.

Aurnhammer-Frith (1969) investigated the effect of syntactic structure on immediate recall in children with autism and clinically normal children. The children were further divided into low span and high span groups based on their digit span score. The results indicated that all groups recalled more of the structured sequences than the unstructured sequences. Error analysis showed that, as expected, reversal of word order occurred more frequently in the unstructured than the structured sequences. This was true for all groups, including children with autism. However, overall the high span groups benefited more from structured linguistic material than the low span groups - the difference in recall and order reversal errors between structured and unstructured sequences was more in the high span group. Since digit span is closely related to developmental age and intelligence, Aurnhammer-Frith (1969) suggested that appreciation of structure increases with development. The recall pattern within the low span groups did not differ based on diagnosis. But, among the high span group the difference in recall for structured and unstructured sequences was more for the clinically normal group than the group with autism. However, the high span group with autism showed order reversal effect to a similar degree to the clinically normal group, suggestive of active coding. Frith suggested that the lack of benefit from structure in autism reported in some studies can be interpreted partly but not entirely in terms of lower developmental age.

Fyffe and Prior (1978) pointed out four ‘flaws’ in Hermelin and O’Connor’s (1967) experiment. First, the children with autism recalled significantly more random material than the children with learning difficulties which suggests inadequate or unreliable matching. Second, since only sequences that were recalled entirely were scored, the result was based on three and four word sequences which were well within the memory span of participants and required no recoding. Third, some of the sequences were questions, which are more difficult to remember. And finally, some studies reported the effect of structure on recall to be significantly more in the high span group than the low span group, suggesting that increased use of structure may be a function of developmental age rather than a deficit in processing which is specific to autism (Aurnhammer-Frith, 1969). Fyffe and Prior (1978) modified Hermelin and O'Connor's (1967) experiment to correct the perceived flaws. They used a stricter procedure for matching digit span and included a group of children with learning difficulty as well as a group of younger typically developing children as controls. The participants (children with autism, children with learning difficulty and children developing typically) were divided into high and low span groups based on their performance on the digit span subtest of the Illinois test for psycholinguistic abilities. The participants were presented with sentences and random sequences, consisting of the same words in the sentence but rearranged. It was ensured that all the sequences presented to a given participant were well above his or her memory span, containing more words than their digit span score. They found that both the high span and the low span group of children, irrespective of their diagnosis, recalled more words when the material was structured. Recency effect which is characteristic of recall of unstructured input and recall of sentences by very young children was observed in all diagnostic groups for random lists, irrespective of memory span. But, the low span group with autism did not benefit from structure as much as their controls and showed recency effect with structured sequences as well. A further experiment, compared recall for proper sentences and anomalous sentences (syntactically consistent but semantically meaningless, for example, 'The house and church can dig like me'). Again, the performance of low span groups differed from the performance of high span groups. Significantly greater recall of proper sentences as opposed to anomalous sentences was observed in the low span typically developing children but not children with autism or learning difficulties. In the high span group, there was no significant difference in performance between the clinical groups. These results suggest that children with autism, irrespective of their developmental age, are aided by meaning contrary to the hypothesis. Fyffe and Prior (1978) suggested that an Intelligence Quotient (IQ) related deficit rather than a specific processing deficit must be considered.

Another study investigating whether the deficit observed in the recall of structured material in autism is specific to autism or whether it could be explained by lower developmental age was carried out by Ramondo and Milech (1984). This study involved immediate recall of sequences by digit span and verbal mental age matched participants with autism, with learning difficulty and children who were developing typically. There were four kinds of sequences - high on syntactic and semantic aspects (for example, 'Last week we all went by train to see the big farm'), low on syntactic and semantic aspects (for example, 'week went see big last the all to train we farm by'), high on syntactic but low on semantic aspects (for example, 'Last six we all went by tree to see the big box'), and low on syntactic but high on semantic aspect (for example, 'red, white, blue, green, dog, cat, bird, horse, train, car, bus, boat'). When the sentences were low on syntactic aspect all groups performed similarly. However when syntactically well formed sentences were presented the typically developing participants performed the best and the participants with autism performed the worst. But, the performance of the group with learning difficulty was not differentiated from either the typically developing group or the group with autism. Hence, it is inconclusive whether the processing deficit is specific to autism or a result of more general developmental delay. The authors suggested this to be the result of low statistical power of the design due to the small size of the sample tested. In other words, they assumed that the group with autism performed differently than the group with learning difficulty, but that a lack of sensitivity in the design prevented this effect from being detected.

The only result that was consistently obtained in the above mentioned studies was the differential effect of structure on recall of sentences in the clinical groups being based on their digit span. In the low span group, poor performance could be the result of either autism or low developmental age. The high span group with autism showed reduced effect of structure on sentence recall compared to the clinically normal group in Aurnhammer-Frith's (1969) experiment. However error analysis suggested that the participants with autism were actively coding the linguistic material. Fyffe and Prior (1978) did not find significant difference in recall of sentences and random sequences or sentences and anomalous sentences between high span group with autism, learning difficulty and typical development. The participants in Fyffe and Prior (1978) study had the highest digit span score in comparison to the other studies described here. The mean digit span of the high span participants in Fyffe and Prior's (1978) study was 6.5 while the digit span of participants in Aurnhammer-Frith's (1969) and Ramondo and Milech's (1984) study was 5.21 and 5.6 respectively. This could explain why there was no difference in performance of the three high span clinical groups in Fyffe and Prior's (1978) study whereas in Aurnhammer-Frith's (1969) and Ramondo and Milech's (1984) study the high span typical participants showed significantly larger effects of structure than the group with autism. This suggests that a developmental account could explain the reduced effect of structure on recall of sentences reported in some studies.

Hence, none of the studies provided conclusive evidence for diminished effect of structure of linguistic material on recall in autism in general. The possible effect of developmental factors cannot be ruled out.

The homograph task

Homographs are words which have the same spelling but different pronunciations and meanings ('bow', for example). Many researchers have found that individuals with Autism Spectrum Disorders have difficulty using sentence context to determine the pronunciation and therefore disambiguate the meaning of the homograph. This difficulty in autism was first demonstrated in a study by Frith and Snowling (1983). Children with autism, children with dyslexia and children developing typically, matched in terms of their reading age (as measured by British Ability Scales word reading test), were compared on a variety of reading tasks. The study found the phonological and syntactic aspects of reading performance intact in children with autism. This was demonstrated by appropriate use of lexical and phonological strategy to read regular words, irregular words and non-words, their ability to differentiate abstract and concrete words as classes of semantic representation and their ability to immediately access to meaning of individual words. However, participants with autism had a specific difficulty in using semantic cues to disambiguate the pronunciation of homographs. Children with autism were found to be as sensitive as clinically normal children to syntactic constrains when pronouncing singular and plural words in a sentence, but were significantly poor at a task that required choosing one of three alternatives to complete sentences within a short story. Thus, difficulty with the homograph task was explained as an inability to utilize semantic rather than syntactic information. The authors suggested that children with autism fail to use contextual semantic cues while reading.

Other researchers (Happe, 1997; Jolliffe & Baron-Cohen, 1999; Lopez & Leekam, 2003) have found similar performance by individuals with autism on the homograph task. Happe (1997) examined the relationship between theory of mind deficits and weak central coherence by testing relatively able individuals with autism, who differed in their theory of mind task performance, on the homograph task. Happe (1997) used a modified version of the homograph task (Snowling & Frith, 1986). In some of the sentences the homograph appeared with the frequent pronunciation (for example, 'There was a big tear in her eye') and in other sentences the homograph appeared with the less frequent pronunciation (for example, 'There was a big tear in her dress'). The position of the homograph was manipulated so that in half the sentences it was placed before the sentence context and in the other half after the sentence context (for example, Molly was very happy, but in Lilly's eye there was a big tear). Happe (1997) found that most of the participants with autism, who passed Theory of Mind tasks made little use of the preceding sentence context when pronouncing the homographs indicating a cognitive characteristic separate from a theory of mind deficit.

Jollife and Baron-Cohen (1999) tested a group of participants with high functioning autism and Asperger's Syndrome using a homograph task similar to the one used by Happe (1997). Both the clinical groups did not make use of the sentence context to disambiguate homographs.

Lopez and Leekam (2003) found their subjects with autism were as able as the comparison group in the use of visual contextual information to facilitate object identification. Both groups of participants were faster and more accurate naming the object when it followed a visual scene appropriate for the object (for example, picture of a kitchen followed by a picture of a jug). Surprisingly this ability was extended to verbal information as well where words were used instead of pictorial representations. These participants with autism, however, were impaired in using sentence context to correctly pronounce the homograph.

The homograph task used by Happe (1997), Jollife and Baron-Cohen (1999) and Lopez and Leekam (2003) was developed by Snowling and Frith (1986). They compared children with autism and children with learning difficulty who had high or low verbal ability as well as younger typically developing controls of similar mental age and reading age. Apart from presenting the frequent and rare pronunciation of the homographs and placing the homographs before and after the sentence context, the task was presented twice. The task was presented the second time after training was given about the nature of homographs. There was a significant effect of verbal ability on performance, with the high verbal ability groups performing better than the low verbal ability groups. The high verbal ability groups (with autism, with learning difficulty and typically developing) performed identically and took the sentence context into account when pronouncing the homographs while the low ability groups (irrespective of diagnosis) were insensitive to sentence context. All subjects improved from the first to second session, with the less frequent pronunciation being used correctly more in the second session. Since the insensitivity to sentence context was observed only in the low verbal ability groups and all participants improved on the task with training, the authors concluded that the inability to disambiguate homographs based on context was not an "autism-specific phenomenon".

In Joliffe and Baron-Cohen's (1999) study the effect of training was not tested. Thus, they concluded that the participants were not using sentence context to disambiguate homographs because of a processing preference rather than an absolute deficit. This conclusion was based on Snowling and Frith's (1986) finding that even the younger and less able individuals with autism could be trained to disambiguate homographs according to the context. Lopez and Leekam's (2003) series of experiments was carried out to test whether "....the context impairment proposed by the Weak Central Coherence theory is simply a reflection of difficulties in processing complex verbal stimuli rather than making semantic connections between different items." Since the participants with autism were using contextual verbal information presented textually to identify objects quickly and accurately, they concluded that the difficulty with homographs may be specific to particularly complex characteristic of the homograph task.

Overall, people with autism perform poorly on the homograph task. However this could be the result of more general developmental delay (Snowling and Frith, 1986), a processing preference rather than a deficit (Joliffe and Baron-Cohen, 1999) or complexity specific to the nature of homographs (Lopez and Leekam, 2003) about which participants may not have been aware until training was given. Definite conclusions about whether participants with autism have difficulty with extracting meaning from sentences cannot be drawn based on failure to correctly pronounce the homographs alone. Direct testing of the comprehension of homographs and the whole sentence was suggested by Happe (1997).

Neurological evidence

The cortical activation during sentence comprehension of a group of high functioning individuals with autism was compared to age and verbal intelligence quotient matched controls by Just, Cherkassky, Keller and Minshew (2004) using functional MRI. The fMRI was carried out when the participants read active and passive sentences and responded to a probe identifying either the agent or the recipient of an action. The results indicated an increased activation of Wernicke's area and a decreased activation of Broca's area in the participants with high functioning autism compared to typical participants, who showed the opposite pattern of activation. Wernicke's area is concerned with comprehension ability and Broca's area is concerned with production including organisation of words into a meaningful syntactic and semantic structure. The results from the fMRI suggested that participants with high functioning autism have an enhanced ability to process single words during comprehension but have difficulty integrating the meaning of the individual words into a coherent and meaningful sentence. This result is consistent with Frith's (2003) theory of Weak Central Coherence which suggests that detail-focused processing is spared and maybe even enhanced in autism but the integrating processes involved in maintaining coherence is impaired. The behavioural data suggested that participants with high functioning autism made more errors than typical participants. Error rates of the participants with high functioning autism were relatively high for the passive sentences than for the active sentences. This suggests that difficulty with integration is observed with only the more complex passive sentences at the behavioural level.

This study provides evidence at the biological level for enhanced detail-focused word processing and impaired global-focused sentence processing in autism resulting in impaired ability to process the meaning of sentences. In conjunction with the behavioural data, these results suggest difficulty with *complex* (passive) sentences in particular.

2.2.3 'Monitoring' text comprehension

In order to test decoding skills with larger units of text, Snowling and Frith (1986) adapted two stories from children's nature stories and presented them to children with autism and children developing typically who had high or low verbal ability as measured by the British Picture Vocabulary Scale. In one story participants had to choose, at intervals, one word from three alternatives that fit the contents of the story. One alternative was appropriate to the immediate context of the sentence but not the story as a whole, the second alternative was appropriate to the immediate sentence as well as the story and the third was inappropriate for both in terms of the sentence and the story. With the second story no alternatives were given; instead, the subjects had to read the story and detect words that were not appropriate to the text. Some of the words were appropriate to the sentence context but not the story (plausible), whereas others were inappropriate to both the immediate sentence as well as the story context (implausible). The authors argued that the first task imposes a "monitor" (authors' quotes) by focusing the reader's attention. This may simulate a metalinguistic process by artificially enhancing text processing. In the second story the processing would be more automatic. Verbal ability was found to be a relevant factor. The autistic and non autistic readers of high verbal ability were able to process the sentences and the story units as well as the matched normal readers. Irrespective of diagnosis, the high verbal ability children preferred story-appropriate over sentence-appropriate words and avoided implausible words when monitoring was stimulated and to a great extent when it was not. The lower ability typically developing group performed similarly to the higher ability groups; however this was not so with the lower ability handicapped group. The handicapped group, irrespective of whether they also had autism, was able to reject implausible alternatives when monitoring was stimulated but otherwise were not able to distinguish between story-appropriate and sentence-appropriate words. Thus, difficulty at comprehending text at the level of sentences and stories was observed in the lower ability group with autism but not the higher ability group. With 'monitoring' even the lower ability groups were able to comprehend text at the level of the story.

2.2.4 Conclusion

To sum up, the evidence for impairment with sentence processing in autism is persuasive, but the possibility that this impairment results from a more general developmental delay or is specific to complex tasks like disambiguating homographs remains open. Evidence for enhanced word processing ability but deficient integrating processes involved in comprehending sentences may be identifiable at biological level. However, behavioural data suggest that this pattern of strength and weakness results in difficulty with complex sentences in particular. Hence, a paradigm presenting simple textual descriptions of behaviour might be suitable in some circumstances for investigating whether people with Autism Spectrum Disorders infer traits.

2.3 Chapter summary

Social impairment is observed across the autistic spectrum independent of successful adjustment in other areas of life. The Theory of Mind hypothesis explains social impairment as the result of a deficit in attributing mental states, a skill required to understand and predict others' behaviour. Attribution research posits that lay explanations of behaviour are based on assumptions about stable dispositions and the effect of transient situations. Dispositions are an important socio-cognitive construct as people tend to attribute the cause of behaviour to the actor's disposition even when it is possible to provide a situational explanation for the action. Extensive Theory of Mind research suggests that people with Autism Spectrum Disorders have difficulty using the situational information to impute mental states to the protagonist which putatively explains why they make errors in predicting behaviour. However, whether individuals with Autism Spectrum Disorders can make behavioural predictions based on information about the protagonist's disposition has not been investigated so far. Some researchers suggest that understanding traits as psychological entities follows the awareness of the subjective nature of mental states. Thus individuals with Autism Spectrum Disorders, who reputedly have difficulty with belief-desire reasoning, should have difficulty with traits as well. However, children who have not yet acquired belief-desire reasoning can still understand traits in terms of behavioural regularity, using rules. Considering that people with Autism Spectrum Disorders sometimes successfully learn and apply rules, they might draw on this ability to good effect when inferring traits. Investigating how individuals with autism construe traits would provide a broader understanding of social cognition in autism than provided by the narrow focus of the Theory of Mind hypothesis. Thus, the aim of the experiments described in this thesis was to investigate whether individuals with Autism Spectrum Disorders infer traits from descriptions of behaviour and if they do so, are they especially sensitive to traits? A paradigm presenting simple textual descriptions of behaviour was used for the purpose.

Chapter Three

Do individuals with Autism Spectrum Disorders infer traits from textual descriptions of behaviour?

3.1 Introduction

In order to investigate whether individuals with Autism Spectrum Disorders infer traits from behaviour a simple paradigm was constructed that did not place much demand on skills like memory, imagination and verbal ability. The paradigm involved presenting sentences that describe a behaviour which implies a trait (for example, 'He picked out the best biscuits for himself before the guests arrived'). Participants read the sentence and then chose the word from a pair of words that best relates to the sentence. There were two categories of word pairs: trait cue-distracter word pair (*greedy* in the above example paired with an unrelated word) and a semantic associate of one of the words in the sentence (*tea* in the above example) paired with a distracter word.

Research (discussed in Chapter Two) suggests that participants with autism who have a lower developmental age often show impairment in processing sentences. They were not aided in recall when structured sentences were presented as opposed to random sequences of words and were not using sentence context to disambiguate homographs. Similar difficulties were not observed consistently in individuals with autism whose developmental age was in the average range. According to Hill and Frith (2003), co-morbidity of learning difficulty may lead to generally depressed task performance. Hence, it was ensured that the participants chosen for the series of experiments described in this thesis have Intelligence Quotients (IQ) in the average range. Difficulty was occasionally observed in higher functioning individuals with autism when complex verbal stimuli like passive sentences were used. Hence, none of the sentences were passive. Straight forward descriptions of actions observable in daily life and within the scope of experience of individuals with Autism Spectrum Disorders were used. Furthermore, the forced choice nature of the paradigm can be compared to the "monitor" used by Snowling and Frith (1986) in their story task. Individuals with Autism Spectrum Disorders show difficulty focusing their attention on a task, unless the task is related to one of their narrow interests (Quill, 1997). The forced choice nature was expected to help focus the reader's attention on the task, and as suggested by Snowling and Frith (1986), this was expected to support text processing. Of primary interest was whether people with Autism Spectrum Disorders decode the meaning conveyed in textual descriptions of behaviour in terms of traits.

Predicting performance of individuals with Autism Spectrum Disorders on the semantic associate cue condition

In studies on the recall of sentences versus non-sense word strings by children with autism (Fyffe & Prior, 1998; Ramondo & Milech, 1984) there was no significant difference between the experimental and the control group with regards to overall recall of the non-sense word strings suggesting that the group with autism were able to keep a string of words in their memory.

The literature on autism provides evidence for both intact and impaired semantic processing. Studies using free recall paradigms consistently report impairment in semantic processing in individuals with Autism Spectrum Disorders.

Hermelin and O'Connor (1967) tested children with autism and children with learning difficulty, matched on digit span, on a free recall task. A list of words was presented to participants ensuring that the list presented to a given participant contained more words than their digit span score. The lists consisted of words which could be grouped into semantic categories (for example, blue, three, red, five, six, white, green, eight). The recall pattern of children with learning difficulty showed clustering of words based on semantic relatedness. But, clustering was not characteristic of recall by children with autism.

Tager-Flushberg (1991) also tested free recall of two types of word lists; the first list contained twelve nouns each drawn from a different semantic category (airplane, apple, brown, cabin, drum, elephant, lamp, onion, pencil, pot, shirt, thumb) and the second list contained twelve words from a single category (all animals). Children with autism, children with learning difficulty and typically developing children participated in this study. The typically developing children recalled significantly more items from the semantically related list than the unrelated list. In contrast, the children with autism performed no better with the related than the unrelated list. Bowler, Matthews and Gardiner (1997) replicated this study with a group of adults with Asperger's Syndrome and verbal intelligence matched typical participants.

However, Toichi and Kamio (2001) found that when semantic cues were provided in an immediate recall task, participants with autism succeed in processing semantic information. In their study, participants (adolescents and young adults with high functioning autism and chronological age, mental age and verbal and performance intelligence matched controls) had to complete fragmented words which were primed by another word. The prime and the target words were either semantically related (for example, bus - train) or unrelated (for example, clock - soup). Analysis of accuracy revealed that both groups showed similar priming effects, with performance for the related items being significantly better than for the unrelated items. The authors concluded that the relationships between concepts of simple common words may not be impaired in high functioning autism, which suggests intact semantic memory for words.

Lopez and Leekam (2003) found that their participants with autism were as able as members of a typically developing comparison group in the use of visual contextual information as well as verbal contextual information to aid object identification and word identification respectively. The verbal contextual task was similar to the semantic priming task used by Toichi and Kamio (2001) but here the participants were required to read the second word rather than complete a fragmented word and the primes were contextual in nature, for example, Kitchen – Jug (appropriate context) or office – lemon (inappropriate context). They found that all children, both those with autism and those with typical development, were faster at recognising (reading) words when preceded by an appropriate context than when preceded by a neutral (a series of five X`s) or an inappropriate context.

Hence the impairment in semantic processing in autism seems to be dependent of the kind of task used. While semantic relatedness of words in a list does not aid participants with autism in a free recall task, they can nevertheless use semantic cues to retrieve words from memory.

In the experiment being introduced here, a strong semantic associate of one of the words in the sentence was presented as a cue in half the trials. The cues were presented immediately after each sentence was read. Participants with Autism Spectrum Disorders were expected to be able to perform well on the trials when the cue was a semantic associate. This condition will serve as a point of comparison for the focal condition where a trait word serves as the cue.

3.2 **Experiment 1:** *Pilot Test 1*

A preliminary study was carried out with a group of typical adults to ensure that the sentences developed do imply the intended traits and that the distracter words were not associated with the sentences.

3.2.1 Method

<u>Participants</u>

Twelve participants were recruited during the open day organised by the School of Psychology at the University of Nottingham. All participants were native English speaking males studying for an undergraduate degree in Psychology. Their age ranged from 18;5 years to 20;2 years ($M = 19.24$, $SD = 0.69$)

<u>Apparatus and Stimuli</u>

The experiment was programmed and presented using E-Prime on an Acer Aspire 1522WLMi laptop with 15.4" widescreen.

Twenty-four trait implying sentences (twenty-two experimental trials and two practice trials) were developed based on a database compiled by Uleman and colleagues (1988). Some of the sentences were slightly modified to make it conform to British English instead of American (for example, 'closet' was changed to 'cupboard'). Nine new sentences were constructed ensuring that all sentences were straight forward descriptions of behaviour, observable in daily life and within the scope of experience of individuals with Autism Spectrum Disorders. For example, the sentence for the trait *honest* in the database was, 'She told the prospective buyer about her problems with her car'. It was felt that buying and selling cars may not be an experience familiar for many individuals with autism. Hence, the sentence 'He told the teacher that he broke the window' was constructed and used instead.

The experimental trial consisted of two sentences each for the traits, clever, strong, honest, friendly, tidy, careful, clumsy, selfish, forgetful, lazy, and shy, making a total of 22 sentences. The first six traits have positive valance (generally considered desirable) and the rest have negative valance (generally considered undesirable). As was the case with the sentences used in studies on Spontaneous Trait Inference, "descriptive action verbs" (Semin & Fielder, 1988) were used in the experiments described in this thesis. Descriptive action verbs like call, meet and kick refer to an action with a clear beginning and end, their interpretation is highly context bound and hence they do not have positive or negative semantic valence. For each sentence, two word pairs were identified.

One word pair consisted of the implied trait word and a distracter word that was not related to the sentence. The other word pair consisted of a semantic associate of one of the words in the sentence and a distracter word. The cue word and the distracter word were matched for frequency (Children's Printed Word Database, Version 1.3, 2002, available online), syllable count, word length as well as word type (adjective or noun). The difference between frequency of the cue and the distracter ranged from 0 to 8 for traits and 0 to 10 for semantic associates. The cue and distracter were also matched for syllable count at a tolerance of $\pm$ 1 and for number of letters within the range of $\pm$ 3. All the participants were given two practice trials. The practice sentences were the same for all participants and consisted of one sentence each for the traits *kind* and *messy*, presented with a trait cue-distracter word pair and a semantic associate cue-distracter word pair respectively. The two practice sentences and the associated word pairs were not presented again in any of the experimental trials. Table 3.1 illustrates the stimuli used for the trait *friendly*. See Appendix B for the full set of stimuli.

Table 3.1: Examples of stimuli used in experiment 1 (Pilot Test 1). The underlined words are the associates of the semantic cue. The semantic cues were taken from the Edinburgh Associative Thesaurus, available online.

Sentence	Trait cue-Distracter	Semantic associate-Distracter
He invited his new neighbour to his house for tea.	friendly - cracked	cup - ship
He chatted with the stranger next to him on the bus.	friendly – cracked	ticket - sweater

All the sentences and the cue-distracter pairs were presented in 18 point Times New Roman font in the centre of the computer screen. The stimuli were presented in black font on a white background. The cue-distracter word pairs were separated by 19.5cms. Each participant was presented with all the sentences. The stimuli were organised into two forms (as shown in Appendix B). Taking the example shown in Table 2.1, one form presented the first sentence ('He invited his new neighbour to his house for tea') with the trait cue (friendly-cracked) and the second sentence ('He chatted with the stranger next to him on the bus') with the semantic associate cue (ticket-sweater). The second form presented the same sentences but the cues were reversed. The sentence 'He invited his new neighbour to his house for tea' was presented with the semantic associate cue (cup-ship) and the sentence 'He chatted with the stranger next to him on the bus' was presented with the trait cue (friendly-cracked). By presenting the two forms to equal number of participants it was ensured that a given sentence was presented with the trait cue to half the participants and with the semantic associate cue to the rest. The position of the cue was counterbalanced so that it appeared on the right and left part of the screen equally often for both the traits and the semantic associates.

Procedure

The participants were tested individually in a quiet room. The participants were assigned to the two forms using systematic allocation, so that the first participant who was tested did form 1, the second did form 2, the third did form 1, and so on till the final participant. They sat half a metre from the laptop. Participants were told that the study deals with "aspects of reading ability" and were instructed (both verbally and textually) as follows; "You will be shown some sentences one by one on the computer screen. Read the sentence aloud once and press the space bar. The sentence will disappear and two words will appear on the screen, one on the left and one on the right. Your task is to match the word that best relates to the sentence that you have just read by pressing 1 if you think it is the word on the left and 0 if you think it is the word on the right."

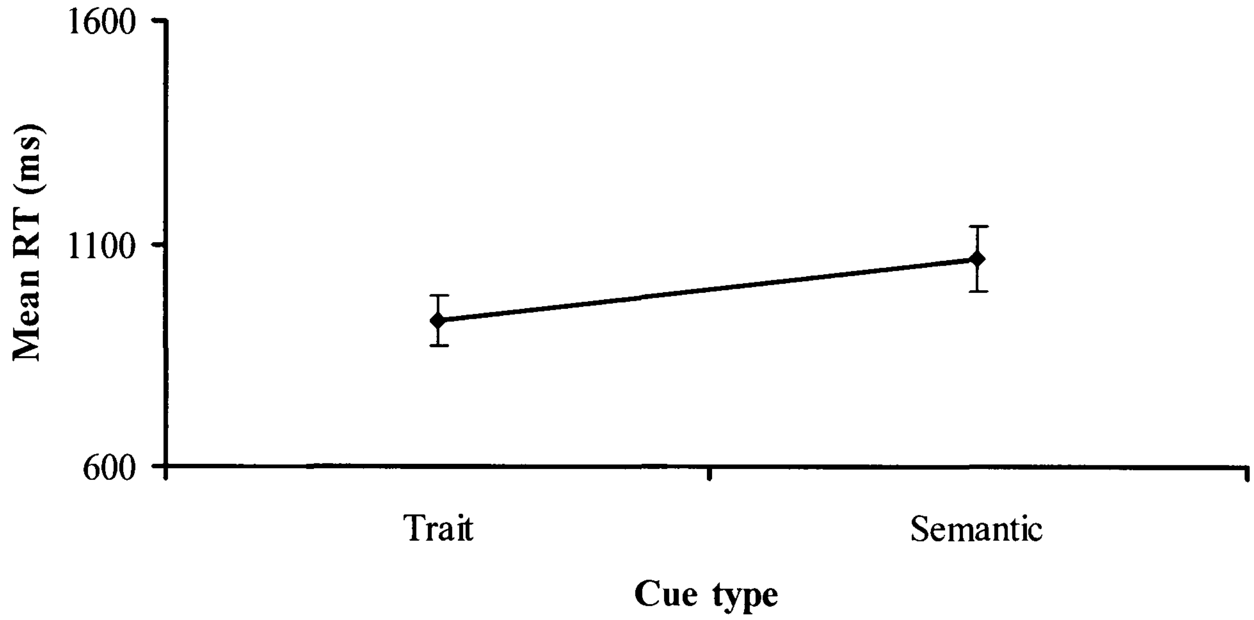
After ensuring that participants were successful with the practice trials, the experimental sentences were presented. The order of the sentences was randomised for each participant. The procedure was self paced and there was a blank screen for 2000 milliseconds between the sentence disappearing (when the spacebar was pressed) and the onset of the words. The keys that were to be used, namely the spacebar, keys '1' and '0' were highlighted. The program was also set so that all the keys except for these were locked.

3.2.2 Results

A score of one was given for each correct response. The maximum score a participant could obtain was 22 (with a maximum of 11 for trait cues and semantic associate cues individually). The performance was at ceiling with accuracy being 98 percent and 93 percent respectively for trait cues and semantic associate cues.

The reaction time was measured from the onset of the word pair to when the participants responded by pressing '1' or '0'. The reaction time for only the correct responses was included in the analysis. The mean reaction time for the trait cue was 926.28 ms (SD = 192.26 ms) and for the semantic associate cue was 1069.09 ms (SD = 254.2 ms). The reaction time data were normally distributed and parametric analysis was carried out. A paired samples t-test revealed that the reaction time for the trait cues was significantly less than that for the semantic associate cues, $t = 2.62, p < .05, d = 0.63$. See figure 3.1.

Figure 3.1: Mean Reaction Time (RT) for trait cue and semantic associate cue (experiment 1, Pilot Test 1). The error bars represent the standard error of the mean.



3.2.3 Discussion

The accuracy of the group was at ceiling and this was irrespective of whether the cue was a trait or a semantic associate. This confirms that the target cues were implied in the sentence and that the distracter words were not perceived to be as strongly related to the sentence.

The mean reaction time for trait cues was found to be significantly less than that for semantic associate cues. This cannot be explained by a speed-accuracy trade off, as being fast in the trait condition was not at the cost of more errors in that condition.

Errors were made in three sentences which were presented with a trait cue and six sentences which were presented with a semantic associate cue. It was suspected that in some of the sentences the errors may have been the result of the distracter being related to the sentences. For example, in the sentence, 'He tripped on the bearskin rug and twisted his ankle' the semantic associate-distracter word pair was 'floor- lion'. 'Floor' was set as the target word as it is a semantic associate of the word 'rug' in the sentence. However, arguably the distracter word 'lion' is a semantic associate of the word 'bear' (in 'bearskin').

Though the results suggest that overall the sentences developed do imply the intended traits and that the distracter words were not perceived to be related to the sentences, the stimuli in which errors were made by some participants could be due to the distracters being related to the sentence. These stimuli were removed or modified.

3.3 Experiment 1: *Pilot Test 2*

In the previous test two forms of the experiment were developed so that a sentence was not presented with its trait cue and its semantic associate cue to the same participant. However, while the trait cues were the same in the two forms the semantic associate cues were not (See Table 3.1). This was corrected so that both the trait cues and the semantic associate cues were the same in the two counterbalanced forms as shown in table 3.2. See Appendix C for the full set of stimuli.

Table 3.2: Examples from the modified stimuli used in experiment 1 (Pilot Test 2). The underlined words are the associates of the semantic cue. The semantic cues were taken from the Edinburgh Associative Thesaurus, available online.

Sentence	Trait cue-Distracter	Semantic associate-Distracter
He invited his new neighbour to his house for coffee.	friendly - cracked	cup - ship
He smiled and said hello to everyone at the tea party.	friendly - cracked	cup-ship

3.3.1 Method

Participants

Sixteen participants, none of whom had taken part in *Pilot Test 1*, were recruited. All were native English speakers who responded to advertisements placed on various notice boards within the University of Nottingham campuses. There were eight males and eight females. Their mean age was 23;8 years (*SD* = 3;4) ranging from 19;6 to 37;7 years. Half the participants were administered form 1 and the other half form 2. Participants were assigned to the two forms using systematic allocation, as described previously.

Apparatus and Stimuli

The apparatus was the same as described in *Pilot Test 1*. The stimuli used in *Pilot Test 1* were modified so that the same semantic associate cue appeared in both forms as shown in table 3. In order to achieve this some of the sentences used in *Pilot Test 1* were changed as shown in Appendix C. The basic nature of the stimuli in terms of number and type of cues and sentences remained the same as outlined in *Pilot Test 1*. The cue word and the distracter word were matched for frequency (Children's Printed Word Database, Version 1.3, 2002, available online), syllable count, word length as well as word type (adjective or noun). The difference between frequency of the cue and the distracter ranged from 0 to 8 for traits and 0 to 10 for semantic associates. The cue and distracter were also matched for syllable count at a tolerance of $\pm$ 1 and for number of letters within the range of $\pm$ 3.

Procedure

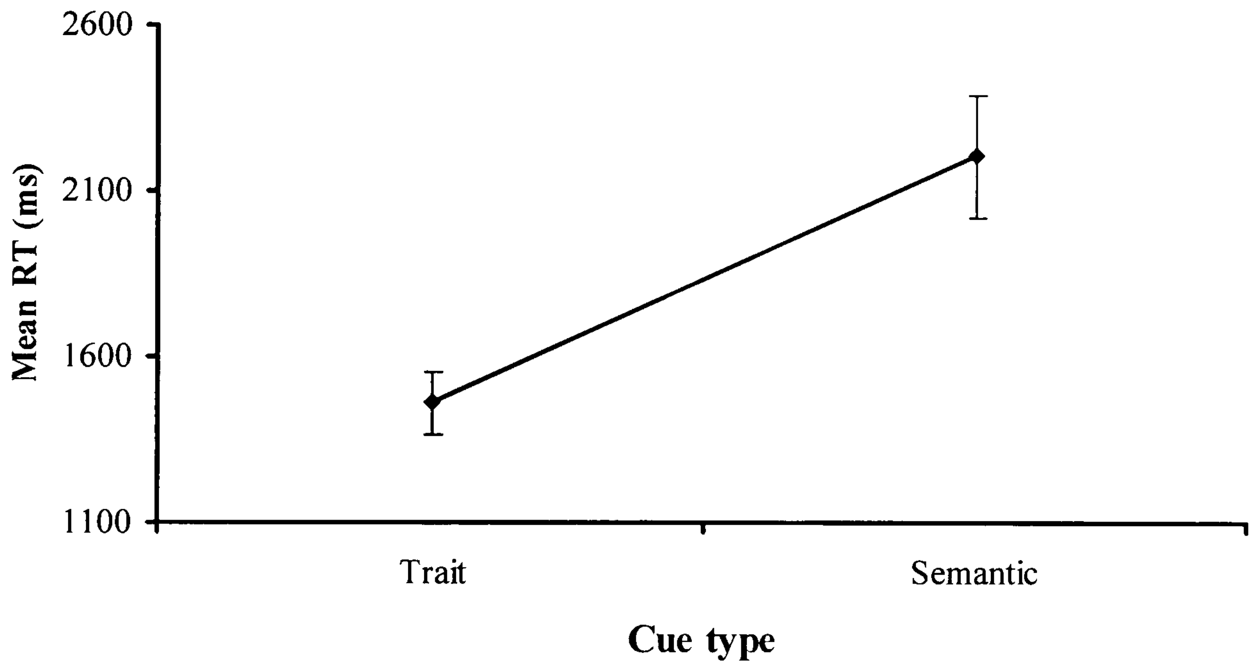
The procedure was as described in *Pilot Test 1*.

3.3.2 Results

As was the case with *Pilot Test 1*, a score of one was given for each correct response. The maximum score a participants could obtain was 22 (with a maximum of 11 for trait cues and semantic associate cues individually). The performance was at ceiling with accuracy being 100 percent and 89 percent respectively for trait cues and semantic associate cues.

The reaction time was measured from the onset of the word pair to when the participants responded by pressing '1' or '0'. The reaction time for only the correct responses was included in the analysis. The mean reaction time for the trait cue was 1461.55 ms (SD = 378.17 ms) and for the semantic associate cue was 2210.8 ms (SD =736.37 ms). The reaction time data were normally distributed and parametric analysis was carried out. A paired samples t-test revealed that the reaction time for trait cues was significantly less than that for semantic associate cues, $t = 6.72, p < .001, d = 1.43$. See figure 3.2.

Figure 3.2: Mean Reaction Time (RT) for trait cue and semantic associate cue (experiment 1, Pilot Test 2). The error bars represent the standard error of the mean.



3.3.3 Discussion

The pattern of results obtained in *Pilot Test 1* was replicated with the modified set of stimuli. Accuracy was at ceiling and the reaction time for trait cues was significantly less than that for semantic associate cues. It was observed that the reaction time increased in *Pilot Test 2* in comparison to *Pilot Test 1*, though the pattern was maintained. This might be because *Pilot Test 1* was carried out as part of the 'research day' organised by the School of Psychology, University of Nottingham. Interested undergraduate students of psychology at the university attend the 'research day', which was organised over an afternoon, to participate in paid experiments. The participants could do as many experiments as they wanted over the afternoon. Earning depended on the number of studies they did. Hence, *Pilot Test 1* participants may have been motivated to perform faster in an attempt to do as many studies as possible. In comparison, participants in *Pilot Test 2* received a fixed payment as they were recruited specifically for this study and came to the lab at a pre-arranged time convenient for them.

3.4 Experiment 2

Performance of participants with Asperger's Syndrome

The stimuli constructed and tested in *Pilot Test 2* were used to investigate whether participants with Asperger's Syndrome infer traits on reading sentences which imply traits.

3.4.1 Method

Participants

Twelve adult participants with a diagnosis of Asperger's Syndrome took part in this study. Individuals were only selected if they had been diagnosed by an experienced clinician and met DSM-IV criteria (American Psychiatric Association, 1994) for Asperger's Syndrome. Twelve participants without Asperger's Syndrome were also tested. Participants with Asperger's Syndrome were recruited from a social support group specifically for individuals with Asperger's Syndrome in Leicestershire, U.K. All 24 participants were native English speakers. Each participant with Asperger's Syndrome was matched individually with a participant in the control group in terms of chronological age

(CA), verbal intelligence quotient (VIQ) and gender. The Wechsler's Abbreviated Scale of Intelligence (WASI, Psychological Corporation, 1999) was used to estimate VIQ. The Wechsler's Abbreviated Scale of Intelligence is a battery of four subsets, two verbal and two performance tests, and provides a brief and reliable estimate of a person's intellectual functioning. The VIQ was based on their scores on the two verbal subsets, vocabulary and similarities. Independent samples t-tests did not identify any significant difference between participants with Asperger's Syndrome and control participants on CA, $t < 1$ and VIQ, $t < 1$. Table 3.3 displays participants' details.

Table 3.3: Details of participants with Asperger's Syndrome (AS) and typical participants (TYP) who took part in experiment 2

Group	Male	Female	CA (Years/Months)			VIQ		
			Mean	SD	Range	Mean	SD	Range
AS	9	3	28;4	9;6	18;11-48;6	117.5	12.88	97-143
TYP	9	3	29;5	10;1	18;11-52;11	117.75	11.09	97-135

The participants in each diagnostic group were divided equally between the two counterbalanced experimental forms.

Apparatus and Stimuli

The apparatus and the stimuli used were as described in experiment 1 *(Pilot Test 2)*.

Procedure

The procedure was as described in experiment 1 *(Pilot Test 1)*.

3.4.2 Results

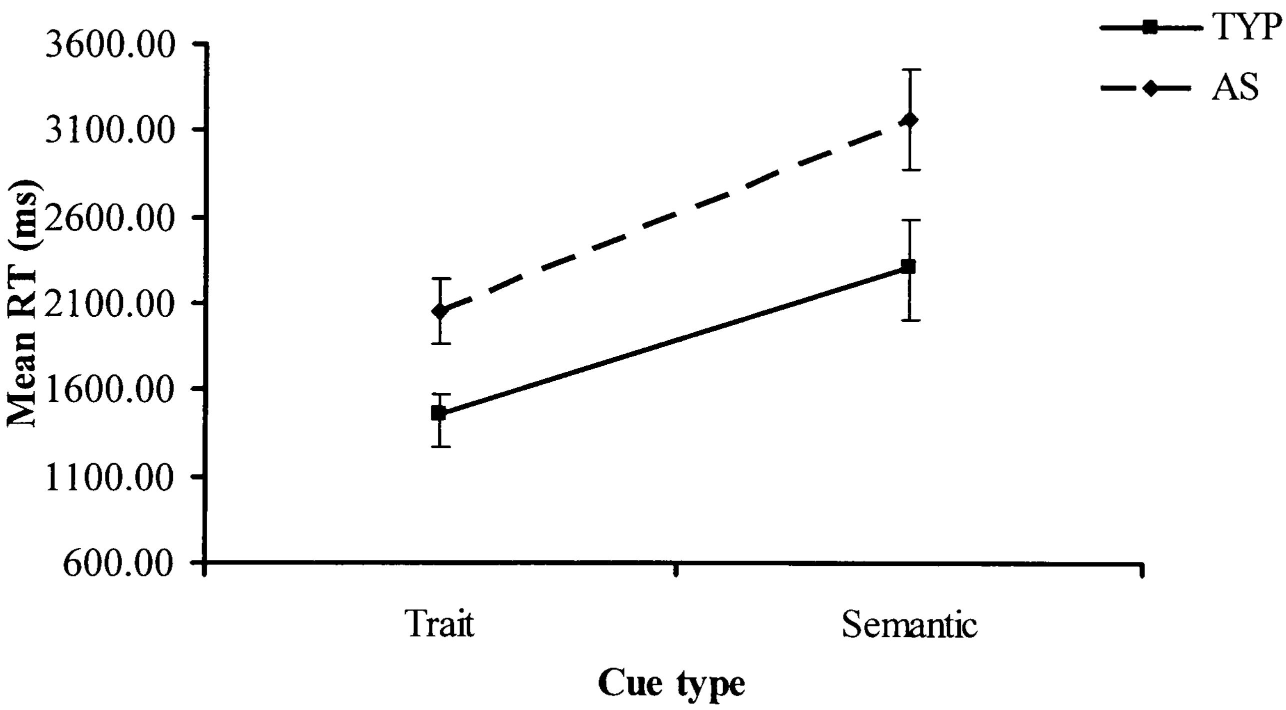
A score of one was given for each correct response. The maximum score a participant could obtain was 22 (with a maximum of 11 for trait cues and semantic associate cues individually). Both groups performed at ceiling. With respect to the trait cues, the typical participants and the participants with Asperger's Syndrome were correct on 100 percent and 99 percent of the trials respectively. With respect to the semantic associate cues participants in both groups made the correct response 89 percent of the time.

The reaction time was measured from the onset of the word pair to when the participants responded by pressing '1' or '0'. The reaction times for only correct responses were included in the analysis. For typical participants the mean reaction time for trait cue was 1452.5 ms (SD = 411.16 ms) and for semantic associate cue was 2314.72 ms (SD = 967.19 ms). For the participants with Asperger's Syndrome the mean reaction time for trait cue was 2052.46 ms (SD = 651.65 ms) and for semantic associate cue was 3177.69 ms (SD = 1032.9 ms). The distribution of reaction time did not meet the conditions for normality and hence the data was submitted to logarithmic transformation and then analysed using repeated measures ANOVA. Cue type (trait versus semantic associate) was the within subject factor and group (Asperger's Syndrome versus typical) the between subjects factor.

There was a significant main effect of cue type on reaction time, $F(1, 22) = 126.69$, $p < .001$, $f = 2.39$ with the reaction time for trait cue being less than that for semantic associate cue. There was a significant main effect of group, $F(1, 22)$

= 7.75, $p < .05$, $f = 0.59$ with typical participants responding more quickly. There was no significant interaction between group and cue type, $F < 1$. See Figure 2.3.

Figure 3.3: Mean reaction time (RT) for trait cue and semantic associate cue for participants with Asperger's Syndrome (AS) and participants of typical development (TYP) (experiment 2). The error bars represent the standard error of the mean.



3.4.3 Discussion

The accuracy of participants with Asperger's Syndrome and typical participants were at ceiling. Though the participants with Asperger's Syndrome were significantly slower than the typical participants, both groups showed the same pattern of reaction times, with significantly faster responses for the trait cues in comparison to the semantic associate cues. This cannot be explained by a speed-accuracy trade off, as being fast in the trait condition was not at the cost of more errors in that condition.

Some researchers have found that frequency and word length affect response latencies (Bargh, Chaiken, Govender, & Pratto, 1992; Whaley, 1978); the higher the frequency, the lower the reaction time. The frequencies of the trait and semantic associate cues and their distracters were obtained from the Children's printed word database (Version 1.3, 2002). This database provides printed word frequencies as read by children aged between five and nine. A database specifically for young children was used as the initial plan was to test teenagers. The word frequency measures might not be suitable for the adult participant groups in the current study and hence it is not possible to determine if frequency was relevant to the results obtained in this experiment.

As the number of syllables increases the longer it will take to pronounce the word. The syllable count of cues and distracters was matched. However, the syllable count of trait cues and semantic associate cues was not matched. It so happened that the trait cues on average contained more syllables, $t = 2.37$, $p < 0.05$. This should lead us to expect longer reaction times for the trait cues. But, it was found that participants were faster on the trait cues. Therefore, participants were fast at inferring traits despite being disadvantaged by cues that had more syllables in that condition. Hence, the pattern of reaction times cannot easily be explained in terms of differences in syllable count.

3.5 Conclusion

Coupled with ceiling level accuracy, the reaction time data suggest that, similar to typical participants, participants with Asperger's Syndrome infer traits from a behavioural description with ease (Asch, 1946). Another possibility, though, concerns the fact that responding to a trait cue requires integration of the different components of the description whereas responding to a semantic cue requires no such integration. The semantic cue *cup* for the sentence 'He invited his new neighbour to his house for coffee' is related to the word *coffee* in the sentence but not to the overall meaning conveyed by the description. Even though trait cues require more processing than semantic cues, participants might naturally attend to the global meaning at the expense of attending to the meaning of individual words. This implies that participants would be faster at inferring not only traits but any feature that requires attention to the global meaning presented.

The theory of Weak Central Coherence (Frith, 2003) suggests that individuals with autism have enhanced ability to process local features of stimuli but are impaired at processing global features. Frith suggested that this is a 'cognitive style' as it is observed in both lower level visual tasks (such as the block design subset of the WASI) and higher level tasks, such as extracting meaning from sentence. Explaining faster response to trait cues in terms of attending to the global meaning at the expense of attending to the meaning of individual words does not support the presence of a 'cognitive style' characterised by weak central coherence.

The next experiment reported in Chapter Four aimed to disentangle these issues.

Chapter Four

Do individuals with Autism Spectrum Disorders infer traits effortlessly?

4.1 Introduction

In experiment 2 both the typical participants and participants with Asperger's Syndrome were significantly faster when the cue was a trait as opposed to a semantic associate. This pattern could arise either because inferring traits is especially easy or because participants naturally attend to the global meaning conveyed. In order to look into these possibilities the experiments described in this chapter employed action cues as controls. Action cues were related to the behaviour described in the sentence and like the trait cues, inferring action also required information presented in the description to be integrated. For example, 'visited' is the action cue for the sentence, 'He took some hot dinner to his ill neighbour'. The action 'visited' cannot be inferred from any one part of the sentence, but required that the global meaning conveyed in the behavioural description be attended to and deciphered. If traits are still inferred faster than actions then it implies that participants (including those with Autism Spectrum Disorders) are especially sensitive to traits, and are inferring them with relatively little effort and not just because traits are inferred from a global reading.

In the experiments described in chapter three, the trait inference could have been triggered by the cues or made spontaneously as soon as the sentences were read (even before the cue-distracter word pairs were presented). Providing the correct response as one of two possible alternatives would cue the reader to the possible meaning conveyed by the sentence. While this helps focus the reader's attention, the trait inference may have been triggered by the cues and not made spontaneously on reading the sentence. Alternatively, if traits were inferred spontaneously, it is possible that the trait inference interfered with performance when the cue was a non-trait semantic associate, resulting in increased reaction time. Such interference would be absent if the sentences were not trait implying, resulting in faster response. Hence, we might enquire whether participants are slower to respond to a semantic associate cue ('pills', for example) when presented with a trait implying sentence (for example, 'He took the sick puppy that he found on the road to his house') than when with a sentence that is not trait implying (for example, 'He found his puppy sick when he reached his house'). Thus, presenting two different types of sentence with a semantic cue allows us to test for interference when the sentence is trait implying, the presence of which would suggest that traits are being inferred spontaneously on reading the sentence, before the cues are presented.

4.2 Experiment 3

Stimuli construction - Pre-testing

The stimuli consisted of two types of sentence, trait implying and neutral. The neutral sentence contained more or less the same words as its corresponding trait implying sentence, but did not imply a trait. Many of the trait implying sentences used in experiment 2 could be modified such that they do not imply a trait. This provided 16 trait sentence-neutral sentence pairs. Eight additional trait sentence-neutral sentence pairs were constructed, some of which were based on the Trait inference norms (Uleman, 1988). All the sentences were straight forward descriptions of actions observable in daily life and within the scope of experience of individuals with Autism Spectrum Disorders. Both the trait and the neutral sentences used descriptive action verbs. Whether a sentence was trait implying or not was pre-tested on a sample of 40 typical participants who were attending various courses at the University of Nottingham. All participants were native English speakers (aged 18 to 39). They were given a list of sentences and asked to tick those sentences they thought implied a trait and to identify (label) the trait. Two forms (each consisting of 16 items) were developed so as to ensure that both sentences of a pair - a trait sentence and its neutral counterpart which was made up of more or less the same words but did not imply a trait - were not presented to the same participant. The 12 trait implying sentences and the neutral sentences chosen finally were considered to be so by a minimum of 75 percent of the pre-test participants, ranging from 75 percent to 100 percent. The data were collected from students while they travelled between campuses on the university shuttle bus and when they were in the common areas around the university.

Stimuli construction - Pilot test

4.2.1 Method

Participants

Twelve participants, none of whom had taken part in any of the earlier studies, were recruited through advertisements placed on various notice boards around the University of Nottingham campuses. All participants were native English speakers. There were ten males and two females. Their ages ranged from 19;2 to 28;2 years (*M* = 24;2, *SD* = 4;4).

Apparatus and Stimuli

The experiment was programmed and presented using E-Prime on an Acer Aspire 1522WLMi laptop with 15.4" widescreen.

The stimuli consisted of four types of sentence-cue pairs, trait sentence-trait cue pair, trait sentence-action cue pair, trait sentence-semantic associate cue pair and neutral sentence-semantic associate cue pair as shown in table 4.1.

Table 4.1: Sentence-cue pair combinations (experiments 3 and 4)

	Trait cue-Distracter	Action cue-Distracter	Semantic associate-Distracter
Trait implying sentence	√	√	√
Neutral sentence	-	-	√

The same set of 12 trait implying sentences was paired with trait cues and action cues. A separate set of 12 trait implying sentences and their corresponding neutral sentences was paired with semantic associate cues. The 12 traits used were - clever, honest, friendly, tidy, careful, strong, greedy, lazy, rude, messy, clumsy, and shy. The first six traits in the list have positive valance (generally considered desirable) and the rest have negative valance (generally considered undesirable). The traits honest, rude and messy were not used in the previous experiments, though honest was used as one of the practice trials. There were two sentences for each trait except for the traits honest and messy which had one sentence each.

All the cue-distracter word pairs were matched for frequency (Children's printed word database, Version 1.3, 2002, was used as teenagers were to be tested in the main study with individuals with Autism Spectrum Disorders), syllable count, word length as well as word type (adjective, verb or noun). In experiments 1 and 2 the distracter words in the trait cue-distracter word pair, though matched for word type (adjective), were not specifically a trait. In the current experiment the distracter words for the trait cues were also traits, but incorrect because they were not implied in the sentence. The cue traits and the distracter traits were matched on valence (positive/negative). The practice sentences were the same for all and consisted of one each of the four sentence-cue pairs. The practice sentences and the associated word pairs were not presented again in any of the experimental trials. A few examples of the stimuli are given in table 4.2 and 4.3. See Appendix D for the complete set of stimuli used.

Table 4.2: Examples trait cue and action cue paired with trait implying sentences (experiments 3 and 4)

Sentences	Trait-Distracter	Action-Distracter
He called the new comers to his house for dinner.	friendly-powerful	invited-boiled
He just sat in front of the television the whole day long.	lazy-cruel	watched-pushed

Table 4.3: Examples of trait sentence and neutral sentence paired with semantic associate cues (experiments 3 and 4). The underlined words are the associates of the semantic cue. The semantic cues were taken from the Edinburgh Associative Thesaurus available online.

Trait implying (Implied trait)	Neutral	Semantic-Distracter
He smiled and said hello to everyone at the <u>tea</u> party. (Friendly)	He met all his friends at the <u>tea</u> party.	cup-bus
He sat alone in a corner at the <u>school</u> Christmas party. (Shy)	He placed the tree in a corner for the <u>school</u> Christmas party.	teacher-country

All the sentences and the cue-distracter pairs were presented in 18 point Times New Roman font in the centre of the computer screen. The cue-distracter word pairs were separated by 19.5cms. The stimuli were presented in black font on a white background. The stimuli were divided into two forms, each consisting of six items from each of the four types of sentence-cue pairs. It was ensured that trait implying sentences and their corresponding neutral sentences were not in the same form and hence were never presented to the same participant. The position of the cue was counterbalanced so that it appeared on both sides of the screen equally often for each of the sentence-cue combinations.

Design

This experiment incorporated two separate repeated measures designs. In the first design the ease of drawing trait inferences was tested by comparing how quickly participants responded to trait cues in comparison to action cues. Both the trait cue and action cue were presented with trait implying sentences and required integration of the information provided in the description.

The second design enquired whether participants were slower to respond to a semantic cue when presented with a trait implying sentence due to interference from spontaneous trait inference. The reaction times for semantic associate cues when they were presented with trait implying sentences and with neutral sentences were compared. Presence of interference would suggest that participants were inferring the traits before the cues were presented. The participants were unaware of the existence of two separate parts to the experiment as all the sentences were presented in a single session.

Procedure

The participants were tested individually in a quiet room. The participants were assigned to the two forms using systematic allocation, so that the first participant who was tested did form 1, the second did form 2, the third did form 1, and so on till the final participant. They sat half a metre from the laptop. Participants were told that the study deals with "aspects of reading ability" and were instructed (both verbally and textually) as follows; "You will be shown some sentences one by one on the computer screen. Read the sentence aloud once and press the space bar. The sentence will disappear and two words will appear on the screen, one on the left and one on the right. Your task is to match the word that best relates to the sentence that you have just read by pressing 1 if you think it is the word on the left and 0 if you think it is the word on the right."

The instructions were the same as in experiments 1 and 2, but the participants were also explicitly told, "Keep your hands on the keyboard throughout the task and try to respond as fast and as accurately as you can". This instruction was added because it was observed in experiment 2 that while the typical group had their hands on the keyboard or the table, members of the group with Asperger's Syndrome sometimes placed their hand in their laps bringing them up each time the keyboard had to be manipulated. The participants with Asperger's Syndrome were significantly slower overall in responding to the cues than the typical participants. It could be that this difference in posture contributed to the slower reaction times in the group with Asperger's Syndrome. This instruction explicitly told the individuals with Autism Spectrum Disorders what was required so as to respond quickly, at least in terms of posture. Only those participants who complied with this instruction were included.

After ensuring that participants were successful with the practice trials, the experimental sentences were presented. Each participant was presented a randomised order of 24 trials consisting of six trials each from the four sentence-cue combinations. The procedure was self paced and there was a blank screen for 1500 milliseconds between the sentence disappearing (when the spacebar was pressed) and the onset of the words. The keys that were to be used, namely the spacebar, keys 'z' and 'm' were highlighted. The keys '1' and '0' were used in the experiments described in Chapter Three. This was changed to 'z' and 'm' in the current experiment as they are closer to the spacebar, thus making the manipulation of the three keys more comfortable and easy. The program was also set so that all the keys except for these were locked.

4.2.2 Results

A score of one was given for each correct response. The maximum score a participant could obtain was 24 (with a maximum of six for each of the four sentence-cue pairs). The performance was at ceiling with respect to accuracy on the four sentence-cue pairs as shown in table 4.4.

Table 4.4: Percentages of correct responses on the four sentence-cue pairs (experiment 3)

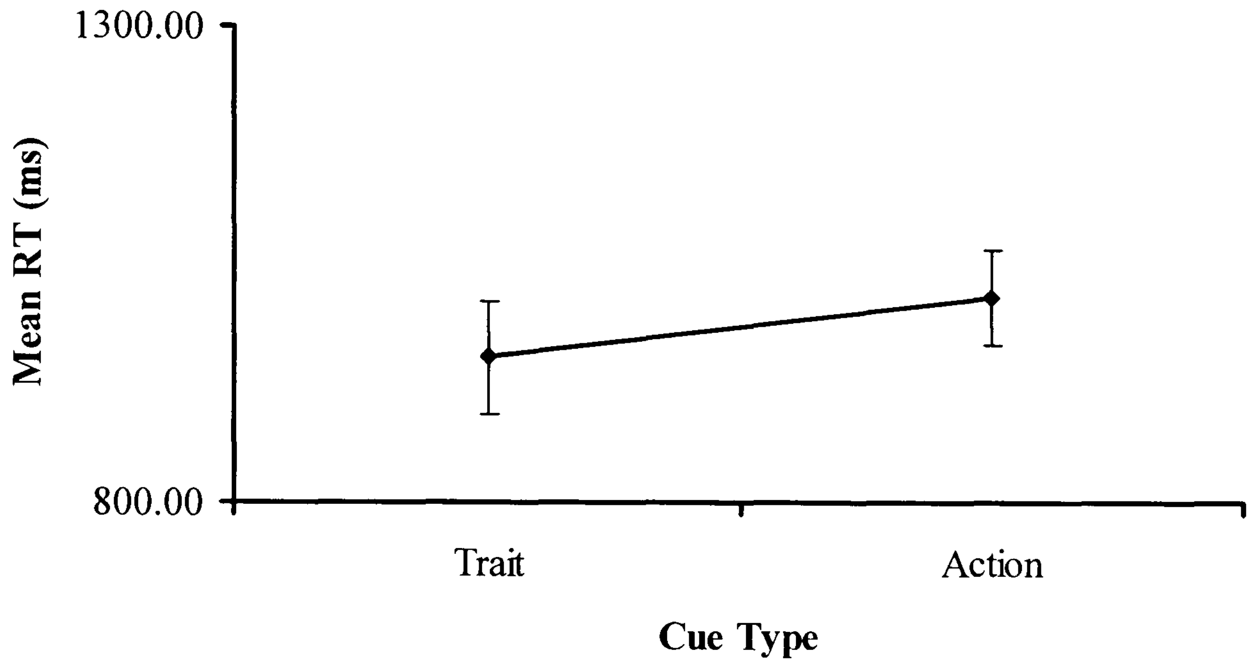
Sentence-cue pair	Accuracy
Trait sentence-trait cue	98%
Trait sentence-action cue	97%
Trait sentence-semantic associate cue	92%
Neutral sentence-semantic associate cue	97%

The sentences in which errors were made were looked at individually. The errors did not appear to be systematic, with no more than two participants getting any given sentence wrong.

The reaction time was measured from the onset of the word pair to when the participants responded by pressing 'z' or 'm'. The reaction times for only the correct responses were included in the analysis.

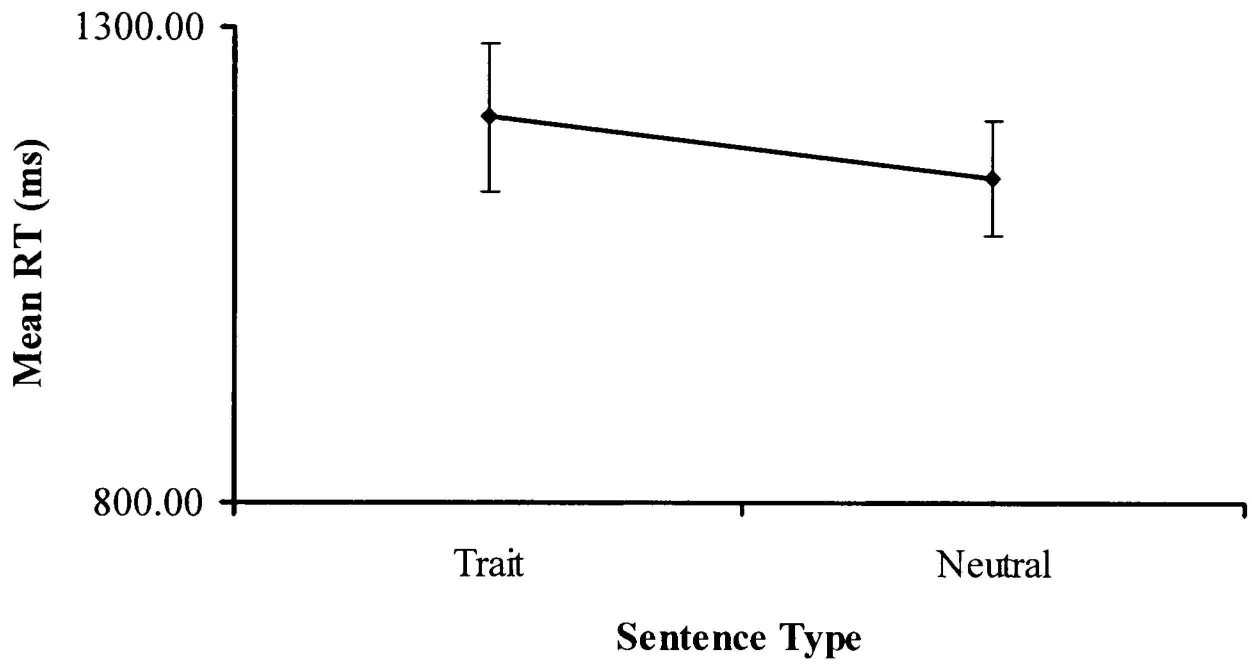
Part 1 of the design compared the reaction times when the sentences were trait implying and the cues were traits (versus distracters) or actions (versus distracters). The mean reaction time for trait cue was 953.15 ms ($SD = 206.45$ ms) and for action cue was 1016.57 ms ($SD = 172.96$ ms). The reaction time data were distributed normally and parametric analysis was carried out. A paired samples t-test revealed that the reaction time for trait cues was significantly less than that for action cues, $t = 2.31, p < .05, d = 0.33$. See figure 4.1. The syllable count and frequency of the group of trait cues and the group of action cues were matched, $t < 1$.

Figure 4.1: Mean Reaction Time (RT) for trait and action cues (experiment 3). The error bars represent the standard error of the mean.



Part 2 of the design compared the reaction times when semantic associate cues were presented with trait sentences and when with neutral sentences. The mean reaction time for semantic associate cue when presented with trait implying sentence was 1206.11 ms (SD = 271.8 ms) and when presented with neutral sentence was 1144.57 ms (SD = 213.07 ms). The reaction time data were distributed normally and parametric analysis was carried out. The reaction time for semantic associate cues did not significantly differ when presented with trait implying and when with neutral sentences, $t < 1$. See figure 4.2. The syllable count and frequency could not have contributed to the results as each semantic associate was presented with its trait implying and neutral sentence equally often between participants.

Figure 4.2: Mean Reaction Time (RT) for semantic associate cue when presented with trait implying sentence and when presented with neutral sentence (experiment 3). The error bars represent the standard error of the mean.



4.2.3 Discussion

The accuracy was found to be at ceiling for the four sentence-cue pairs indicating that the cues were implied in the sentence more strongly than the distracters. The reaction time for trait cues was found to be significantly less than that for action cues which suggests the traits were inferred effortlessly and are easy not just because they were inferred from a global reading. Traits may be a social concept that participants are especially sensitive to which enables faster processing. The reaction time for semantic associate cues was less when presented with neutral sentences than when with trait implying sentences. However the difference was not significant. The current experiment was carried out with a small sample of 12 participants. Hence, though the pattern of raw reaction time data suggests interference from the trait inference, we cannot be certain and replication using a larger sample is warranted. The pattern of reaction time seen in the two analyses cannot be explained in terms of speed-accuracy trade off as being fast on trait cues and semantic associate cues when presented with neutral sentences was not at the cost of more errors in those conditions.

4.3 Experiment 4

Performance of participants with Autism Spectrum Disorders

The stimuli constructed and tested in experiment 3 were used to investigate whether participants with Autism Spectrum Disorders are inferring traits with minimal effort and whether the inferences were made spontaneously even before cues are presented.

4.3.1 Method

Participants

Seventeen participants with a diagnosis that falls within Autism Spectrum Disorders, none of whom had participated in experiment 2, took part in this study. Individuals were only selected as participants if they had been diagnosed by an experienced clinician and met DSM-IV criteria (American Psychiatric Association, 1994) for Autism Spectrum Disorders. Of the seventeen participants, eleven had a diagnosis of high functioning autism and six had a diagnosis of

Asperger's Syndrome. Seventeen participants without Autism Spectrum Disorders were also tested. Those with Autism Spectrum Disorders were recruited from two special schools in Northamptonshire and Shropshire in the U.K. All 34 participants were male native English speakers. Each participant with a diagnosis of Autism Spectrum Disorders was matched individually with a participant in the control group in terms of Chronological Age (CA) and Verbal Intelligence Quotient (VIQ). The VIQ was based on their scores on the vocabulary and similarities subset of Wechsler's Abbreviated Scale of Intelligence (WASI, Psychological corporation, 1999). Independent samples t-tests did not identify any significant difference between participants with Autism Spectrum Disorders and control participants on CA and VIQ, $t < 1$ for both. Table 4.5 displays participants' details.

Table 4.5: Details of participants with Autism Spectrum Disorders (ASD) and participants developing typically (TYP) who took part in experiment 4.

Population	Chronological age			Verbal I.Q			ASSQ		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
ASD	14;96	0.93	13;2-16;4	109.06	16.17	77-139	25.18	8.38	13-36
TYP	14;79	0.67	13;6-15;6	111.82	15.69	86-142	2.33	2.84	0-10

The High functioning Autism Spectrum Screening Questionnaire (ASSQ, Ehlers, Gillberg & Wing, 1999) was administered to all the participants in order to estimate levels of autistic features at the time of testing. The questionnaire was completed by the form tutor of each participant. The group of participants with Autism Spectrum Disorders scored significantly more than the typical group with respect to the ASSQ rating, $t = 10.87, p < .001$. Ehlers *et al.* (1999) suggested 22 as the cut-off for teacher rating and the average rating for the group with Autism Spectrum Disorders falls well above this cut-off, though some (4) with a diagnosis of Autism Spectrum Disorders had a score less than 22.

The participants in each group were divided between the two forms equally.

Apparatus and Stimuli

The apparatus and stimuli used were the same as those described in experiment 3.

Design

This experiment incorporated two separate 2x2 factorial designs. In the first design participants of typical development and participants with Autism Spectrum Disorders were compared on the ease of drawing trait inference by assessing how quickly they responded to trait cues and action cues. Both the cues were presented with trait implying sentences and required integration of the information provided in the description. The within subjects factor was cue type (trait versus action) and the between subjects factor was group (Autism Spectrum Disorders versus typical).

The second design enquired whether participants were slower to respond to a semantic cue when presented with a trait implying sentence due to interference from the trait inference. This was investigated by comparing the reaction time to semantic associate cues when they were presented with trait implying sentences and when with neutral sentences that do not imply a trait. The within subjects factor here was sentence type (trait implying versus neutral) and the between subjects factor was group (Autism Spectrum Disorders versus typical). Of particular interest was whether participants with Autism Spectrum Disorders show interference effect, the presence of which would suggest that the traits were inferred spontaneously before the cues were presented.

The participants however were unaware of the existence of two separate parts to the experiment as all the sentences were presented to the participants in a single session.

Procedure

The procedure described in experiment 3 was followed.

4.3.2 Results

A score of one was given for each correct response. The maximum score was a participant could obtain was 24 (with a maximum of six for each of the four sentence-cue pairs) and both groups performed close to ceiling on the four sentence-cue pairs as shown in table 4.6.

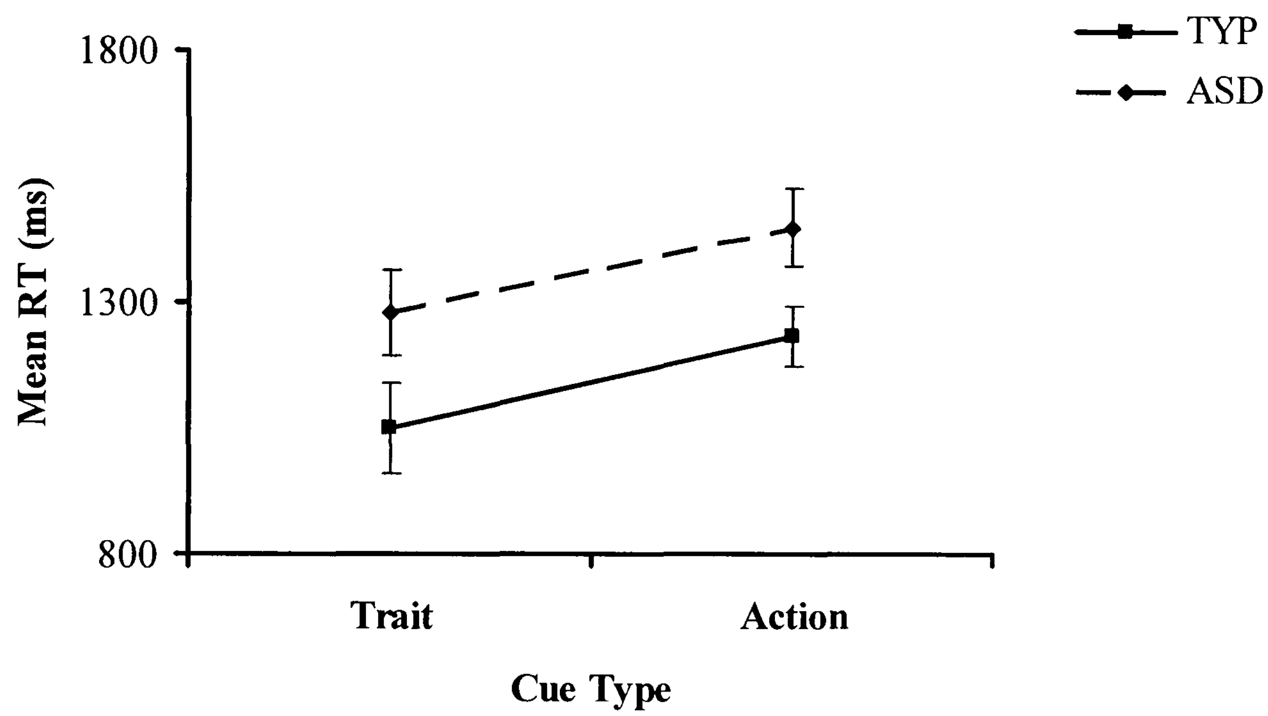
Table 4.6: Percentages of the correct responses (experiment 4)

	Autism Spectrum	Typical
Trait sentence-trait cue	98%	95%
Trait sentence-action cue	94%	95%
Trait sentence-semantic associate cue	81%	84%
Neutral sentence-semantic associate cue	95%	93%

The reaction time was measured from the onset of the word pair to when the participants responded by pressing ‘z’ or ‘m’. The reaction times for only the correct responses were included in the analysis. The distribution of reaction times did not meet the condition for normality and hence the data was submitted to logarithmic transformation and then analysed using two separate 2x2 repeated measures ANOVAs.

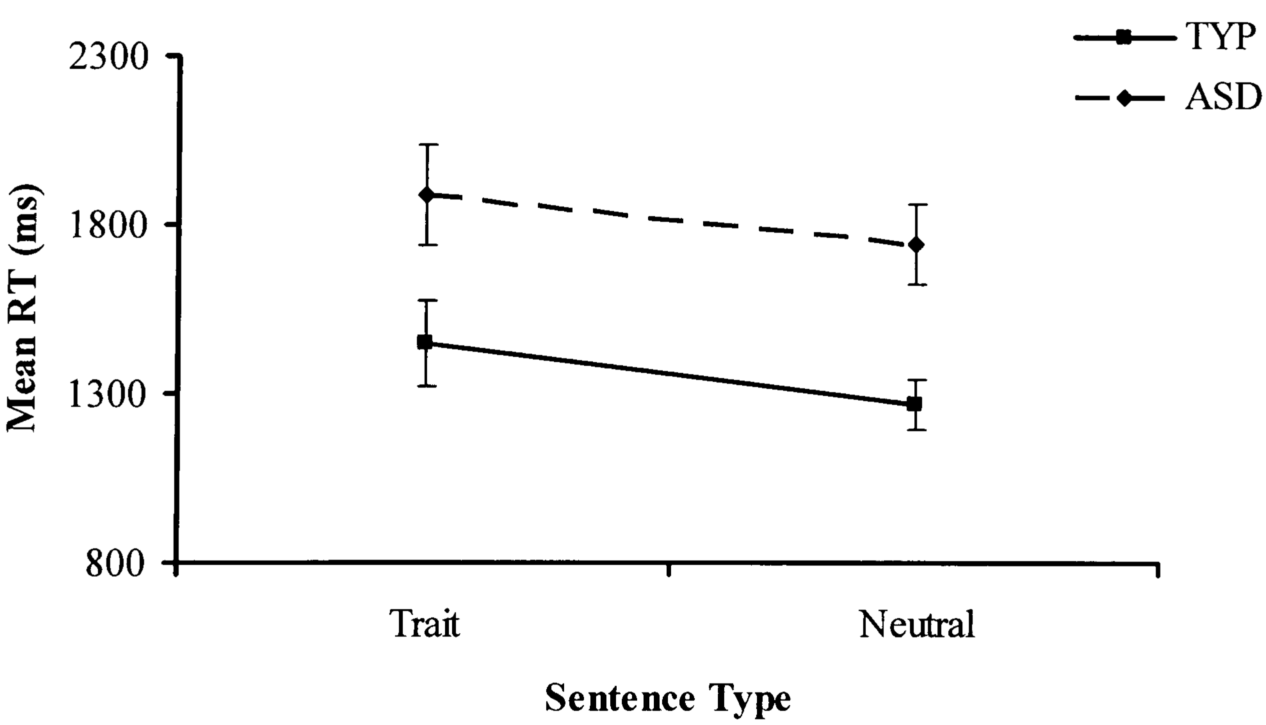
Part 1 of the design compared the reaction times when the sentences were trait implying and the cues were traits (versus distracters) or actions (versus distracters). For the typical participants the mean reaction time for trait cues was 1052.31 ms (SD = 245.77 ms) and for action cues was 1235.29 ms (SD = 371.08 ms). For the participants with Autism Spectrum Disorders the mean reaction time for trait cues was 1280.5 ms (SD = 317.98 ms) and for action cues was 1451.36 ms (SD = 354.71 ms). There was a significant main effect of cue type on reaction time, $F(1, 32) = 31.32, p < .001, f = 0.99$, with the reaction time for trait being less than that for action. There was a significant main effect of group, $F(1, 32) = 5.42, p < .05, f = 0.41$, with the typical group responding faster. There was no significant interaction between cue type and group, $F < 1$. See figure 4.3.

Figure 4.3: Typical (TYP) and Autism Spectrum Disorders (ASD) groups' reaction time (RT) for trait and action cues presented with trait implying sentences (experiment 4). The error bars represent the standard error of the mean.



Part 2 of the design compared the reaction times when semantic associate cues were presented with trait implying sentences and when with neutral sentences. For the typical participants the mean reaction time for semantic associate cue when presented with trait implying sentence was 1448.12 ms (*SD* = 513.05 ms) and 1278.06 ms (*SD* = 311.01 ms) when presented with neutral sentence. For the participants with Autism Spectrum Disorders the mean reaction time for semantic associate cue when presented with trait implying sentence was 1891.52 ms (*SD* = 620.89 ms) and 1750.08 ms (*SD* = 488.63 ms) when presented with neutral sentence. There was a significant main effect of sentence type, $F(1, 32) = 5.34, p < .05, f = 0.41$, and group, $F(1, 32) = 9.43, p < .005, f = 0.54$, but no significant interaction between sentence type and group, $F < 1$. Typical participants were faster than participants with Autism Spectrum Disorders; but both groups showed the same pattern of reaction time - being faster when the sentences were neutral than when the sentences were trait implying. See figure 4.4.

Figure 4.4: Typical (TYP) and Autism Spectrum Disorders (ASD) groups' reaction time (RT) for semantic associate cues when presented with trait sentences and when with neutral sentences (experiment 4). The error bars represent the standard error of the mean.



The reading time for sentences was measured from the moment a sentence appeared on the screen to when the spacebar was pressed. An independent samples t-test revealed no significant difference between the typically developing group and the group with Autism Spectrum Disorders with respect to the reading time, $t < 1$.

4.3.3 Discussion

Both groups of participants, typically developing and those with Autism Spectrum Disorders, were significantly faster on trait cues than action cues. Both these cues require the sentence to be processed for global meaning. This pattern of reaction time suggests that trait inference in particular is easier than action inference, even though both kinds of inference depended on global processing. Hence, these results indicate that participants with Autism Spectrum Disorders are good at inferring traits not just because they required global processing; rather, the relatively effortless processing suggests that they may be especially sensitive to traits despite the need for global processing.

Furthermore, both the typically developing group and the group with Autism Spectrum Disorders were significantly slower on semantic associate cues when they were presented with trait implying sentences as opposed to neutral sentences. Trait inference could have interfered with performance on the task in the former case, thus increasing the reaction time. In the later case such interference would be absent resulting in no impediment to fast performance. This suggests that trait inference is not only effortless but also perhaps made spontaneously on reading the behavioural description, even before the cues were presented.

Frith (2003) suggested that enhanced local feature processing at the expense of impaired global feature processing is a 'cognitive style' in autism and is observed in both higher and lower level tasks. The results obtained in this experiment suggest that all participants, including those with Autism Spectrum Disorders, were attending to the global meaning conveyed in the behavioural description. This does not support weak central coherence in autism at the level of sentences. Possibly, the use of a forced choice response type may have enhanced text processing as suggested by Snowling and Frith (1986).

In experiment 2 participants with Asperger's Syndrome were significantly slower than the participants of typical development. In experiment 4, unlike in experiment 2, participants were given explicit instructions to respond as fast as possible and were also asked to keep their hand on the keyboard throughout the task, ready to respond. Only those who complied with this instruction were included in the study. Still, the participants with Autism Spectrum Disorders were significantly slower than the participants of typical development. The participants were instructed to read the sentence aloud just once before pressing the space bar to investigate whether the participants with Autism Spectrum Disorders had slower reading time. The two groups were not significantly different in terms of the time taken to read the sentences; however the participants with Autism Spectrum Disorders were significantly slower at choosing the correct cue. This does not lend support to the possibility that participants with Autism Spectrum Disorders are generally slower to comprehend.

The clinical picture of Autism Spectrum Disorders is often characterised by motor clumsiness (Campbell & Shay, 2005). Ghaziuddin, Butler, Tsai and Ghaziuddin (1994) reported that children with Autism Spectrum Disorders exhibited problems with motor co-ordination on Bruininks-Osetsky test of fine and gross motor skills. Miyanhara *et al.* (1997) administered the Movement Assessment Battery for children to children with Asperger's Syndrome and reported significant delay on task performance. Rinehart, Bradshaw, Brereton and Tonge (2001) argued that performance on standardised tests of motor performance can be confounded by attentional and intellectual ability. They developed a reaction time based motor reprogramming task which also enabled the researchers to separately analyse movement preparation and movement execution times. The task involved depressing circular buttons in response to illumination of an LED light within each button. Pressing the target triggered the next target to be illuminated. The task involved reciprocally moving left or right as quickly as possible between two target buttons. Once, during a given block of eight trials, an oddball was introduced where the button next to the depressed button but in the direction opposite to expected was illuminated. The programme provided measures of two indices of response times. 'Down time' measures how long a button is held down before the move to the next button was executed. This measure arguably reflects aspects of movement preparation time. 'Movement time' measures the time between the release of one button and the depression of the next and reflects the time taken to execute the planned action. This task was administered to children with Asperger's Syndrome, children with High Functioning Autism and typically developing control children matched on Chronological Age, gender and full scale Intelligence Quotient. The results indicated that children with Autism Spectrum Disorders have a normal ability to execute movements but showed anomalies in movement preparation.

In the experiment described in the previous and this chapter, participants had to execute a motor response depending on which side of the computer screen the cue appeared. This entails a certain amount of motor planning. There is evidence for motor planning and co-ordination difficulty in Autism Spectrum Disorders from clinical descriptions, performance of standardised tests and experimental studies. A motor movement planning deficit could possibly explain why participants with Autism Spectrum Disorders were generally slower than the participants of developing typically.

The pattern of the reaction time of the group with Autism Spectrum Disorders was similar to that of the typically developing group and this pattern suggests that both groups of participants are especially sensitive to traits and thus infer them effortlessly and spontaneously in a way that interferes with their performance on the task when the cue was not a trait. The pattern of reaction time seen in the two analyses cannot be explained in terms of speed-accuracy trade off as being fast on trait cues and semantic associates when presented with neutral sentences was not at the cost of more errors in those conditions. There was no significant difference in the mean frequency and mean syllable count of the trait cue and action cue. Each semantic cue was presented an equal number of times with its trait implying sentence and neutral sentence between participants. Hence, neither could difference in the relative frequency or syllable count of the cues have contributed to the reaction time pattern obtained.

If participants respond quickly to trait cues, then it implies that they experience a strong association between the cue and the sentence. If we conducted an independent test of the degree of association we might find that some trait cues were more strongly associated with the sentences than the action cues. Conversely, we might find that some trait cues were no more associated than action cues. Is it the case that fast responding to trait cues is explained entirely as a high degree of association between cue and sentence or is it the case that participants respond rapidly even to trait cues when they are not perceived to be strongly associated with the sentence? To find the answer we conducted a post hoc survey on the degree of relatedness between the sentence and trait/action cue.

4.4 Post-hoc

<u>Sentence-cue relatedness and reaction time pattern</u>

To test the relative degree of association between the sentence and the trait/action cue a paper and pencil rating scale was constructed. Participants (52 first year psychology students at the University of Nottingham) read the sentences and chose the correct word from the given cue-distracter word pair. The participants also had to rate the chosen word on the degree to which they thought it matched the sentence on a four point scale that ranged from a good match to a perfect match. For each participant half the sentences were presented with a trait cue-distracter word pair and half with an action cue-distracter word pair. Two forms of the rating scale were used so that a given sentence was not presented with both the trait cue and the action cue to the same participant. Between participants, each sentence was presented with its trait cue and action cue equally often.

As expected, participants chose the correct word 100 percent of the time. An independent samples t-test carried out on the mean rating given to a sentence on the implied trait and the implied action revealed that the difference was approaching significance, $t = 1.82, p = .08, d = 0.3$, with the rating for trait ($M = 2.61, SD = 0.26$) being higher than that for action ($M = 2.4, SD = 0.4$). The sentences were ranked based on their independent samples t-test value and effect size comparing its rating for trait and action. The sentences could be divided into two sets, one set where the sentence was rated higher on the trait than the action ($t > 0.5$) and the other where there was minimal difference in the rating it was given for the trait and the action ($t < 0.5$). Table 4.7 shows the ranked sentences along with the respective trait cue and action cue.

Table 4.7: Sentences ranked based on t values comparing its rating on trait and action cues. The cut-off value for t was set at 0.5. The Sentences having a t value below 0.5 show minimal difference in the degree to which the trait and action are implied and those above 0.5 can be said to be biased towards the traits. Two sentences that were biased towards action and one sentence where no significant bias was observed were also grouped with the former sentences.

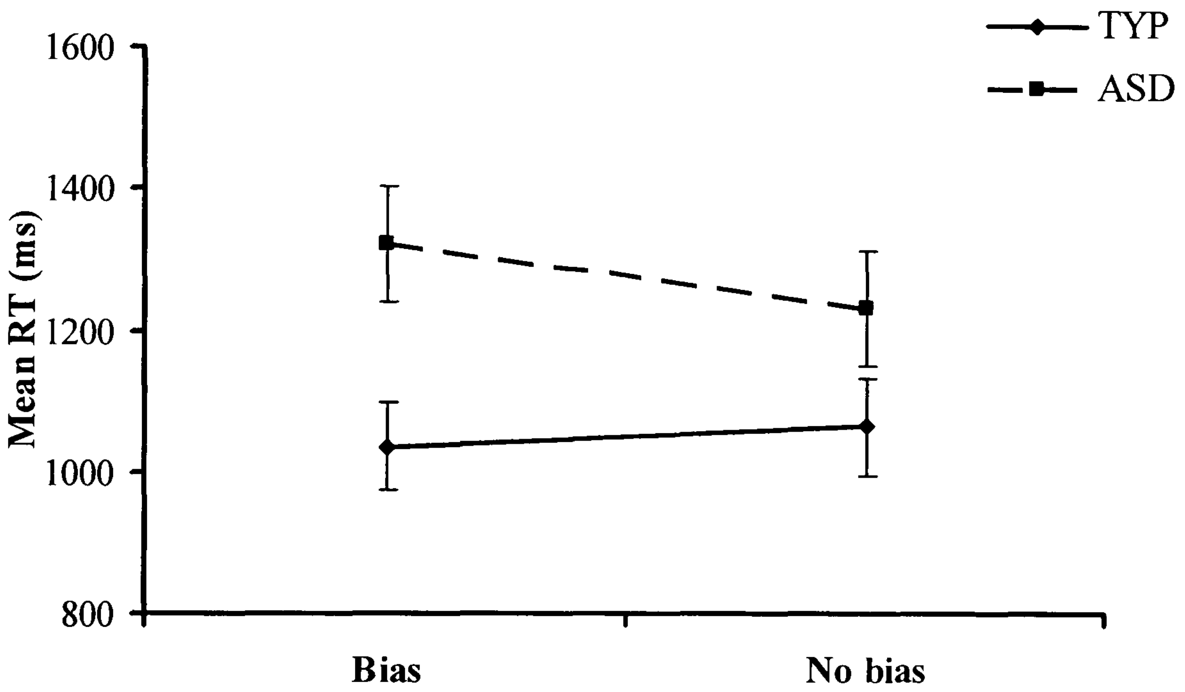
Sentence	Word cues	Difference	t	p	d
He called the newcomers to his house for dinner.	Friendly-Invited	-0.69	-2.59	.01	1.17
He bumped into the cupboard door and hit his nose.	Clumsy-Hurt	-0.04	-0.12	.9	0.1

He ate all the scones without leaving any for his younger brother.	Greedy-Finished	0	0	1	0
He just sat in front of the television the whole day long.	Lazy-Watched	0.04	0.15	.88	0.06
He wore a spotless and well ironed shirt each day.	Tidy-Dressed	0.12	0.43	.67	0.27
He always drove a little below the speed limit.	Careful-Slowly	0.19	0.7	.49	0.43
He looked down when he said hello to his new classmate.	Shy-Greeted	0.31	1,24	.22	0.6
He did not wipe off the sauce that he dropped on his shirt.	Messy-Spill	0.31	1.25	.22	0.6
He left the dinner party without thanking the hostess.	Rude-Went	0.54	1.96	.06	1.02
He usually got all the answers correct in the math class.	Clever-Solved	0.58	2.11	.04	1.07
He carried the office chair with just one hand up three floors.	Strong-Climbed	0.85	3.18	.002	1.85
He took some hot dinner to his ill neighbour.	Kind-Visited	0.88	3.96	0.0002	1.76

Traits were given a significantly higher rating in the first set of sentences in comparison to the second ($t = 2.24$, $p < .05$) whereas rating given to the action cue was not significantly different between the two ($t = -1.23, p > .05$). Thus the first set shows a bias for a stronger trait association than the second set.

If participants were faster on trait cues as a result of their being the more strongly associated cue and not because of the participants being especially sensitive to traits per se, then the reaction time for traits would be significantly less in the biased set in comparison to the non-biased set. The mean reaction time for trait cues in the biased condition for the typical participants was 1064.93 ms ($SD = 282.62$ ms) and 1234.53 ms ($SD = 344.95$ ms) for the participants with Autism Spectrum Disorders. The mean reaction time for trait cue in the no-bias condition was 1035.47 ms ($SD = 256.51$ ms) for the typical participants and 1322.68 ms ($SD = 334.71$ ms) for the participants with Autism Spectrum Disorders. A 2x2 ANOVA was carried out with bias (presence versus absence) being the within subject variable and group (Autism Spectrum Disorders versus Typical) being the between subjects variable. The results indicated no significant main effect of bias, $F < 1$. There was a significant main effect of group, $F(1, 32) = 5.93, p < .05, f = 0.43$, with the typical participants being faster, but the interaction between bias and group was not significant, $F(1, 32) = 1.92, p > .05, f = 0.24$. Hence, the faster response to trait cues cannot be accounted for only in terms of the strength of the cue alone. See figure 4.5.

Figure 4.5: Typical (TYP) and Autism Spectrum Disorders (ASD) groups' reaction time (RT) to trait cues when the sentence set was biased and when not biased towards a stronger trait association (experiment 4, Post-hoc). The error bars represent the standard error of the mean.



The results offered no evidence to suggest that participants responded promptly to trait cues because they were perceived to be strongly associated with the sentence. Instead the results suggest that participants seem compelled to make the trait inference on reading the sentences even when the traits are not perceived to be strongly associated with the sentence.

4.5 Conclusion

Participants of typical development and participants with Autism Spectrum Disorders were attending to the global meaning conveyed by the sentences. They were especially good at traits, inferring them faster than actions. even though both required similar global processing. Furthermore, trait inference apparently was not triggered by the cues. The traits were inferred before the cues were presented, thus, interfering with the task and slowing down the participants when the cue was not a trait. This result cannot be explained by differences in frequency, syllable count or strength of the cue. The participants with Autism Spectrum Disorders were generally slower than participants developing typically. A motor movement planning deficit could possibly explain this difference. The results suggest that participants, including those with Autism Spectrum Disorders, are especially sensitive to traits, inferring them with relatively little effort and spontaneously from textual descriptions of behaviour.

One possibility for participants being especially sensitive to traits could be that traits were explicitly presented as cues in some of the trials. This may have predisposed the participants to infer the traits on reading the sentences. The next experiment investigated whether participants, especially those with Autism Spectrum Disorders, continue to make trait inferences spontaneously even in the absence of explicit presentation of trait cues.

Chapter Five

Does mere comprehension of trait implying sentences result in trait inference?

5.1 Introduction

Attribution theory concerns how the layman understands the cause of others' behaviour. The traditional models of attribution present the layman as a "naïve scientist" who systematically observes and analyses behaviour over many instances before drawing conclusions. Heider's concept of equifinality (1944) suggests that the naïve psychologist would attribute the cause of behaviour to a person's intention when the behaviour leads to identical effects under different conditions. According to Jones and Davis's (1965) Correspondence Inference Model, correspondence between action and intention or disposition increases as the non-common effects (unique to the particular action) and universal desirability of effects decreases. Kelly's Covaraition Principle (1973) conceives of the causal attribution made by people as being about the person, the entity or the circumstance depending on which of the causes the person finds the effect covaring with. Thus, based on traditional models of attribution traits are comprehended based on logic rather than intuition. As discussed in Chapter Two this implies that trait inference may be a spared socio-cognitive function in Autism Spectrum Disorders. However, one criticism of traditional models of attribution is that they do not describe what happens in real life. In reality, impressions are made rapidly, without the necessary information or the cognitive resources required for carrying out complicated inferential processes, and rarely as a result of instructions or an explicit aim.

Asch (1946) talks about the remarkable rapidity and great ease with which impressions are formed and Kelly (1973) suggested that people use "causal schemata", a general learned conception about how certain kinds of causes interact to produce a specific kind of effect, in most everyday attributions. However, the automatic nature of impression formation was never portrayed in the traditional models. It was only in the late 1970's that models of attribution started presenting impression formation as consisting of both automatic and controlled processes interacting with one another. Furthermore, researchers suggested that it was the automatic aspect of a process that determined its ecological validity. The frequency of occurrence of a psychological process is more in real life when it occurs without the person intending to engage in the particular process (Uleman, 1999; Winter & Uleman, 1984). For example, we would engage in impression formation far more often if the only condition required for the process to be triggered was the presence of behaviour. If so, we would automatically form impressions every time a person exhibits relevant behaviour. If apart from the presence of a person exhibiting relevant behaviour, we must intend to form impression and need to have sufficient attentional resource then the process would occur less frequently. After all, we may not want to form impressions of every person we meet or have the resource to do so with each person.

5.1.1 Automatically coding behaviour in terms of trait

Researchers have consistently found that people automatically code behaviour in trait terms. Gilbert, Pelham and Krull's (1988) model of disposition inference identifies three processes - categorisation, characterisation and correction. First, the stimulus is identified and categorised in terms of behaviour, situation, and disposition (Trope, 1986). Categorisation is followed by characterisation which involves drawing dispositional inference about the actor. Finally, the inference made is adjusted based on information available about situational constraints. Gilbert *et al.* (1988) contended that of the three stages, categorisation and characterisation are relatively automatic processes whereas correction is more deliberate, relatively controlled and uses a significant portion of the perceiver's processing resources. If this is the case, "cognitive busyness" would not affect our ability to draw dispositional inferences from behaviour (characterisation), but would disable our ability to use situational information to correct the inferences. In order to test this Gilbert *et al.* (1988) showed silent videotapes of a female target having a discussion with a stranger. In five of seven clips the target was seen to behave anxiously. Half the participants were told that in these five clips the target was discussing anxiety inducing topics. The other half of the participants were told that all topics were relaxation inducing. All participants were informed that they would be asked to make judgements about the target's personality (regarding state and trait anxiety). Participants in both conditions were divided into two groups. The cognitive resource of one group was taxed as, apart from having to make personality judgements, they were also asked to memorize the seven different topics discussed. The topics of discussion were presented in writing at the beginning of each video clip. Results indicated that while the passive perceivers (who did not have to do the memory task) used information about the situation provided by the discussion topics to correct their inferences, the active perceivers did not, despite the fact that they were more likely to remember the discussion topics. As hypothesised, having a heavier cognitive load was not found to affect the task of characterising the behaviour and person but did affect the ability to make corrections to the inferences based on the information provided about the situation. Thus, participants were able to attribute traits to the behaviour and the person even when their attentional resource was limited, suggesting that trait inference is an automatic process.

Spontaneous Trait Inferences are said to occur when attending to another person's behaviour produces a trait inference in the absence of any explicit intention to infer traits or to form an impression of that person (Uleman, Newman and Moskowitz, 1996). Initial studies on Spontaneous Trait Inferences employed a cued recall paradigm based on Tulving and Thompson's (1973) encoding specificity principle (for example, Winter & Uleman, 1984; Winter, Uleman & Cunniff, 1985). Participants studied trait implying sentences for a later memory test. Recall was compared under three cueing conditions - no cue, trait cue and semantic cue. Semantic cues were related to the actor who was designated by his occupation (for example, the semantic cue for the sentence 'The decorator tells the dentist all about her neighbour's habits' was 'interior') or the verb in the sentence ('talk' for the example given above). If traits were inferred spontaneously when the sentences were comprehended then the inferred trait would be stored in memory along with the respective sentence and act as a good retrieval cue for the sentence. The occurrence of such a process would be evident if the trait, though not a strong semantic associate of the sentence, were as effective as a retrieval cue as a strong semantic associate. This was indeed the case even when the sentences were presented as distracters to the focal task of remembering digit sequences. Winter, Uleman & Cunniff (1985) also tested the participant's awareness of making trait inferences while they memorised the sentences. Following the presentation of the last sentence, the participants were asked to report what he or she thought about while reading it. They rated how much they had thought about visual images, word associations, who caused the event in the last sentence, and the actor's personality or personal qualities on 11-point scales. Awareness of making dispositional inferences was only weakly correlated with disposition-cued recall.

Occurrence of Spontaneous Trait Inference has been demonstrated using different paradigms, a few which are discussed here. Uleman, Hon, Roman and Moskowitz (1996) used a recognition probe paradigm to study Spontaneous Trait Inference. Participants read paragraphs of various lengths at the end of which a single trait word was presented. The participants had to decide whether the word was literally presented in the preceding paragraph or not. Some of the paragraphs were trait implying while others were neutral. If participants, on reading trait implying paragraphs, were inferring the traits spontaneously then the trait word would be active while the participants made their decision. The activated trait concept would make it harder for the participants to reject a probe, which was implied but not actually presented. This would be evident in more errors and increased reaction time when the probe followed a trait implying paragraph than a neutral paragraph, as similar activation would be absent in the latter case. Results indicated that participants were indeed making Spontaneous Trait Inference.

Another paradigm used to study Spontaneous Trait Inference is the lexical decision paradigm. Zarate and Uleman (1994) asked participants to decide as quickly as possible whether a string of letters is a word. Sometimes the letters (forming a trait word) followed a trait implying sentence and at other times it followed a neutral sentence. If participants were forming Spontaneous Trait Inference, they would be faster when the string of words followed a trait implying sentence than a neutral sentence. This was a result of the inference possibly acting as a prime, making the decision easier when the letter strings corresponded to the implied trait. The results obtained by Zarate and Uleman (1994) supported Spontaneous Trait Inference.

In a relearning paradigm used by Carlston and Skowronski (1994) participants were presented with photographs of people paired with self descriptive statements that implied traits. After a period of time the same participants attempted to learn photo-trait word pairs. Half of the photo-trait word pairs were presented at time 1 (relearning pairs). Of course, the trait word was only implied in the self description at time 1. The other half of the photo-trait word pairs were novel. Finally, participants viewed the photographs and tried to recall the paired traits. The recall for the relearning pairs and the novel pairs was compared. It was observed that participants recalled the trait word for the relearning pairs better than the novel pairs. This was irrespective of whether participants were told to "form an impression" or "familiarise themselves with the material" at time 1. This is taken as evidence that participants were forming impressions at time 1 even when there was no obvious reason to do.

Thus, there is compelling evidence that typical individuals automatically - without intention (Winter & Uleman, 1984), with minimal awareness (Winter, Uleman & Cunniff, 1985) and with diminished resources (Gilbert *et al.*, 1988) - process behavioural information in terms of traits. Spontaneously categorizing behaviour in trait terms serves as the foundation on which conscious inferences can be made when need arises. Even though individuals draw trait inferences in the absence of current goals, Spontaneous Trait Inference serves the distal goal of much human psychological functioning which deals with search for meaning and understanding of the social world (Uleman *et al.*, 1996).

In experiment 4, trait words were cues in only 25 percent of the trials, so that making trait inferences would actually hinder performance in a majority of the trials. Still participants, on reading the sentences, seemed to spontaneously draw trait inferences and appeared unable to inhibit making these inferences. However, it may be that explicitly presenting the trait cues, even in a minority of trials, predisposed the participants to infer the traits on reading the sentences. In other words, participants may not have inferred the traits had they never been rewarded for it in any trial. Thus, spontaneousness of the inference may have been as much the function of the trait cue as the trait implying sentences. In the current experiment, trait cues were removed and trait implying and neutral sentences were presented with action cue-distracter word pairs and semantic associate cue-distracter word pairs. Under these conditions trait inference could only be stimulated as a result of the nature of the sentences alone. The aim of the experiment was to assess whether participants (particularly those diagnosed with Autism Spectrum Disorders) continue to interpret the behaviour described in the sentences in terms of traits although participants had no intention or reason to do so. The sentence-cue combinations used are illustrated in table 5.1.

Table 5.1: Sentence-cue pairs used in experiment 5

	Semantic associate-Distracter	Action cue- Distracter
Trait implying sentence	√	√
Neutral sentence	√	√

5.1.2 Interference as a measure of automaticity

Stroop experiments are often employed in studies on automaticity and control. In Stroop experiments multidimensional stimuli are used, for example, the word *red* written in blue. Participants are instructed to report one of the dimensions while ignoring others. The degree to which the ignored dimension interferes with the main task, indicated by increased response time latencies or errors, is taken as an index of the degree to which attention is drawn to the irrelevant dimension uncontrollably and without intention. Pratto and John (1991) tested whether attention was directed to negatively evaluated stimuli by presenting desirable and undesirable personality trait adjectives like *honest* and *sadistic* to subjects who had to name the colour in which the adjectives were presented. As hypothesised, although participants had no intention or reason to do so, they attended to the undesirable traits more than to the desirable traits. The additional attention led to relatively longer response latencies for the undesirable traits.

In the current experiment, as in experiment 4, the reaction times were analysed to test for interference when the sentences were trait implying. Presence of interference would be evident if the time taken to select the correct cue was more when the sentence was trait implying than when the sentence was neutral. Presence of interference would suggest that as with the stroop tasks participants were presumably unable to ignore the irrelevant trait dimension of the stimuli when the sentences were trait implying. This would presumably increase the time taken to respond. In the case of neutral sentences the irrelevant and attention-grabbing trait dimension was absent and hence there would be no impediment to fast performance.

Unlike in experiment 4, the current experiment did not present trait words as cues in any trial. But for the fact that the behaviour described 'implied' traits, there was no explicit reason for participants to infer traits. In fact, making trait inferences presents an obstacle to quick responding in all trials. Thus, the presence of interference in the current experiment would suggest that participants were compelled to code the behaviour described in trait terms, even when there was no reason for or benefit from doing so.

5.2 Experiment 5

Stimuli construction - Pre-testing

The stimuli consisted of four types of sentence-cue pairs as illustrated in table 5.1. Twelve semantic associate cues to be presented with trait implying and its corresponding neutral sentences and 12 action cues to be presented with a separate set of trait implying and neutral sentences were constructed. The trait implying and neutral sentences chosen for the experiment were considered to be so by at least 68 percent of the pre-test participants described in experiment 3.

Experiment 3 (Post-hoc) revealed that the strength of association between the cue and the sentence could vary. In this experiment a pre-test was carried out to ensure that the degree of association of the action cues did not differ significantly when the sentences were trait implying and when they were neutral.

Forty typical participants, who were studying for an undergraduate course in psychology at the University of Nottingham, read the sentences and chose the correct word from the given cue-distracter word pair. The participants also rated the chosen word on the degree to which they thought it matched the sentence on a four point scale that ranged from a good match to a perfect match. Half the participants were presented with the trait implying sentences and the other half with the neutral sentences so that each participant rated the action cue for either trait implying sentences or neutral sentences alone. The data were collected at the beginning of a lecture. There were 12 trait implying and 12 neutral sentences. Accuracy was 100 percent indicating that the cues were implied by the sentence. An independent samples t-test did not identify any significant difference in the degree to which the action cues were associated with the trait implying and neutral sentences, $t < 1$.

Performance of participants with Asperger's Syndrome and chronological age and verbal IQ matched controls

5.2.1 Method

Participants

Sixteen adult participants with a diagnosis of Asperger's Syndrome (fifteen males and one female) took part in the current experiment. Individuals were only selected as participants if they had been diagnosed by an experienced clinician and met DSM-IV criteria (American Psychiatric Association, 1994) for Asperger's Syndrome. Sixteen participants without Asperger's Syndrome were also tested. None of the participants had taken part in any of the earlier experiments. Those with Asperger's Syndrome were recruited from a specialist college for individuals with Asperger's Syndrome in Somerset, U.K. All 32 participants were native English speakers. The two groups were matched in terms of Chronological Age (CA), Verbal Intelligence Quotient (VIQ) and gender. The VIQ was based on their scores on the vocabulary and similarities subset of Wechsler's Abbreviated Scale of Intelligence (WASI, Psychological corporation, 1999) and independent samples t-tests did not identify any significant difference between participants with Asperger's Syndrome and control participants on CA and VIQ, $t < 1$ for both. Table 5.2 displays participants' details.

Table 5.2: Details of participants with Asperger's Syndrome (AS) and typical participants (TYP) who took part in experiment 5

Group	Males	Females	CA (Years/Months)			VIQ		
			Mean	SD	Range	Mean	SD	Range
AS	15	1	17;8	1;2	16;3-20;6	107.5	11.13	87-125
Typical	15	1	17;8	1;4	16;5-20;8	106.81	11.74	78-125

Apparatus and Stimuli

The experiment was programmed and presented using E-Prime on an Acer Aspire 1522WLMi laptop with 15.4" widescreen.

The stimuli consisted of four types of sentence-cue pairs. The experimental trial consisted of 12 semantic associate cues presented with trait implying and its corresponding neutral sentences and 12 action cues presented with a separate set of trait implying and neutral sentences. The 12 traits implied were friendly, clever, honest, tidy, helpful, kind, rude, lazy, careless, greedy, forgetful and shy. The first six traits have positive valance (generally considered desirable) and the rest have negative valance (generally considered undesirable). All the traits have been used in the previous experiments described in this thesis. As shown in Appendix E some of the sentences were new. Examples are given in table 5.3.

Table 5.3: Examples of the stimuli used in experiment 5. The underlined words are the associates of the semantic associate cue. The semantic cues were taken from the Edinburgh Associative Thesaurus, available online.

Trait implying (Implied trait)	Neutral	Cue- Distracter
He told the teacher that he broke the window. (Honest)	He told the teacher about the window that was stuck	reported-appeared (action)
He did not offer his seat to the old lady on the crowded bus. (Rude)	He sat next to an old lady on the crowded bus.	ticket-forests (Semantic associate)

All the cue-distracter word pairs were matched for frequency (MRC Psycholinguistic Database was used as adult participants were recruited for the current experiment), syllable count, word length as well as word type (verb or noun). All the sentences and the cue-distracter pairs were presented in 18 point Times New Roman font in the centre of the computer screen. The stimuli were presented in black font on a white background.

The cue-distracter word pairs were separated by 19.5cms. See Appendix E for the full set of stimuli used in experiment 5.

Two forms of the experiment were constructed, with each form consisting of 24 trials, six trials from each of the four sentence-cue pairs, so that a trait implying sentence and its corresponding neutral sentence were not in the same form. Each cue was presented with its trait implying and neutral sentence an equal number of times between participants.

Design

This experiment incorporated two separate 2x2 factorial designs, enquiring whether traits were inferred on reading textual descriptions of behaviour although participants had no intention or reason to do so. The first design enquired whether participants were slower to respond to semantic cues and the second design enquired whether participants were slower to respond to action cues, when presented with a trait implying sentence than with a neutral sentence. In both parts, the within subjects factor was sentence type (trait implying versus neutral) and the between subjects factor was group (Asperger's Syndrome versus typical). The participants were unaware of the existence of two separate parts to the experiment as all the sentences were presented in a single session.

Procedure

The participants were tested individually in a quiet room. The participants were assigned to the two forms using systematic allocation, so that the first participant who was tested did form 1, the second did form 2, the third did form 1, and so on till the final participant. The participants sat half a metre from the laptop and were told that the study deals with "aspects of reading ability". They were instructed (both verbally and textually) as follows; "You will be shown some sentences one by one on the computer screen. Read the sentence aloud once and press the space bar. The sentence will disappear and two words will appear on the screen, one on the left and one on the right. Your task is to match the word that best relates to the sentence that you have just read by pressing z if you think it is the word on the left and m if you think it is the word on the right." The participants were also explicitly told, "Keep your hands on the keyboard throughout the task and try to respond as fast and as accurately as you can".

After ensuring that participants were successful with the practice trials, the experimental sentences were presented. The sentences appeared in a different random order for each participant. The procedure was self paced and there was a blank screen for 1500 milliseconds between the sentence disappearing (when the spacebar was pressed) and the onset of the words. The keys that were to be used, namely the spacebar, keys 'z' and 'm' were highlighted. The program was also set so that all the keys except for these were locked.

In the practice session participants were presented with a trait sentence-action cue pair and with a neutral sentence-semantic associate cue pair. In the experimental trials, each participant was presented a random order of 24 trials consisting of six trials each from the four sentence-cue combinations. Which six sentence-cue pair from each combination was presented varied between participants depending on which experimental form was presented. A trait implying and its corresponding neutral sentence were not presented to the same participant and all 48 stimuli were presented an equal number of times between participants.

5.2.2 Results

A score of one was given for each correct response. The maximum score a participant could obtain was 24 (with a maximum of six for each of the four sentence-cue pairs). Both groups performed close to ceiling for all four sentence-cue pairs as shown in table 5.4.

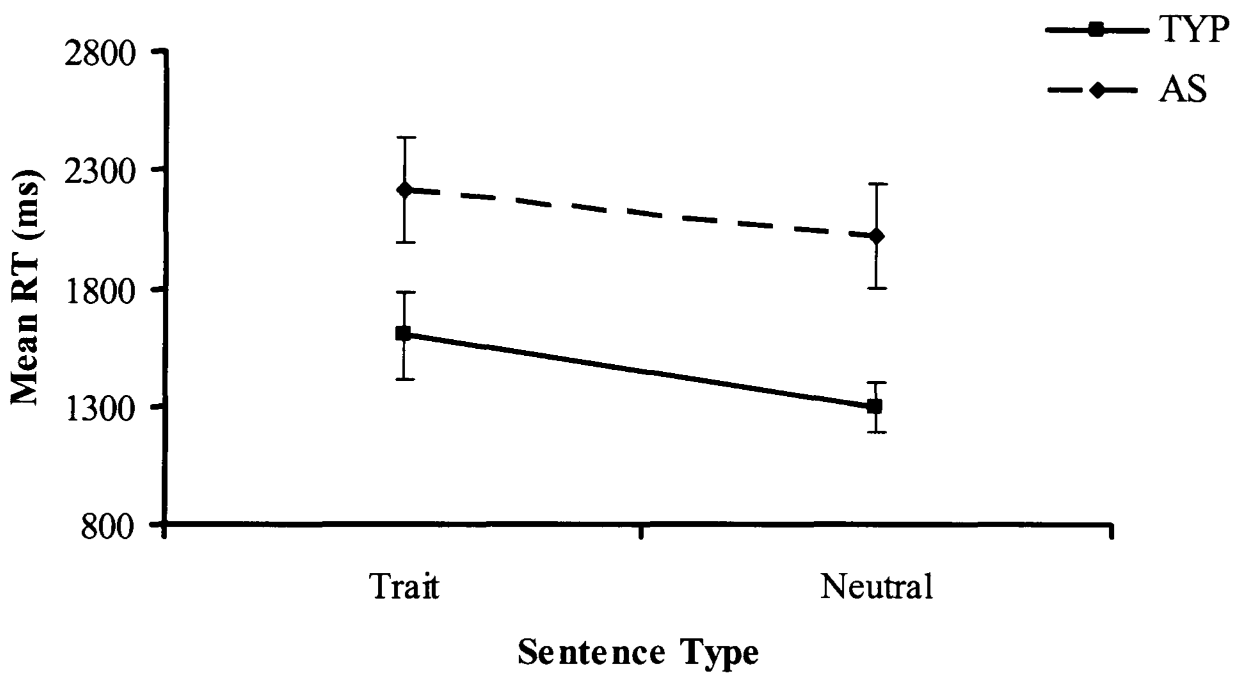
Table 5.4: Percentages of the correct responses (experiment 5)

	Asperger's	Typical
Trait sentence- semantic associate cue	93%	98%
Neutral- semantic associate cue	90%	98%
Trait sentence-action cue	98%	98%
Neutral sentence-action cue	98%	100%

The reaction time was measured from the onset of the word pair to when the participants responded by pressing 'z' or 'm'. The reaction times for only the correct responses were included in the analysis. The distribution of reaction times did not meet the condition for normality and hence the data was submitted to logarithmic transformation and then analysed using two separate 2x2 repeated measures ANOVA.

The first part of the design compared the reaction time for semantic associate cues for trait implying and neutral sentences for participants with Asperger's Syndrome and typically developed participants. The mean reaction time of the typical participants for semantic associate cue when presented with trait implying sentence was 1599.57 ms (SD = 742.61 ms) and when presented with neutral sentence was 1298.91 ms (SD = 424.32 ms). The mean reaction time of the participants with Asperger's Syndrome for semantic associate cue when presented with trait implying sentence was 2215.61 ms (SD = 883.84 ms) and when presented with neutral sentence was 2025.93 ms (SD = 900.1 ms). There was a significant main effect of sentence type on reaction time, F (1, 30) = 15.51, $p < .001$, f = 0.72, with the reaction time for trait implying sentences being longer than that for neutral sentences. There was a significant main effect of group, $F(1, 30) = 8.33, p < .01, f = 0.53$, with the typical group responding faster. There was no significant interaction between cue type and group, $F(1, 30) < 1$. See figure 5.1.

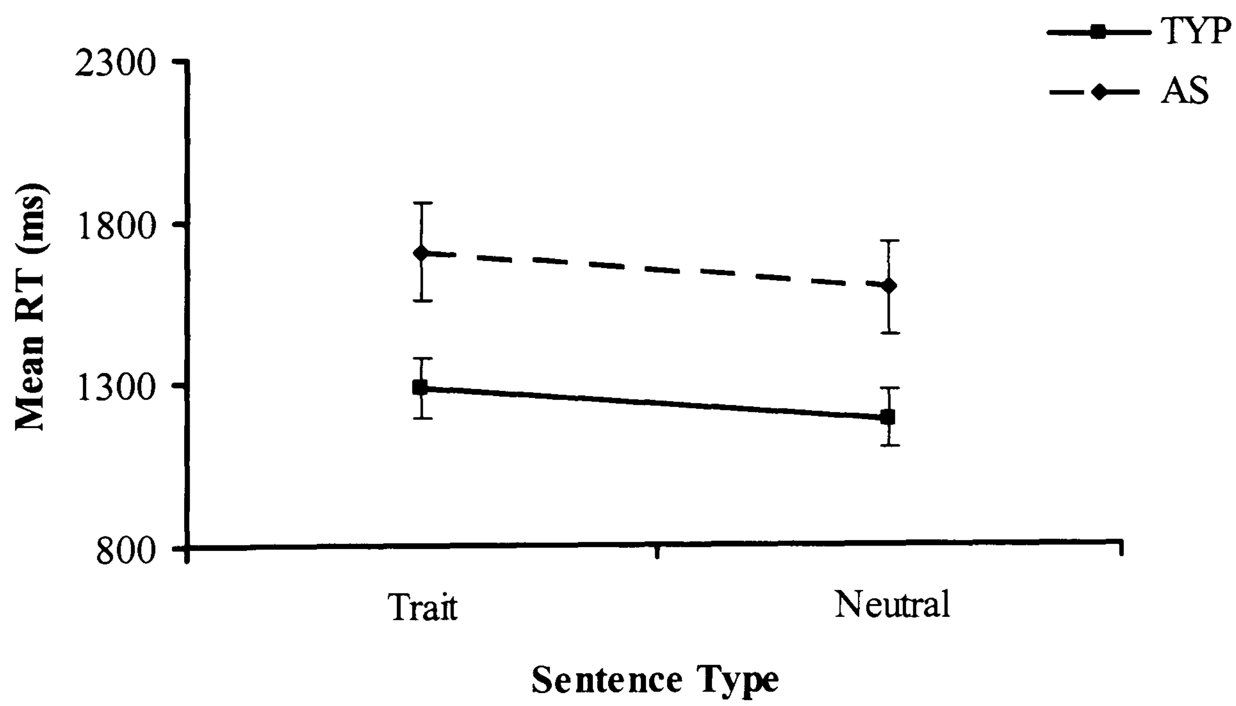
Figure 5.1: The mean reaction time (RT) of typical participants (TYP) and participants with Asperger's Syndrome (AS) for semantic associate cue when presented with trait implying and neutral sentence (experiment 5). The error bars represent the standard error of the mean.



The second part of the design compared the reaction time for action cues for trait implying and neutral sentences for participants with Asperger's Syndrome and typically developed participants. The mean reaction time of the typical participants for action cue when presented with trait implying sentence was 1284.71 ms (*SD* = 371.03 ms) and when presented with neutral sentence was 1190.09 ms (*SD* = 355.02 ms). The mean reaction time of the participants with

Asperger's Syndrome for action cue when presented with trait implying sentence was 1706.6 ms (*SD* = 597.24 ms) and when presented with neutral sentence was 1592.83 ms (*SD* = 561.81 ms).There was a significant main effect of sentence type on reaction time, $F(1, 30) = 6.22, p < .05, f = 0.45$, with the reaction time for trait implying sentences being longer than that for neutral sentences. There was a significant main effect of group, $F(1, 30) = 6.64, p = .01, f = 0.47$, with the typical group responding faster. There was no significant interaction between cue type and group, $F < 1$. See figure 5.2

Figure 5.2: The mean reaction time (RT) of typical participants (TYP) and participants with Asperger's Syndrome (AS) for action cue when presented with trait implying and neutral sentence (experiment 5). The error bars represent the standard error of the mean.



5.2.3 Discussion

The accuracy of participants with Asperger's Syndrome and participants of typical development was close to ceiling on the four sentence-cue pairs. The participants with Asperger's Syndrome were significantly slower than participants of typical development. As discussed in Chapter Four this could be explained in terms of a motor movement planning deficit. The pattern of reaction time was similar in both groups of participants. Both groups were faster at responding when the sentences were neutral than when the sentences were trait implying. This was so when the cue was a semantic associate and when the cue was an action.

In the current experiment, as in the previous, the participants were told that the study investigated "aspects of reading ability" and hence presumably they were unaware of the social nature of the task. Furthermore, traits were not presented as cues in any trials, which may have primed participants to make trait inferences in the previous experiments. Thus, there was no reason for or benefit from making trait inferences. Despite that, it seemed participants continued to infer traits spontaneously on reading the trait implying sentences, without intention. Like in stroop tasks, participants were presumably unable to ignore the irrelevant trait dimension of the stimuli when the sentences were trait implying. This probably explains the increased time taken to respond. In the case of neutral sentences the irrelevant and attention grabbing trait dimension was absent and hence responding was not hindered. The pattern of reaction time seen in the two analyses cannot be explained in terms of speed-accuracy trade off as being fast when the sentences were neutral was not at the cost of more errors in that condition. Neither can differences in the strength of association between the cues and the sentences or frequency and syllable count of the cues used with trait implying and neutral sentences explain the pattern of reaction time, as each cue was presented with both the trait and the neutral sentence an equal number of times.

5.3 Conclusion

The frequency of occurrence of a psychological process is more in real life when it occurs without the person intending to do so (Uleman, 1999; Winter & Uleman, 1984). The results obtained in the current experiment provide indirect evidence that participants infer traits when comprehending trait implying sentences even in the absence of any intention to do so. Since participants were told that the study deals with "aspects of reading ability", they were presumably unaware of the social nature of the task. Since trait cues were not presented in any of the trials there was no reason for or benefit from making trait inference either. If Uleman (1999) is correct, this is a sign that participants, including individuals with Autism Spectrum Disorders, readily and frequently make trait inferences in the real world.

The only requirement for the traits to be inferred was that the participant attend to and be motivated to comprehend the meaning of the information (behaviour) presented. Coding the information in relation to traits hindered performance in every trial. Possibly, the participants were unable to ignore the trait dimension and thus inhibit drawing the inference, even though it was irrelevant to the task. Hence, the trait inference observed can be considered to be the unintended consequence of the intended comprehension of the sentence. It reflects what Bargh (1989) referred to as an "unintended side effect of another intended process".

Chapter Six

Do individuals with Autism Spectrum Disorders associate the inferred trait with the actor?

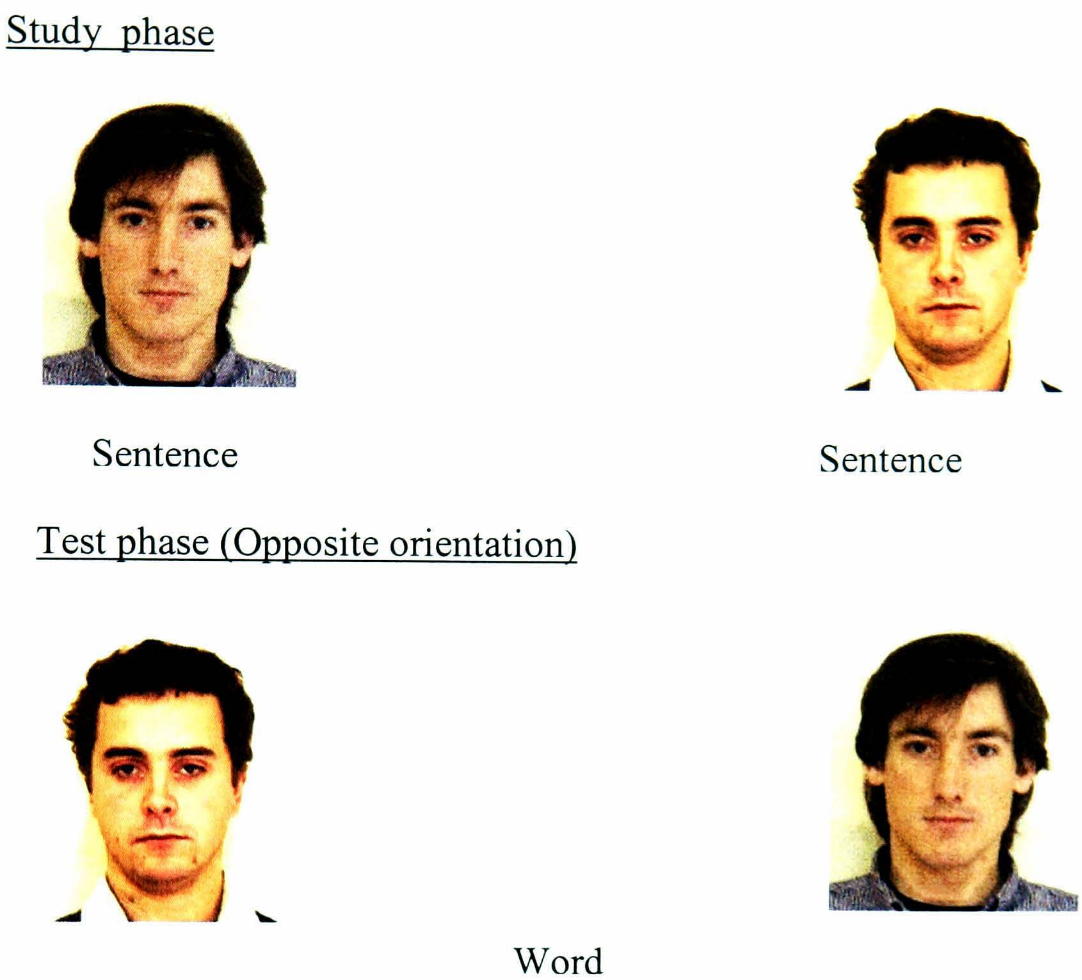
6.1 Introduction

Results from experiments 4 and 5 suggest that individuals with Autism Spectrum Disorders infer traits spontaneously, with minimal effort and in the absence of reason for or benefit from making the inference. In other words, participants presumably inferred the traits implied in the behavioural descriptions even though they did not intend to do so. The frequency of occurrence of a psychological process is more in real life when it occurs without the person's intention (Winter & Uleman, 1984; Uleman, 1999). This suggests that participants, including individuals with Autism Spectrum Disorders, probably make trait inferences readily and frequently in the real world. But what does the trait relate to? The inference 'clumsy' drawn on reading the sentence, "He slipped on the rug and twisted his ankle" could be about the action or the person carrying out the action (actor). Being able to infer traits might not be of much practical use unless the traits are associated with the actor. People regard traits as a relatively stable and enduring characteristic of a person. A person attributed as having a particular trait is expected to behave consistently with the trait across time and across situations. Attributing a trait to a person serves the social function of making predictions about his or her future behaviour. For this purpose the inferred trait should be linked to a representation of the actor. The representation chosen should enable us to distinguish the actor from other people (of the same age and gender, for example) and thus allow us to predict how his/her behaviour would differ from those of other people. Faces are a perceptually salient and relatively stable representation of a person (Todorov & Uleman, 2004). Furthermore they are unique, unlike a person's gender, colour and attire. Being stable and unique makes faces an ideal representation of the actor in attributional processes. Hence the current study investigated whether individuals with Autism Spectrum Disorders identify people, represented by frontal photographs of their faces, based on traits implied in behavioural descriptions provided about them.

6.1.1 The paradigm

A forced choice reaction time paradigm was used in this study. Each experimental trial consisted of a 'study phase' and a 'test phase'. In the study phase a pair of colour photographs (frontal view of the face, chosen from a database developed in the School of Psychology, University of Sterling, which is available online) of Caucasian males was presented along with a single sentence description of each person. In the test phase the same pair of photograph was presented, either in the same or in the opposite spatial orientation as in the study phase, with a single word (see figure 6.1). The word was implied in the description of one of the person in the pair. The participants were required to identify the person the word best described based on the information provided in the study phase.

Figure 6.1: Illustration of the two phases in experiment 6 and 7



This paradigm is a modification of one used by Todorov and Uleman (Experiment 4, 2004) to study whether Spontaneous Trait Inference is related to the person who performed the behaviour or restricted to classifying the behaviour. In Todorov and Uleman's (2004) experiment, the study phase consisted of 36 trials in which participants were presented with pairs of faces and trait implying sentences similar to the illustration of the study phase in figure 6.1. In some cases the traits were implied (for example, 'Judith picked out the best chocolates before the guests arrived') and in others the traits were literally present in the sentence (for example, 'Tom was so aggressive that he threatened to hit her unless she took back what she said'). The test phase, which followed the 36 trials, showed the faces individually from the first part accompanied by a single word (trait). Participants had to decide whether the word was part of the sentence presented specifically about the person shown. The authors argued that if Spontaneous Trait Inference is about the person carrying out the behaviour then the participants would be more likely to recognize the implied trait and recognize the explicitly presented traits in the context of the actor's face than the control face (the other face in the pair). Analysis of reaction time and errors showed that traits were associated spontaneously with the actor carrying out the behaviour. In other words, participants seemed to draw inferences about the kind of person the actor is and not just what kind of behaviour the actor carried out, without intending to do so.

Todorov and Uleman (2004) used a memory-based recognition probe paradigm as they were interested in the spontaneousness with which inferred traits are associated with the actor. Given the evidence for difficulty with face recognition in Autism Spectrum Disorders (discussed later), our interest in this study was whether participants with Autism Spectrum Disorders were able to use trait information to differentiate and identify people. This ability can be viewed as the minimum necessary requirement for the inferred trait to be applied in social perceptual processes to make predictions about future behaviour. For this purpose we modified Todorov and Uleman's (2004) paradigm so that each trial consisted of a study phase immediately followed by the test phase.

The information provided by the sentences was of two types - traits and facts. Facts referred to relatively concrete characteristics of the actor like physique (*tall*) and occupation (*waiter*). Traits, on the other hand, referred to more abstract mental characteristic like *rude* and *clever*.

6.2 Experiment 6: Pre-test

The stimuli were pre-tested to ensure that the sentences implied the intended trait or fact. A rating scale questionnaire was developed in which each item consisted of a face paired with a sentence. The pre-test participants were asked to rate the person shown on the trait or fact implied in the sentence, which shall be called the “target characteristic”. They were also required to rate a trait/fact about which no information was given, called the “random characteristic”.

The face database used did not provide information about the actors’ age and hence the pre-test participants were asked to guess the age of the person shown in the picture. This information was used to ensure that the face pairs used in the main experiment were matched on age.

Figure 6.2 illustrates items from the rating scale. In the first example (A), *forgetful* (trait) is the target characteristic and *sick* (fact) is the random characteristic. In the second example (B) *non-smoker* (fact) is the target characteristic and *friendly* (trait) is the random characteristic.

Figure 6.2: Two items used in the rating scale.

A

He left his bag of groceries on the bus.

Forgetful — Does not apply at all ... Applies very well

1 2 3 4 5 6 7 8 9 10

Sick — Does not apply at all ... Applies very well

1 2 3 4 5 6 7 8 9 10

Age ________

B

He is six and a half feet in height.

Tall — Does not apply at all ... Applies very well

1 2 3 4 5 6 7 8 9 10

Careful — Does not apply at all ... Applies very well

1 2 3 4 5 6 7 8 9 10

Age ________

Traits and facts were paired randomly ensuring that pairs were matched for valance as far as possible. For example, *Tall* (fact) and *careful* (trait) are desirable and hence have positive valance, whereas *sick* (fact) and *lazy* (trait) are undesirable and hence have negative valance. The trait-fact pairs used were: Careful-Tall, Clever-Waiter, Tidy-Vegetarian, Friendly-Non-smoker, Fashionable-Student, Determined-American, Kind-Rich, Funny-Pilot, Careless-

Deaf, Poor-Clumsy, Forgetful-Sick, Daring-Smoker, Shy-Actor, Rude-Thin, Greedy-Short and Ignorant-Fat.

Each questionnaire consisted of 16 items with half the photographs presented along with trait sentences and the other half of the photographs presented with fact sentences. Thus, in the former the fact was the random characteristic and in the later the trait was the random characteristic. A given trait or fact was presented only once to a participant either as the target characteristic or the random characteristic. Each photograph was presented with all 16 traits and 16 facts as the target characteristic between participants.

Sixty-four native English speaking psychology undergraduate students filled in the questionnaire at the beginning of one of their lectures. Participants were asked to read the sentences and then rate the person on a scale from one to ten on the two characteristics given so that a rating of ten means that the characteristic aptly describes the person and a rating of one means that the characteristic does not describe the person at all. They were also asked to guess the person's age.

The ratings given were analysed at the level of the stimuli to see whether the traits and facts were implied in the sentence or not. If they were then the actor would be rated higher on the target characteristic than on the random characteristic. A Mann-Whitney U test was carried out, as the data were not normally distributed, which revealed this was indeed the case, $U = 0.00$, $N1 = 16$, $N2 = 16$, two tailed $p < .001$. This result also indicates that the face stimuli are apparently neutral, such that a person was rated high on the trait/fact when it was the target characteristic but not when it was the random characteristic.

Comparison between the ratings for traits and facts did not reveal any significant difference between the mean rating given for traits ($M = 3.69$, $SD = 0.87$) and facts ($M = 3.69$, $SD = 0.6$) when both were random characteristics, $t < 1$. However the mean rating for facts ($M = 7.88$, $SD = 0.86$) was significantly more than for traits ($M = 7.19$, $SD = 0.4$) when both were the target characteristic, $t = 2.83, p < 0.01$.

A higher rating for the facts suggests that participants were more confident labelling a person based on factual information than trait information. This was expected as describing someone as "six and a half feet in height" does not leave much doubt about the actor being tall in the population tested; whereas describing someone "who left his bag of groceries on the bus" as forgetful is merely a possible explanation.

Many of the fact sentences differed from the trait sentences in terms of being statements as opposed to descriptions (doing something which implied the characteristic). Hence the fact sentences were modified so that they too were descriptive (for example, 'He has to bend down to enter most doors'). This was not expected to affect the rating given to facts as we assume that the comparatively greater confidence with which participants label a person based on inferred facts comes from inherent differences between traits and facts as a concept. As mentioned before, facts refer to concrete characteristics whereas traits are more abstract mental characteristics. Traits and facts differ in terms of ambiguity as well. There are potentially a large number of behaviours that can imply a given trait and a single behaviour can be perceived to imply different traits. For example "He carried the old lady's bag of groceries to her car" can be thought of as *kind* or *helpful*. This is not the case with facts. The behaviour used to describe facts unambiguously refers to the particular fact. For example, "He carried the lunch ordered by the customer to their table" is a relatively unequivocal description of a *waiter*. To ensure that all the facts were descriptive, some of the factual statements which were pre-tested were removed and new ones introduced.

A pilot study of the computer based task was carried out with three participants with Autism Spectrum Disorders in order to ensure that they do not experience difficulties with the task in terms of understanding instructions or processing the information required to carry out the task.

6.3 Experiment 6, *Pilot Test 1* on a few individuals with Autism Spectrum Disorders

6.3.1 Method

Participants

Three individuals who were diagnosed by an experienced clinician and met DSM-IV criteria (American Psychiatric Association, 1994) for Asperger's Syndrome were tested. There were two males and one female (CA range: 21;6-30;7; VIQ range: 98-112; PIQ range: 102-121).

Apparatus and Stimuli

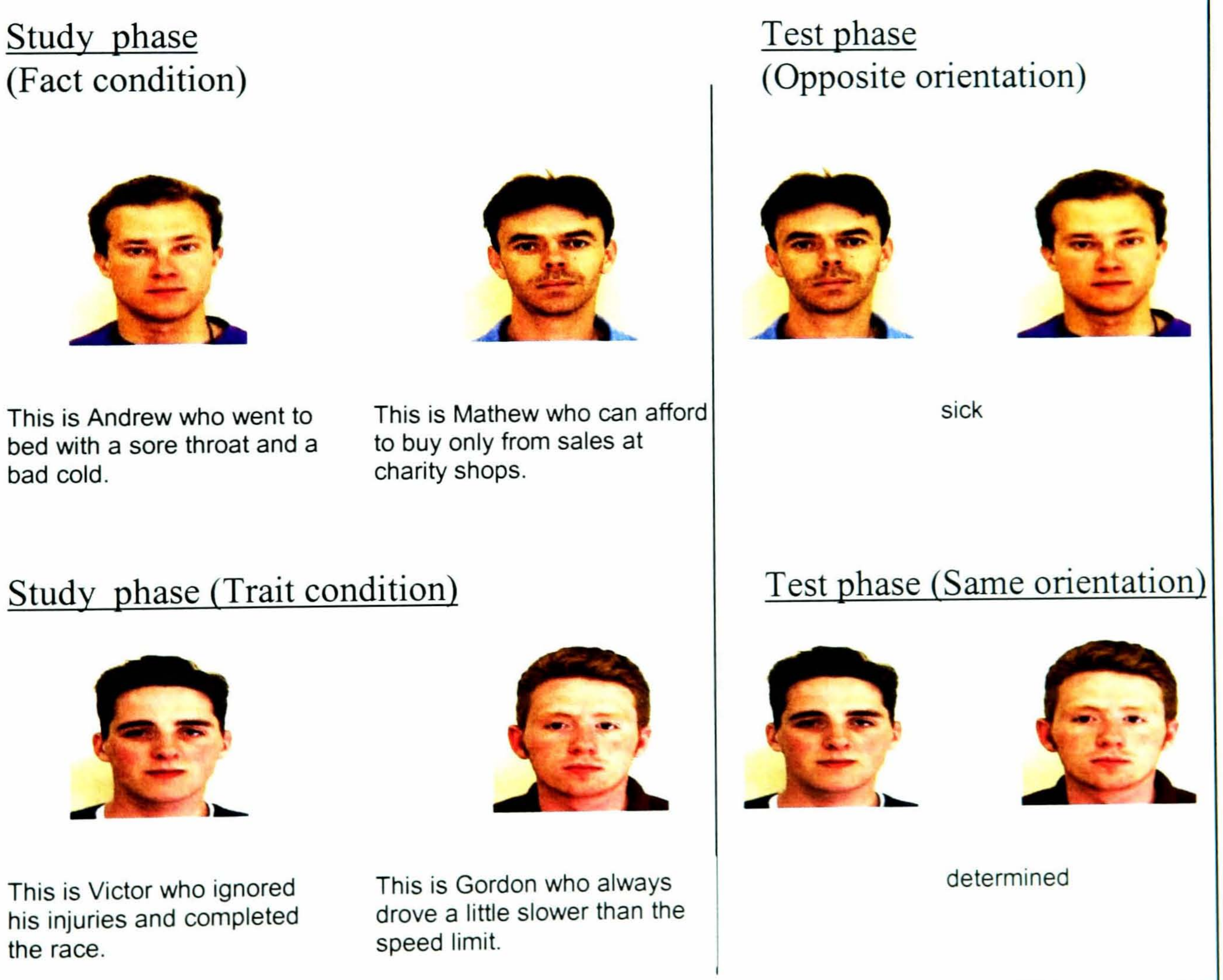
The experiment was programmed and presented using E-Prime on an Acer Aspire 1522WLMi laptop with 15.4" widescreen.

The stimuli consisted of six pairs of trait implying sentences and six pairs of fact implying sentences. The fact implying sentences used in the pre-test were modified to make them descriptive, similar to trait implying sentences. As far as possible only those traits that were descriptions of a "mental characteristic" were included; traits that refer to "physical characteristics" like strong were not included.

The traits and facts were grouped into pairs by random assignment ensuring that they were matched on valence as far as possible. The degree of desirability/undesirability was not taken into account when matching because at least in the case of traits, evaluative extremity was not found to affect response latencies, suggesting that traits are evaluated categorically in the first instance (Pratto and John, 1991). Trait pairs selected were: Clever-Friendly, Daring-Confident, Determined-Careful, Impulsive-Ignorant, Shy-Forgetful and Lazy-Careless. And the fact pairs were: Waiter-Student, Vegetarian-Actor, Non-smoker-Tall, Deaf-Wet, Sick-Poor and Foreigner-Father. The photographs (coloured, frontal view of the face of Caucasian males, matched on age which was the average of the age guessed by the 64 pre-test participants) were also grouped into pairs by random assignment.

The study phase consisted of a pair of photographs presented with a pair of one-sentence descriptions. In half the trials the sentence pair consisted of trait implying sentences and in the other half of the trials the sentence pair consisted of fact implying sentences. The trait and fact implying sentences were assigned to photographs by random assignment. In the experimental and practice trials the dimension of the photographs was 6.5 x 6.5 cm (length x breadth). The photograph pairs were separated by 12 cm. The sentences were presented directly beneath each photograph in two single spaced lines. There was a distance of at least 3 cm between the two sentences. The word in the test phase was presented in the same line as the sentences but in between the two photographs as illustrated in figure 6.1 and 6.3. The textual description and the word were presented in 12 point Arial black font. The background was white. Figure 6.3 illustrates examples of stimuli used in experiment 6, *Pilot Test 1*.

Figure 6.3: Examples of stimuli used in experiment 6 (Pilot Test 1 and Pilot Test 2) and experiment 7



Each participant was administered a different form of the experiment such that each photograph was presented with both sentences of its pair equally often, each photograph pair in the test phase was presented in the same and opposite spatial orientation as the study phase an equal number of times, and the trait/fact implied in both the sentences of a pair was presented equally often in the test phase.

Procedure

The participants were tested individually in a quiet room. The participants were assigned to the different forms using systematic allocation, so that the first participant who was tested did form 1, the second did form 2, the third did form 3, and so on till the final participant. The participants sat half a metre from the laptop and were instructed (both verbally and textually) thus; "On each slide you will be shown a pair of pictures with some information about each written below it. Read the information given one by one and then press the space bar. A pair of pictures will come up on the screen again but this time with a single word in between the two pictures. Your task is to identify the picture you think best matches the word, by pressing 'z' if you think it is the picture on the left and 'm' if you think it is the picture on the right, based on the information you read. Please keep your hands on the keyboard ready to respond throughout the task. You will have two practice trials."

The first practice trial presented a face pair with a pair of trait implying sentences and the second presented a different face pair with a pair of fact implying sentences. The spatial orientation was same in study and test phase for the first trial and opposite for the second trial. No feedback was given during the practice session. Each participant was presented a random order of 12 experimental trials - six trials with trait implying sentence pairs and six trials with fact implying sentence pairs. The correct answer was on the left side in half the trials and on the right in the rest. The procedure was self paced and the test phase came up on the screen 1500 milliseconds after the participants pressed the space bar. The keys that were to be used, namely the spacebar, keys 'z' and 'm' were highlighted. The program was also set so that all the keys except for these were locked.

The photograph-sentence pairing in the study phase, spatial orientation of the photograph in the test phase and the words presented in the test phase were counterbalanced between participants.

6.3.2 Results

The rate of accuracy for the three participants was found to be 50 percent. The three participants showed the same pattern of accuracy in the practice and experimental trials. All of them got 100 percent correct when the face pair in the test phase was presented in the same spatial orientation as in the study phase. But, when the spatial orientation of the face pair was opposite in the two phases, the three participants were 100 percent wrong. The reaction time was not analysed because the accuracy rate was at chance. In order to ascertain that this pattern was not the result of some flaw in the experimental procedure, three typical postgraduate students were administered the same experiment. It was observed that the accuracy rate of the three control participants was well above chance for traits and facts irrespective of spatial orientation. The percentage of correct response for traits and facts was 89 percent and 98 percent respectively for same spatial orientation and 85 percent and 89 percent respectively for opposite spatial orientation.

6.3.3 Discussion

The typical participants were able to identify the actor based on both traits and facts. However, the participants with Asperger's Syndrome appeared to associate the trait and fact implied in the sentences spatially but not with the actor's identity. This may be due to general difficulty with face processing in Autism Spectrum Disorders as suggested by some researchers. Boucher and Lewis (1992) investigated unfamiliar face recognition in children with autism. They presented 30 black and white photographs to three groups of children namely, children with autism, children with learning disability and typically developing children. The three groups of participants were matched on Chronological Age, gender and non-verbal ability. Performance on a forced choice recognition test which followed immediately afterwards revealed that participants with autism made significantly fewer correct responses than either the typical or the learning disabled groups. This impaired ability to recognise recently viewed faces was observed even when the groups were matched on verbal ability. Further, their ability to discriminate between faces was significantly poorer compared to their ability to discriminate between buildings. Klin, Sparrow, Bildt, Cicchetti, Cohen and Volkmar (1999) found that participants with autism performed significantly worse than participants diagnosed with Pervasive Developmental Disorder - Not Otherwise Specified (PDDNOS, an umbrella term for people who show some features of autism but not enough to warrant a diagnosis of autism) and non-PDD groups on the face recognition subset of the Kaufman Assessment Battery for Children (K-ABC). The Face Recognition subtest of the K-ABC measures the child's ability to attend closely to one or two faces whose photographs are exposed briefly, and then to select the correct face(s) shown in a different pose and/or emotional expression, from a group photograph.

Williams, Goldstein and Minshew (2005) administered the Wechsler Memory Scale – III to a group of high functioning adults with autism and found their performance to be significantly poorer than typical controls on delayed as well as immediate recall of the face recognition subset.

As with research on most areas in autism, research on face recognition too has its share of contradictory results. Celani, Battacchi and Archidiacono (1999) did not find individuals with autism to be significantly different from verbal mental age matched individuals with Down's syndrome and typical individuals on face recognition using a matching task. In this task a target photograph was presented on the screen for 750ms following which a choice of three photographs were presented and the participants were asked to identify which of the three photographs was the target photograph initially presented. The levels of accuracy between the three groups of participants did not differ significantly.

Jemel, Mottron and Dawson (2006) reviewed behavioural and physiological evidence of face processing in autism and concluded that peculiarities in processing may be present without a deficit in recognising faces. Thus conclusive evidence for impaired face recognition in autism is lacking.

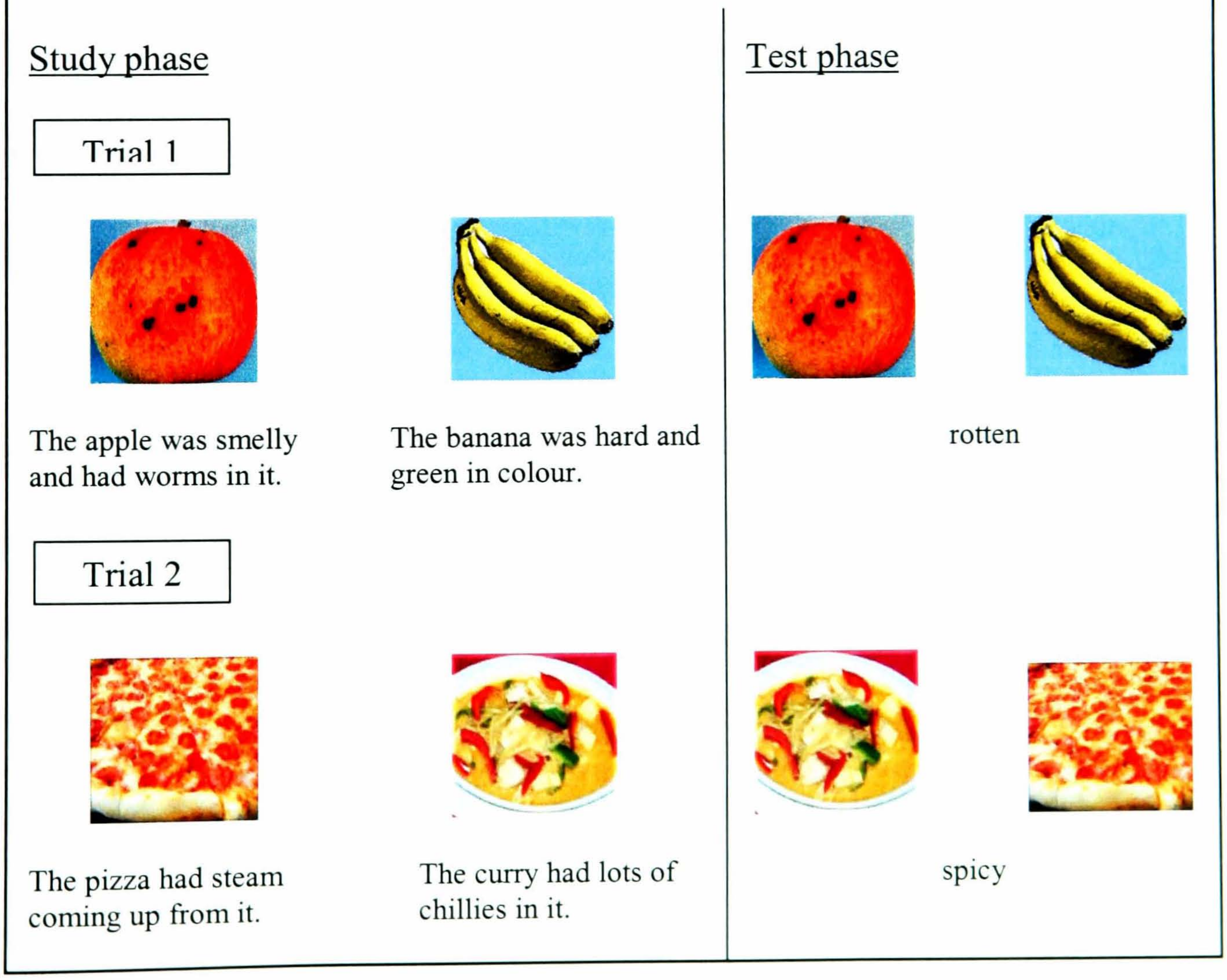
Another possible reason for the pattern of accuracy rate obtained could be that, unlike typical participants, the participants with Asperger's Syndrome may not have spontaneously paid attention to the faces in the practice trials. The term "social orienting impairment" was coined by Dawson and colleagues (Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998; Dawson *et al.*, 2004) to refer to the failure of young children with autism to spontaneously orient to naturally occurring social stimuli in their environment, including faces.

Beeger, Rieffe, Terwogt and Stockmann (2006) found that high functioning children with autism were less attentive to emotional expression when asked to sort photographs depicting smiling or frowning faces. Instead, they sorted the photographs based on non-social features like presence of moustache or glasses. However, when attending to the face was made crucial to the task (by instructing the participants to focus on how the people in the photographs would behave towards them) participants with High Functioning Autism sorted the photographs based on the emotional expression. In contrast, the typical control participants sorted the photographs based on the emotional expression in both conditions.

For the participants to realise that the spatial orientation of the photographs would be changed in some trials they needed to attend to the photographs. However, the three participants with Asperger's Syndrome appeared not to attend to the photographs at all. Had the three participants with Asperger's Syndrome realised in the practice trials that the spatial orientation of the photographs would be changed in some trials maybe they would have attended to the photographs in the experimental trails. In order to encourage participants with

Autism Spectrum Disorders to attend to the photographs, and thus be made aware of the possibility that the spatial orientation of the photographs would be changed in some trials, it was decided to modify the current experiment. One modification was to use non-social stimuli and feedback in the practice session. If participants with Autism Spectrum Disorders were oblivious to the change in the spatial orientation of the photographs as a result of difficulty with faces, the non-social stimuli were expected to make the change in spatial orientation more obvious. Apart from being non-social these stimuli maybe more distinct from one another than faces (see figure 6.4).

Figure 6.4: Illustration of the two practice trials used in experiment 6 (Pilot Test 2) and experiment 7



A further modification involved beginning all sentences in the experimental trials with a name (for example, 'This is George who checked the soup packet to make sure that it does not contain any meat.'). This was expected to direct the attention of the participant to the person in the photograph as the agent of the described action. In the test phase apart from traits and facts, a third condition, *name*, was also introduced. The name condition differs from the other two conditions in that the stimuli were present in the study phase. In the trait and fact condition participants have to draw an inference and then associate this inference with the actor. One possible difficulty that participants with Autism Spectrum Disorders could have with the trait and fact conditions was the level of difficulty. The difficulty level of the name condition is relatively less as the information needed to identify the person was explicitly presented.

The modified experiment was piloted on a group of typical participants to ensure that the new set of sentences implied the intended facts.

6.4 Experiment 6: *Pilot Test 2*

6.4.1 Method

Participants

There were 16 participants, eight males and eight females, none of whom had taken part in the earlier pre-testing or in any of the earlier experiments. All participants were native English speaking students recruited through advertisements placed on various notice boards around the University of

Nottingham campuses. The mean age of the participants was 20;8 years (*SD* = 3;1 years) ranging from 18;1 years to 34;11 years.

Apparatus and Stimuli

The experiment was programmed and presented using E-Prime on an Acer Aspire 1522WLMi laptop with 15.4" widescreen.

Apart from the six pairs of trait implying and fact implying sentences used in *Pilot Test 1*, three more pairs of trait (funny-kind, nosy-fussy, greedy-rude) and fact (pilot-barber, rich-slim, Scottish-short) implying sentences were introduced for the name condition. The names were selected from a database for popular English names available online. All sentences began with a name, for example, 'This is Neil who is going to learn skydiving over the summer holidays'.

The nature of the stimuli in terms of the dimension of the photograph, font of the sentences and words and positioning of the stimuli were the same as described in *Pilot Test 1*. Figure 6.5 demonstrates the name condition used in this experiment. The trait and fact conditions are the same as demonstrated in figure 6.4. The complete set of stimuli used in the current experiment is listed in Appendix F.

Figure 6.5: Illustration of the name condition used in experiment 6 (Pilot Test 2) and experiment 7

Procedure

The instructions given to the participants were the same as in *Pilot Test 1*. The only difference was that feedback was provided for the practice trials. If error was made participants were told that the response was incorrect and were asked to attempt that particular trial again. The experimental trials were administered only after the participants successfully passed both practice trials. In the study phase, each participant was presented a random order of 18 trials – nine trials with trait implying sentence pairs and nine trials with fact implying sentence pairs. The test phase consisted of six traits, facts and names (three from trait sentence pairs and three from fact sentence pair). Similar to *Pilot Test 1,* the procedure was self paced and the test phase came up on the screen 1500 milliseconds after the participants pressed the spacebar. The keys to be used, namely the spacebar, keys 'z' and 'm' were highlighted. The program was also set so that all the keys except for these were locked. The counterbalancing procedure followed in *Pilot Test 1* was carried out with the current experiment too.

6.4.2 Results

A score of one was given for each correct response. The maximum score a participant could obtain was 18 (with a maximum of six for traits, facts and names individually). Table 6.1 gives the accuracy on the three words when the spatial orientation of the photographs in the two phases was the same and when opposite.

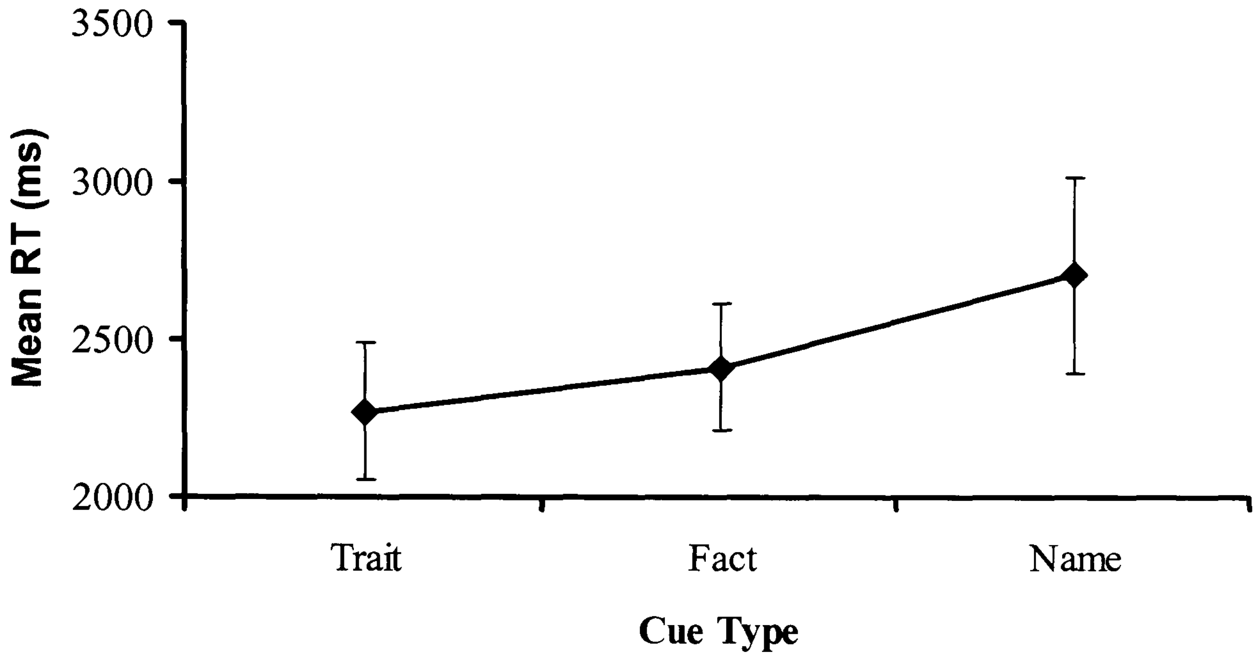
Table 6.1: Percentages of correct responses on the three word condition in the two orientations (experiment 6, Pilot Test 2)

	Accuracy rate		
	Trait	Fact	Name
Same Orientation	92%	94%	80%
Opposite Orientation	88%	92%	78%
Total	90%	93%	79%

The participants' accuracy for traits and facts were close to ceiling. The accuracy on names was not as high as on trait and fact but a one sample t-test with test value set at 0.5 (which is the accuracy rate expected by chance) indicated it to be well above chance when the spatial orientation was the same, t = 5.22, p <.001 and when opposite, t = 3.74, p < .01. On all three words the participants were scoring higher when the photographs were in the same spatial orientation in the study phase and test phase, but a Wilcoxon signed ranks test revealed that overall there was no significant effect of spatial orientation, $N = 16$, $z = 0.4$, $p > .05$. Since spatial orientation was not found to significantly affect accuracy, the total scores for the three words were analysed. The data did not meet the condition for normality, hence a Wilcoxon signed ranks test was administered. There was no significant difference between the mean score obtained on traits and facts while the mean score on names was found to be significantly less than traits, $N = 16$, $z = 2.64$, $p < .01$, and facts, $N = 16$, $z = 2.56$, $p < .01$.

The reaction time was measured from the onset of the test phase to when the participants responded by pressing ‘z’ or ‘m’. The reaction times for only correct responses were included in the analysis. The mean reaction time for the trait condition was 2159.6 ms ($SD = 884.22$ ms) when the spatial orientation was the same and 2385.79 ms ($SD = 1112.69$ ms) when the spatial orientation was the opposite. The respective reaction times for the fact condition were 2379.31 ms ($SD = 1006.07$ ms) and 2450.3 ms ($SD = 779.61$ ms); and 2599.48 ms ($SD = 1176.38$ ms) and 2821.32 ms ($SD = 1742.73$ ms) for name condition. The distribution of reaction times did not meet the conditions for normality and hence the data was submitted to logarithmic transformation and then analysed using a 3 (word: trait versus fact versus name) x 2 (orientation: same versus opposite) repeated measures ANOVA. There was no significant main effect of word, $F(2, 30) = 2.21$, $p > .05$, or orientation, $F(2, 30) = 2.14$, $p > .05$. Neither was the interaction between word and orientation significant, $F < 1$. See figure 6.6.

Figure 6.6: Mean reaction time (RT) for traits, facts and names (experiment 6, Pilot Test 2). The error bars represent standard error of mean.



6.4.3 Discussion

The raw data suggest that performance was better in terms of accuracy and reaction time when the spatial orientation of the photographs was the same in the study and test phases; although statistically this was not found to be significant.

The accuracy was found to be close to ceiling for the traits and facts. Thus, the modified descriptions used do imply the traits/facts as intended. The accuracy data and the pattern of reaction times indicate that participants were equally adept at discriminating between the actors based on the implied facts as well as traits. Facts refer to concrete and unambiguous characteristics. Hence, participants were expected to discriminate between the actors relatively quickly and accurately based of factual information. Traits, on the other hand, referred to relatively more abstract mental characteristics and are more ambiguous. Thus, they were expected to be slower at discriminating between actors based on trait information.

The finding that participants were not significantly different in terms of accuracy and quickness in choosing the correct actor when based on concrete and unambiguous facts and when based on relatively abstract and ambiguous traits suggests that participants use trait and fact information with equal ease to identify someone. In other words, participants seem to be equally good associating the characteristic of tallness to a person as associating cleverness to a person based on a single behavioural description.

The participants found identifying the actor based on a name comparatively more difficult as indicated by significantly more errors on the name condition than the trait or fact conditions. Though not significant, the reaction time for the name condition was also more than for the trait or fact. This finding is compatible with our common experience of being unable to remember the name of a person though we can recollect other details. Difficulty with identifying faces based on names has been observed in many laboratory experiments. Young, Hay and Ellis (1985) asked 22 people to describe and keep records of errors and difficulties they experienced in recognising other people. Diarists often reported knowing who an encountered person was, but still searched for some details, including the person's name. Difficulty with name retrieval has been demonstrated in reaction time studies as well. Scanlan and Johnston (1997) presented a matching task where participants were presented with face-name, face-occupation and face-nationality pairings of highly familiar celebrities. The task was presented on a computer and participants were asked to identify whether the pairing were correct or incorrect by manipulating appropriate keys. It was observed that adult participants took more time to match faces to names than to occupation or nationality. But young children, up to the age of 12 years, showed the opposite pattern and were significantly faster with names than with the other two types of semantic information. These patterns of reaction time were also observed when the responses where vocal rather than key presses. Rahman, Sommer and Olada (2004), however, found children also showed advantage of retrieving semantic over name information when cartoon characters were used instead of celebrities, as was the case in Scanlan and Johnston's (1997) study. McWeeny, Young, Hay and Ellis (1987) used faces of unfamiliar people which were presented one by one to participants along with their (invented) name and occupation under instructions to try and remember both kinds of information. Ambiguous labels (for example, carpenter and baker) which could be either a surname or an occupation were used along with unambiguous labels to identify the effect of meaningfulness and imageability. Surnames were found to be harder to recollect irrespective of ambiguity. Participants recalled an occupation without a name more often than recalling a name but not the occupation. Young *et al.* (1985) found similar results in their diary study where no cases were reported where the diarist retrieved additional information, like the name, without being aware of 'who' the person was.

Thus, difficulty retrieving names is a well established finding in face processing literature (Burton and Bruce, 1992). The relatively poor performance of the participants on the name condition in this experiment is consistent with existing literature.

6.5 Experiment 7

Performance of participants with Asperger's Syndrome

6.5.1 Introduction

When forming an impression of someone we link the inferences we draw from behaviour to a representation of the person based on their face. Experiments 2, 4 and 5 strongly suggest that participants with Autism Spectrum Disorders infer traits from a behavioural description. But, on the basis of the results obtained from studies on face recognition in autism, one could argue both for and against the possibility of difficulty at a more basic level in identifying people based on the inferred traits. If there was any difficulty with face recognition, this would be evident in poor performance on all three word conditions.

The name condition was introduced as a test against the possibility that people with autism may find difficulty associating traits and facts with the actor as a result of the higher level of task complexity. Trait and fact conditions involve associating inferences drawn from behavioural descriptions to the actor. On the name condition explicitly presented stimuli merely needed to be remembered and individuals with Autism Spectrum Disorders arguably do not have difficulty with paired associative learning (Minshew *et al.*, 1992). Difficulty as a result of task complexity was expected to be evident in poor performance on the trait and fact conditions but not the name condition.

Individuals with Autism Spectrum disorders may experience difficulty with traits because of it being a social construct. This was expected to be evident in poor performance on trait condition but not fact or name conditions.

6.5.2 Method

Participants

Sixteen adult participants with a diagnosis of Asperger's Syndrome took part in this study. There were 14 males and two females. Individuals were selected as participants if they had been diagnosed by an experienced clinician and met DSM-IV criteria (American Psychiatric Association, 1994) for Asperger's Syndrome. Sixteen participants without Asperger's Syndrome were also tested and none had any autistic features. Those with Asperger's Syndrome were recruited from a specialist college for individuals with Asperger's Syndrome in Somerset, U.K. All 32 participants were native English speakers. The two groups were matched in terms of Chronological Age (CA), Verbal Intelligence Quotient (VIQ), Performance Intelligence Quotient (PIQ) and gender. The VIQ was based on their scores on the verbal subsets (vocabulary and similarities) and PIQ on the performance subsets (block design and matrix completion) of Wechsler's Abbreviated Scale of Intelligence (WASI, Psychological corporation, 1999). Independent sample t-tests did not identify any significant difference between participants with Asperger's Syndrome and control participants on CA, VIQ, PIQ or full-scale IQ $t < 1$ for all. Table 6.2 displays participants' details.

Table 6.2: Details of participants in experiment 7. There were two females and fourteen males in each group.

Group		CA	VIQ	PIQ	IQ
Asperger's	Mean	17;8	105.31	102.25	104.19
	SD	1;2	12.12	13.68	11.97
	Range	16;3-20;6	84-125	71-118	85-125
Typical	Mean	17;10	103.94	103.56	104.19
	SD	1;6	10.01	10.54	8.61
	Range	16;5-21	78-123	86-121	84-117

All participants had taken part in experiment 5 which was administered first followed by the WASI before this experiment was presented. It was ensured that none of the sentences shown to a participant in experiment 5 were shown again in this experiment by manipulating which form of the experiment the participant got. Since experiment 5 never presented trait words as cues and the participants were debriefed about the social nature of the experiment only at the very end of the session, carrying out both experiments in a single session was not expected to influence the results of either.

Apparatus and Stimuli

The apparatus and stimuli used are the same as described in experiment 6, *Pilot Test 2*.

Procedure

This experiment followed the procedure described in experiment 6, *Pilot Test 2*.

6.5.3 Results

A score of one was given for each correct response. The maximum score a participant could obtain was 18 (with a maximum of six for traits, facts and names individually). Table 6.3 gives the accuracy of the participants with Asperger's Syndrome and participants of typical development on the three words when the spatial orientation of the photos in the two phases was the same and when opposite.

Table 6.3: Percentage of correct responses of typical participants (TYP) and participants with Asperger's Syndrome (AS) (experiment 7)

	Fact			Trait			Name		
	Same	Opposite	Total	Same	Opposite	Total	Same	Opposite	Total
AS	96%	77%	86%	96%	85%	90%	83%	84%	84%
TYP	90%	88%	89%	98%	88%	93%	76%	76%	76%

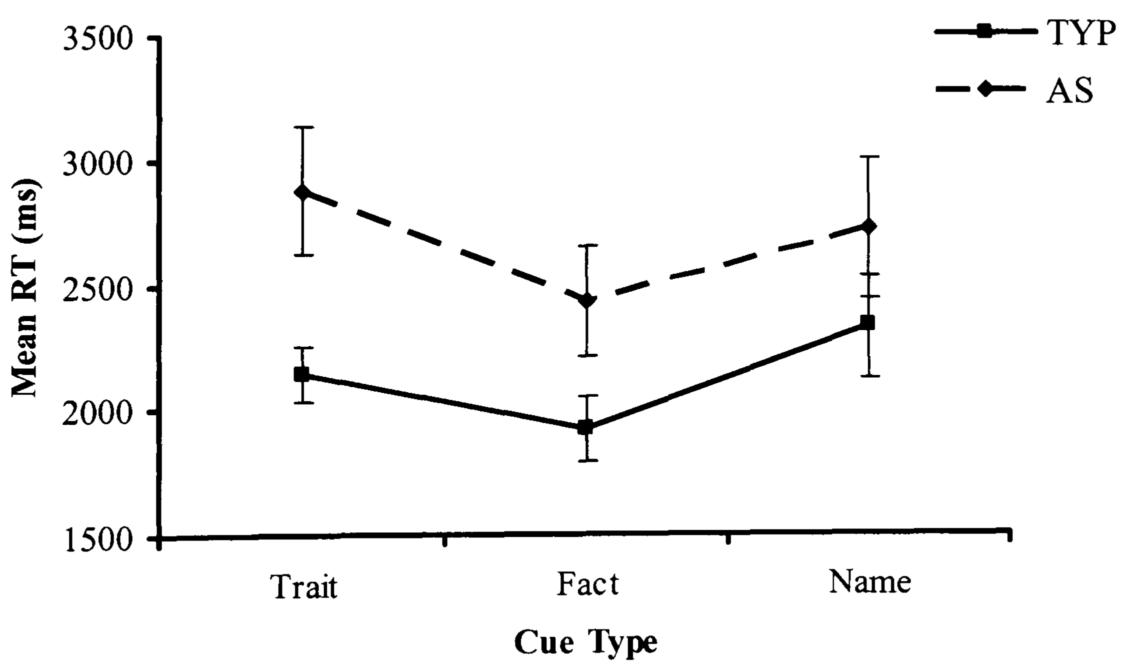
One sample t-tests with test value as 0.5 (which is the expected accuracy by chance) was carried out. The results indicated that the accuracy rate of the group of individuals with Asperger's Syndrome and the group of individuals of typical development was significantly above chance in all three word conditions irrespective of orientation. A parametric analysis taking spatial orientation as a within subjects variable was not possible as the accuracy rate distribution did not meet the condition of normality. However, the distribution of the total scores for the three words was normally distributed and a repeated measures ANOVA with word (trait versus fact versus name) as the within subject variable and group

(Asperger's Syndrome versus Typical) as the between subjects variable revealed a main effect of word type, F (2, 60) = 12.6, $p < .001$, $f = 0.21$. Post hoc (Bonferroni) revealed that the accuracy for the name was significantly less than the fact, $p < .01$, and trait, $p < .001$. There was no significant main effect of group, $F < 1$, and the interaction was not significant, F (2, 60) = 1.29, $p > .05$.

The reaction time was measured from the onset of the test phase to when the participants responded by pressing 'z' or 'm'. The reaction time for only the correct responses was included in the analysis. For the participants of typical development the mean reaction time for the trait condition was calculated to be 1915.75 ms (*SD* = 410.38 ms) and 2386.47 ms (*SD* = 611.07 ms) for the same and opposite spatial orientation respectively; for the fact condition they were 1750.91 ms (*SD* = 611.12 ms) and 2063.73 ms (*SD* = 654.73 ms) respectively; and for the name condition they were 2356.05 ms (*SD* = 945.38 ms) and 2330.03 ms (SD = 1007.09 ms) respectively. For the participants with Asperger's Syndrome the mean reaction time for the trait condition was calculated to be 2750.44 ms (SD = 1165.99 ms) and 3085.41 ms (*SD* = 1154.62 ms) for the same and opposite spatial orientation respectively; for the fact condition they were 2144.66 ms (*SD* = 662.81 ms) and 2864.98 ms (*SD* = 1409.51 ms) respectively; and for the name condition they were 2475.06 ms (*SD* = 1144.68 ms) and 2774.03 ms (*SD* = 118.43 ms) respectively. The reaction times data did not meet the conditions for normality and hence the data were submitted to logarithmic transformation and then analysed using a 3 (word: trait versus fact versus name) x 2 (spatial orientation: same versus opposite) x 2 (group: Asperger's versus typical) mixed ANOVA. The analysis indicated a significant main effect for word, F (2, 60) =

4.24, $p < .05$, $f = 0.38$. Post hoc (Bonferroni) revealed that the reaction time for facts was significantly less than for traits, $p < .05$. There was a significant main effect of spatial orientation, $F(2, 60) = 22.92$, $p < .001$, $f = 0.87$, with the reaction time being significantly less when the photographs in the test phase were in the same spatial orientation as in the study phase. A significant main effect of group was also observed, $F(2, 60) = 4.34$, $p < .05$, $f = 0.38$, with the typical group being significantly faster than the group with Asperger's Syndrome. None of the interactions were significant. See figure 6.7.

Figure 6.7: Mean reaction time (RT) of the typical group (TYP) and the group with Asperger's Syndrome (AS) on trait, fact and name conditions (experiment 7)



6.5.4 Discussion

All the participants in this experiment had taken part in experiment 5 as well. The two experiments were presented in a single session. It was ensured that none of the sentences shown to a participant in experiment 5 were shown again in this experiment by manipulating which form of the experiment the participant got. Since experiment 5 never presented the trait cues and the participants were debriefed about the social nature of the experiment only at the very end of the session, carrying out both experiments in one session was not expected to influence the results of either. In order to confirm this, performance of the pilot participants (experiment 6, *Pilot Test 2*), who had not participated in experiment 5, was compared to performance of the typical participants in this experiment. The scores obtained by the two groups on the traits, fact and names were analysed using Mann Whitney tests since the data were not normally distributed. The analysis did not reveal any significant difference between the two groups of participants on any of the cue conditions in either spatial orientation. The reaction time data were distributed normally and independent samples t-tests did not reveal any significant difference between the two groups of participants on any of the cue conditions in either orientation. Hence, administering the two experiments in a single session may not have influenced the results obtained in experiment 7.

Accuracy was significantly above chance for participants with Asperger's Syndrome and participants of typical development on the three word types irrespective of spatial orientation. This suggests that participants of both groups were associating the traits, facts and names with the actor. Participants could either make the association in the study phase or in the test phase following the presentation of the word. If participants were making the link in the study phase, they might on seeing the word orient towards the spatial location where they had initially seen the face matching the word. This would increase the reaction time for the opposite spatial orientation condition as participants would, on finding the incorrect face, need to re-orient to the opposite side. The results indicated that the reaction time was significantly less when the spatial orientation was the same compared to when opposite for both groups of participants. Thus, participants (including those with Asperger's Syndrome) were inferring the traits and facts implied in the behavioural descriptions and associating the inference with the actor in the study phase. In the test phase they used this information to correctly identify the actor.

Difficulty with face recognition would have been evident in poor performance on all three word conditions. Surprisingly, the performance of participants with Asperger's Syndrome was comparable to participants of typical development on all three word conditions. This result contradicts some research that suggests difficulty with face recognition in autism, especially in immediate recognition (Williams, Goldstein and Minshew, 2005). At least when the task demanded that an impression be formed of a person, participants with Asperger's Syndrome do process faces and distinguish between people. One possible reason for successful processing of faces by individuals with Asperger's Syndrome in this experiment may be that the task demanded elaborate processing of the stimuli.

The name condition was introduced as a test against the possibility that people with Autism Spectrum Disorders may perform poorly on the trait and fact condition since they are of a higher level of complexity. In the trait and fact condition participants have to draw an inference and then associate this inference with the actor. The participants with Asperger's Syndrome were expected to perform better on the name condition than on traits and facts as the name condition merely required participants to recall explicitly presented information. An ANOVA revealed that the reaction time for names did not differ significantly from traits or facts in either group. However, the accuracy for names was found to be significantly less than for traits and facts in both groups. Thus, participants with Asperger's Syndrome, like typical participants, were more accurate when identifying actors based on inferences made rather than explicitly presented names. Relatively poor performance on the name condition in this experiment is consistent with existing literature on identifying faces based on names in typical participants. However, it is surprising that participants with Asperger's Syndrome were better at identifying people based on a social concept like traits which required inferences to be drawn than simple labelling as was involved in the name condition.

Participants with Asperger's Syndrome were significantly slower than participants of typical development. As discussed in Chapter Four this could be explained in terms of a motor movement planning deficit. The pattern of reaction times was similar for participants with Asperger's Syndrome and typical participants. This suggests a general delay in responding rather than difficulty on any specific word type.

Both groups of participants were faster on facts than traits. The accuracy for traits was found to be more than for facts, though not significantly so. Thus, though quicker, both participants with Asperger's Syndrome and typical participants made slightly more errors identifying the actor based on facts than on traits. Overall, the participants with Asperger's Syndrome performed similarlly to the participants of typical development, identifying the actor with relatively high level of accuracy and speed based on trait, fact and name information. Participants with Asperger's Syndrome were able to draw inferences about straight forward facts as well as inherently ambiguous traits of an individual from behavioural description. Furthermore, they were able associate names as well as the inferred traits and facts with the actor, even when the actor was represented by his face.

6.3 Conclusion

This experiment enquired whether individuals with Asperger's Syndrome associate inferred traits with the actor representation. The speed and accuracy of participants with Asperger's Syndrome was comparable on traits and facts. Facts were relatively unambiguous and traits were about mental characteristics, apart from being ambiguous. Associating the trait with the actor would be difficult for individuals with Asperger's Syndrome if they lack understanding about the mind on a very broad level. Surprisingly, participants with Asperger's Syndrome did not have difficulty processing the relatively large amount of social information and they were more accurate when identifying actors based on inferences drawn from behavioural descriptions (facts as well as traits) than explicitly presented names. Thus, individuals with Autism Spectrum Disorders associated the inferred traits with the actor without difficulty, even when the actor was represented by his face.

Chapter Seven

Conclusions and General Discussion

7.1 Introduction

In this chapter the background literature is discussed along with the summary of the four studies, followed by caveats and possible future studies. The chapter concludes with the implications of the findings for our understanding of Autism Spectrum Disorders.

7.2 Summary of the thesis

7.2.1 Background

Over the last three decades, since Premack and Woodruff's (1978) seminal article was published, many studies investigating the theory of mind abilities in autism have been carried out. The majority of these focus specifically on the understanding of false beliefs. Thus, our understanding of social cognition in autism is based on a large number of studies with a narrow focus. How we understand and predict other's behaviour is a central theme in attribution research as well. The well established equation of attribution considers behaviour to be the joint product of stable dispositional factors and transient situational circumstances. Research suggests that individuals, particularly in Western society, tend to attribute the cause of behaviour to the actor's disposition even when it is possible to provide a situational explanation for the action. This phenomenon, referred to as the observer bias (Jones and Harris, 1967), fundamental attributional error (Ross, 1977) or correspondence bias (Gilbert & Malone, 1995), illustrates the influential role played by traits in social cognition.

The tasks used to study theory of mind can be considered to be a special kind of attribution task where the participant need not consider the disposition of the protagonist. The participants need to understand how the situation influences the behaviour as the false belief is generated under specific situational contexts which are transitory (Rosati *et al.*, 2001). Because the participant is not required to consider traits, one might argue that the task tests only part of the mentalistic understanding involved in predicting other peoples' behaviour.

Thus, traits are a potentially important, hitherto ignored, socio-cognitive construct in autism research. The aim of the experiments described in this thesis was to investigate whether individuals with Autism Spectrum Disorders infer traits from descriptions of behaviour and if so, are they especially sensitive to traits like typical individuals? Do they infer traits with minimal effort, even when there is no obvious reason for or benefit from making the inference? And, can they differentiate and identify people based on behavioural information which imply traits?

7.2.2 Summary of the experiments

<u>Chapter Three: Do individuals with autism spectrum disorders infer traits from textual descriptions of behaviour?</u>

In the experiments described in Chapter Three, participants were presented with textual descriptions of behaviour and asked to choose one of two words that best relate to the sentence. There were two categories of word pairs: trait cue-distracter word pair and a semantic associate of one of the words in the sentence paired with a distracter word. Participants with Asperger's syndrome and typical participants showed similar patterns of reaction time, being significantly faster when the cues were traits as opposed to semantic associates.

Interpretation

The pattern of reaction time obtained cannot be explained in terms of speed-accuracy trade off since the accuracy of both groups of participants was at ceiling. Coupled with ceiling level accuracy, the reaction time data suggests that participants with Asperger's Syndrome infer traits from textual descriptions of behaviour.

One possible reason for why participants were faster on trait cues than semantic associate cues could be that they naturally attend to the global meaning conveyed by the sentences. Responding to a trait cue required integration of the different components of the description whereas the semantic associate cues were related to just one of the words in the sentence and hence required no such integration. Another possible reason for participants being faster on trait cues than semantic associate cues could be that trait inferences were made as soon as the sentences were read, even before the cues were presented. If so, it is possible that the trait inference interfered with performance when the cue was a non-trait semantic associate, resulting in increased reaction time.

Chapter Four: Do individuals with autism spectrum disorders infer traits effortlessly?

The experiments described in Chapter Four investigated whether participants were faster on the trait cues as a result of a natural tendency to process the text globally or because trait inference in particular was effortless. The reaction time for action cues and trait cues, both of which required information presented in the description to be integrated, was compared. If former (global processing) was the case then participants would be faster at inferring not only traits but any feature that required attending to the global meaning presented. Thus, there would be no significant difference in the reaction time for trait cues and action cues. But, if participants find trait inference in particular effortless then they would be faster on trait cues than action cues, despite the fact that both cues required the sentences to be processed for global meaning. Results indicated that the participants with Autism Spectrum Disorders (High Functioning Autism and Asperger's Syndrome) and typical participants were significantly faster on trait cues than action cues.

The experiments described in Chapter Four also investigated whether trait inference was made spontaneously as soon as the sentences were read (even before the cue-distracter pairs were presented). The semantic associate cues were presented with two different types of sentence, trait implying sentence and neutral sentence. The neutral sentences were made of more or less the same words as their corresponding trait implying sentences but did not imply a trait. Comparing the reaction time for semantic associate cues when the sentences was trait implying and when neutral allowed testing for interference which would be present only in the case of trait implying sentence, resulting in increased reaction time. The presence of interference would suggest that traits were being inferred spontaneously. Alternatively, if the trait inference was triggered by the cues and not made spontaneously (before the cues were presented) then the nature of sentence would not affect reaction time. There would be no significant difference when the sentence was trait implying and when neutral. Results indicated that participants with Autism Spectrum Disorder and participants developing typically were significantly faster when the sentence was neutral than when the sentence was trait implying.

Interpretation

Significantly faster responding to trait cues than to action cues suggest that participants with Autism Spectrum Disorders are good at inferring traits not just because they required global processing. This pattern of reaction times cannot be explained as a speed-accuracy trade off as the accuracy of both groups of participants was at ceiling. Neither can it be explained in terms of difference in frequency, syllable count or strength of cue-sentence association between the trait cue and action cue. Indeed, participants seemed compelled to make the trait inference even when the traits were not perceived to be strongly associated with the sentence. This result challenges the concept of weak central coherence in autism at the level of sentence processing. Possibly, the use of a forced choice response procedure may have enhanced text processing as suggested by Snowling and Frith (1986). According to Frith and Happe (1994) weak central coherence is expressed in autism as a non-strategic processing preference which is supposedly most evident in open ended tasks.

The participants were significantly faster at choosing the semantic associate cues when the sentence was neutral than when the sentence was trait implying. The participants were possibly making trait inference spontaneously on reading the sentence even before any cues were presented. Inferring the traits spontaneously could have interfered with performance when the sentence was trait implying, resulting in increased reaction time. Since the neutral sentences do not imply a trait such interference would be absent resulting in no impediment to fast performance. The presence of interference suggests that trait inference was not only effortless but also perhaps made spontaneously on reading the behavioural description, even before the cues were presented.

One possibility was that the effortless and spontaneous trait inference could be the result of an artefact in the procedure. Having traits as cues in some of the trials may have primed participants to attend to traits.

Chapter Five: Does merely comprehending trait implying sentence result in trait inference?

In order to investigate whether trait inference was primed by explicit presentation of trait cues in a few trials, experiment five compared the reaction time for semantic associate cues and action cues when the sentence was trait implying and when the sentence was neutral without presenting trait cues in any trial. In all the experiments in this thesis, including experiment 5, participants were told that the study investigated "aspects of reading ability". Thus, the goal was to comprehend the sentences and there was no explicit reason for participants to infer the traits. Since trait cues were not presented in any trial, there was no benefit from making the trait inference. Presence of interference would suggest that participants inferred traits spontaneously on reading the sentence even though they did not intend to do so. Results indicated that the participants with Asperger's Syndrome and typical participants were significantly faster when the sentence was neutral than when the sentence was trait implying, for both semantic associate cues and the action cues.

Interpretation

Significantly faster response on semantic associate cues and action cues when the sentence was neutral than when trait implying suggests that participants, including those with Asperger's Syndrome, spontaneously code the behaviour described in terms of traits, even in the absence of any explicit reason for or benefit from making the inference. Similar to stroop tasks, participants were presumably unable to ignore the irrelevant trait dimension of the stimuli when the sentence was trait implying. This probably explains the increased time taken to respond when the sentence was trait implying. In the case of neutral sentence the irrelevant and attention grabbing trait dimension was absent and hence responding was not hindered. Differences in the strength of association between the cues and the sentence or frequency and syllable count of the cues used with the trait implying and neutral sentence cannot explain the pattern of reaction time as each cue was presented with both trait and neutral sentence an equal number of times.

Along with ceiling level accuracy, the reaction time pattern suggests that trait inference in autism can be considered to be automatic, occurring without intention and reflecting what Bargh (1989) refers to as "an unintended side effect of another intended process".

Chapter Six: Do individuals with autism spectrum disorders associate the inferred trait with the actor?

Experiments described in Chapter Three, Chapter Four and Chapter Five suggest that participants with Autism Spectrum Disorders infer traits effortlessly and spontaneously. The inferences were made even in the absence of any explicit reason for or benefit from making the inference. Being able to infer traits may not be of much practical use unless the traits are associated with the person carrying out the behaviour (actor). It is only by associating the trait with the actor that the information can be used to predict his or her future behaviour.

The experiments described in Chapter Six investigated whether participants with Asperger's Syndrome associate the inferred trait with the actor. Participants were presented with a pair of different faces with a sentence each (study phase). Subsequently the same face pair was presented with a single word (test phase). Participants had to choose which of the faces best related to the word. There were two types of sentences: trait implying and fact implying. The words presented were of three types: trait word, fact word and name. The performance of participants with Asperger's Syndrome was similar to the performance of typical participants. Participants with Asperger's Syndrome were inferring the traits and facts implied in the behavioural descriptions and associating them with the actor's face in the study phase. They then used this information to correctly identify the actor in the test phase. In fact, both groups of participants were faster and more accurate when identifying actors based on inferences about straight forward facts as well as inherently ambiguous traits than the explicitly presented names.

Interpretation

The results obtained in experiment 7 contradict research evidence suggesting impaired face recognition in autism. When the task demanded that an impression is formed of a person, participants with Asperger's Syndrome do process faces and distinguish between people. Surprisingly, the participants with Asperger's Syndrome, similar to typical participants, performed better on the trait and fact condition than the name condition. Traits and facts involved associating inferences drawn from behavioural descriptions to the actor. Furthermore, traits are social constructs. Names involved making an association between two explicitly presented stimuli. Intriguingly, participants, including those with Asperger's Syndrome, performed better on traits than names. Thus, individuals with Autism Spectrum Disorders, under some circumstances, do process faces and distinguish between people based on social information, like ambiguous mental characteristics.

7.2.3 Overall conclusion

Results obtained in the experiments described in Chapter Three to Chapter Six suggest that individuals with Autism Spectrum Disorders can infer traits from textual descriptions of behaviour and they do so spontaneously: The inferences were not triggered by the cues and were made in the absence of any explicit reason for or benefit from making trait inference. In fact, in experiment 6, making trait inference always hindered efficient performance. Furthermore, when the task required that impressions be made, they were able to associate the inferred trait with the actor even when the actor was represented by his face. The results from the four experiments conducted with individuals with Autism Spectrum Disorders suggest that they can not only make inferences about others' traits, but they are especially sensitive to traits. This raises the possibility that understanding traits as corresponding to behaviour may be a spared socio-cognitive ability in autism.

7.3 Caveats: Orienting attention, goals and spontaneous processing of social information in Autism Spectrum Disorders

Impairment in social orienting

In order to infer traits, individuals need to first attend to the relevant behaviour. Research suggests that individuals with Autism Spectrum Disorders may not spontaneously attend to relevant stimuli in the environment, particularly when the stimuli are social in nature. Many of the children described by Kanner (1943) were more interested in objects than people. The term "social orienting impairment" was coined by Dawson and colleagues (Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998; Dawson *et al.*, 2004) to refer to the failure of young children with Autism Spectrum Disordres to spontaneously orient to naturally occurring social stimuli in their environment. Dawson *et al.* (1998) investigated the ability of young children with Autism Spectrum Disorders and chronological age, receptive language and verbal intelligence matched children with Down's syndrome and children developing typically, to orient to familiar social (clapping hand and calling the child's name) and non-social (playing a musical jack in the box and shaking a rattle) stimuli. Children with Autism Spectrum Disorders exhibited a general impairment in orienting ability but this impairment was significantly more severe for the two social stimuli.

In experiment 7, participants were presented with behavioural information about two people represented by frontal photographs of their face. The participants were then required to use this information to choose which actor a given word best described. In an initial version of the experiment, the participants were given two practice trials using stimuli, pairs of faces and sentences, similar to the experimental session. Results from three participants with Asperger's Syndrome revealed that they did not attend to the faces. They inferred the traits and facts implied in the sentences but associated them with the spatial location and not the actor identified by his face. This resulted in their response being 100 percent correct when the spatial orientation of the photograph was the same in the study phase and the test phase. But when the spatial orientation of the photograph was opposite in the study and the test phase, the three participants were incorrect in every trial. Three participants of typical development, however, were able to correctly identify the actor when the spatial orientation was the same and when opposite suggesting that they spontaneously attended to the faces. Though three is a very small sample to consider social orienting deficit, other researchers have reported improved task performance under instructions which encouraged participants with Autism Spectrum Disorders to focus their attention on social stimuli relevant to the task. For example, Beeger *et al.* (2007) reported that high functioning children with autism do not attend to faces when sorting photographs of people having a smiling or frowning face. Instead they used non-social features like presence of moustache or glasses. However, when attending to the face was made crucial to the task (by instructing the participants to focus on how the people in the photographs would behave towards them) participants with High Functioning Autism sorted the photographs based on the emotional expression.

In experiment 7, the procedure was modified so as to encourage participants with Autism Spectrum Disorders to focus on the pictures as well. This was achieved by the use of non-social stimuli like fruits in the practice trials. For example, the study phase presented a picture of an apple paired with the sentence, 'The apple was smelly and had worms in it' and a picture of a banana paired with the sentence, 'The banana was hard and green in colour'. In the test phase the same pictures were presented with the word 'rotten'. It was felt that the use of non-social cues would make the change in spatial orientation more obvious to the participants with Asperger's Syndrome, encouraging them to pay attention to the pictures (faces) in the experimental session. When this paradigm was administered to sixteen individuals with a diagnosis of Asperger's Syndrome, it was observed that most of them spontaneously detected the change in spatial orientation in the practice session. By making the importance of focusing on the pictures evident to participants with Autism Spectrum Disorders by using non-social stimuli, it was observed that they continued to focus on the pictures in the experimental trials even when they were faces. Thus, they performed similar to the control typical participants and associated the names as well as traits and facts with the actor.

The results obtained in the experiments described in this thesis suggest that if individuals with Autism Spectrum Disorders attend to others' behaviour they can draw inferences about social constructs like traits. Future research could investigate whether individuals with Autism Spectrum Disorders spontaneously attend to others' behaviour.

Goal dependent automaticity

There is compelling evidence that typically developing individuals process behavioural information in terms of traits in a largely automatic manner - without intention (Winter & Uleman, 1984), with minimal awareness (Winter, Uleman & Cunniff, 1985) and with diminished resources (Gilbert *et al.*, 1988). The frequency of occurrence of a psychological process is more in real life when it occurs without the person intending to do so (Uleman, 1999; Winter & Uleman, 1984). The results obtained in the experiments described in Chapter Four and Chapter Five yielded indirect evidence to suggest that participants, including those with Autism Spectrum Disorders, make trait inferences without intending to do so. If Uleman is correct, this is a sign that participants readily and frequently make trait inferences in the real world provided that they attend to the relevant behaviour.

According to Bargh (1989), the activity of encoding behaviour in trait terms is a goal dependent automatic process where the goal of understanding the meaning of the behavioural information was a pre-requisite for spontaneous encoding to occur. In other words, individuals not only have to observe behaviour but also be motivated to attribute meaning or cause to it. However, the tendency to impute social meaning to events could be hyper potent in people, as suggested by Heider and Simmel's (1944) study. They presented a short (two and a half minute) moving picture film of geometrical figures moving in various directions and speeds to participants who were given a very general instruction to "write down what happened in the picture". All but one of the 34 participants interpreted the movements as actions of animate beings, in most cases of humans. The participants often attributed human characteristics like 'aggressive' and 'possessive' to the geometric shapes. Thus, people seem to have a pervasive tendency to understand and give meaning to what is happening in their environment, often in social terms. Klin (2004) presented Heider and Simmel's (1944) procedure to individuals with Asperger's Syndrome and higher functioning adults with autism. While the control participants used anthropomorphic terms and referred to fundamentals of social relationships, the group with Autism Spectrum Disorders used geometric terms and referred to fundamentals of physical relationships, to describe the scene. The participants with Autism Spectrum Disorders showed reduced capacity for deriving personality features from the geometric character's actions. Most of the attributions made were physical in nature and the few social attributions made were simplistic, based on one or two behaviours. Thus, participants with Autism Spectrum Disorders showed a marked deficit in the spontaneous search for social meaning in visual stimuli. One possible criticism of this study may be that the use of geometric shapes was too far removed from reality, especially for individuals with Autism Spectrum Disorders who are known to have poor imagination and who often understand events literally. Further research could test directly whether individuals with Autism Spectrum Disorders naturally attend to behaviour with the goal of attributing social meaning using more naturalistic stimuli.

The textual descriptions used in the series of experiments reported here presented instances of individual behaviour. In everyday life behaviour rarely occurs in isolation. There would be many contextual cues which would provide further information about the behaviour. One of the behavioural descriptions used in the experiments described in this thesis was 'He bumped into the cupboard door and hurt his nose'. By itself the behaviour clearly implies clumsiness. However, if we were actually seeing the behaviour happening, we may notice that the actor walked unsteadily, smelt of alcohol and his speech was slurred. This extra information would tell us that the behaviour was clumsy but not due to a stable disposition but the result of a temporary drunken state.

Scenes we observe in our daily life usually consist of many people doing different things simultaneously and we are rarely able to focus our attention entirely on a specific event unless it is particularly interesting or important to us. Comprehending the textual description 'He smiled and said hello to everyone at the party' is comparatively easy compared to making the same observation at an actual party. In the latter case the observation would have to be made amidst many people doing different things and while we ourselves are engaged in socialising.

Further research using visual presentation of behaviour, for example using video clippings, would help test whether individuals with Autism Spectrum Disorders naturally attend to the relevant behaviour and use the different contextual cues to draw inferences.

7.4 Other relevant issues and future studies

The experiments described in this thesis represent a first attempt to tackle a vast and important field in autism. A few related areas which require further investigation are discussed below.

7.4.1 Heterogeneous nature of traits

Fletcher (1984) argued that the behaviourist approach (traits as corresponding to behaviour) that many models of attribution follow is wrong as dispositions are not homogeneous in nature. He made a distinction between behavioural, mental and character dispositions. Behavioural dispositions, like *untidy*, refer to observable behaviour and therefore can be inferred from explicitly manifested behaviour. Mental dispositions, on the other hand, refer to sensations or internal perceptions (like emotions) or abstract unspecified mental structures (like states of knowledge or attitudes), the meaning of which cannot be equated with their corresponding behavioural manifestation. Many traits, referred to as character traits by Fletcher (1984), are characterised by both cognitive/affective components as well as behavioural components to varying degrees. For example, the trait *shy* entails certain behaviours but also mental events in the form of feelings (uncomfortable in company) or maybe beliefs (about how to behave), which are enduring.

Consistent with Fletcher's character traits, Aloise (1993) suggested that traits fall on different points of a continuum from concrete instances of behaviour to abstract psychological categories. Aloise (1993) investigated whether traits differed in the extent to which they relate to overt behaviour by asking adult participants to indicate on a rating scale whether their judgement about a list of traits was based on psychological information (1 on the rating scale) or behavioural information (9 on the rating scale). The mean ratings suggested that although participants believe behaviour to be a strong element when judging all traits, the traits differed in the extent to which inferences were made directly from behaviour. Some traits were more psychological and other traits were more behavioural. The traits which were rated to depend predominantly on psychological information were also rated as more abstract and the behavioural traits were rated as more concrete by the same group of participants. Aloise (1993) also observed different developmental patterns for psychological and behavioural traits. Children in the third (mean age: 9 years), fourth (mean age: 10;1 years) and fifth grade (mean age: 10;11 years) were asked to describe one person they liked and one person they disliked. Though there was no significant difference in the overall number of traits used, there was an increase in the use of psychological traits and a decrease in the use of behavioural traits with age.

Yuill (1992) differentiated between what she termed social-intentional terms and internal-state terms. Traits like *kind* and *helpful* are social-intentional terms as they are directed towards other people and internal-state terms like *brave* and *anxious* refer to mental states experienced by a person. Social-intentional terms have a moral value whereas internal-state terms, even though they can be assigned positive and negative values, are not moral. For example being brave is desirable but is not considered to be morally praiseworthy. Yuill (1992) found that when five to ten year old children were asked to provide definitions of trait terms and label trait descriptions, internal-state terms were understood and produced later than social-intentional terms.

According to both Aloise (1993) and Yuill (1992) children's conceptualisation of traits becomes more complex with age. They understand traits not only as concrete, observable behavioural manifestations but as abstract psychological characteristics of an individual. This developmental change is considered, by both authors, to be suggestive of an increased emphasis on and the ability to explain than describe behaviour with age. According to Livesley and Bromley (1973), the ability to think reflectively and understand that others may not share the child's opinion increases with age. By middle childhood, children often attempt to explain others' behaviour and offer examples and illustrations to support their statements about others. In order to explain behaviour, traits need to be understood not only in terms of simple behavioural regularity (like the Aloise's behavioural traits) or evaluations (like Yuill's social-intentional terms) but as causing a stable mental state in the actor which drives the behaviour. Such a conceptualization of traits arguably develops after children acquire an understanding of subjective mental states (emotions and propositional attitudes, which is the focus of theory of mind research in autism) as discussed in Chapter Two (Gnepp and Chilamkurti, 1988; Yuill & Perason, 1998).

In the experiments reported here, different *types* of traits were used which were presented as they relate to behaviour. The results suggest that trait inference in Autism Spectrum Disorders is a spared socio-cognitive function at least at the level of relating to behaviour. Further research could look into whether individuals with Autism Spectrum Disorders also understand how traits are mediated by stable mental states. For example, a generous person is not just someone who displays behaviours that imply generousness in various situations, but one who 'wants' to share and is 'happy' to do so. Thus, the generous action is viewed as intentional and lay explanations take into account the trait that is a *desire* to share as forming the causal link between the disposition of generosity and the generous act. Is it possible that individuals with Autism Spectrum Disorders only understand traits as they relate to behaviour? Do they also understand traits as they relate to mental life? For example, a nervous person might feel anxious in some situations which do not elicit anxiety in others. Would individuals with Autism Spectrum Disorders infer a trait such that they make sensible predictions about how a person will feel in a given situation? If individuals with Autism Spectrum Disorders understand traits in relation to behaviour and not in relation to mental entities then one might argue that they are 'trait behaviourists' rather than 'trait mentalist'.

7.4.2 Higher order rules of attribution and contextual processing of behaviour

As discussed in Chapter One, research shows that on tasks like the Wisconsin Card Sorting Task although individuals with Autism Spectrum Disorders do not show difficulty learning rules, they do find shifting to a new rule difficult. According to the Cognitive Complexity and Control theory, put forth by Frye, Zelazo and Palfai (1995), judging how to sort a card on this task involves integrating two incompatible rules into a single higher order rule which arbitrarily states, 'If colour game, if red triangle, then sort into red pile, but if shape game, if red triangle, then sort into triangle pile'. Difficulty with higher order rules of the nature 'if-if-then' leads to poor performance on the Wisconsin Card Sorting Task.

In the experiments described in this thesis participants were provided with descriptions of behaviour that implied a trait, but no additional information was provided. The effortless and spontaneous inference of implied traits by participants with and with out Autism Spectrum Disorders suggest that they have no difficulty using the rule 'Behaviour = Disposition', that is, a person's behaviour is a reflection of his inner self. However, can a person's behaviour be considered to reveal his or her true character always? Kelly (1973) suggests that people do not always consider behaviour to reflect a person's true nature. According to Kelly's discounting principle, if an obvious situational cause is present, people discount the extent to which they attribute a dispositional cause to behaviour. But, we are apt to make a dispositional attribution if a person behaves in a manner that is inconsistent with the requirements of the situation. This is referred to as augmenting principle. For example, we would not be inclined to say that someone is shy based on his or her sitting quietly at a funeral. However, if a person sits quietly in a corner at a party we would be quick to assume that he or she is shy. Thus, people use higher order rules of the nature 'if behaviour, if no contextual reason then infer trait' but 'if behaviour, if contextual reason then infer situation' when attributing cause to behaviour. If individuals with autism do have difficulty using hierarchical rules, as proposed by Frye, Zelazo and Palfai (1995), then they might wrongly attribute a dispositional cause even when the behaviour could be explained in terms of the context. They might fail to take into account the situational pressure to behave in a particular manner. Future research could investigate the ability of individuals with Autism Spectrum Disorders to use complex social reasoning like discounting and augmenting principles.

Social reasoning, like discounting and augmenting, involves processing behaviour in the context of the situation in which the behaviour occurs. In the experiments described in this thesis behavioural descriptions were presented without contextual information. For example, one of the sentences used "He invited the newcomers to his house for coffee" implies the trait friendly. Contextual information could either increase or decrease our tendency to attribute traits by the use of discounting or augmenting principle. For example, on reading the sentence "He invited his new boss to his house for dinner", we may take into account the possibility that the invitation was extended only because the newcomer is his boss. 'He' might not have invited a newcomer who is his junior, and thus not attribute a disposition of friendliness. The Weak Central Coherence hypothesis suggests that individuals with Autism Spectrum Disorders have difficulty taking into account contextual information. When asked to attribute meaning to a person's behaviour, it is possible that individuals with Autism Spectrum Disorders may focus 'locally' on what the actor is doing but not on the 'global' context in which the behaviour occurs. They may understand the behaviour to be friendly but not the ingratiating context which suggests that the person need not be friendly by nature though he exhibits a friendly behaviour in this situation. Future research could investigate whether individuals with autism take into account the context in which the behaviour is expressed when making trait inferences.

7.5 Implications of the thesis

Research documenting deficits experienced by individuals with Autism Spectrum Disorders in social functioning is extensive. However, this thesis provides evidence for a spared socio-cognitive function in autism. Individuals with Autism Spectrum Disorders are able to code behaviour in terms of traits spontaneously and use trait information to identify actors by their faces. This result emphasises the need for research on theory of mind abilities to expand from the current narrow perspective on propositional attitudes.

In typical individuals coding behaviour in terms of traits is automatic. Although the process is dependent on the goal of comprehending the behavioural information, there is evidence that such a goal may be prepotent. The experiments reported in this thesis indicate that individuals with Autism Spectrum Disorders also infer traits automatically. However, in everyday life it is possible that individuals with Autism Spectrum Disorders may not spontaneously attend to the relevant behaviour. If this is the case, then social skills training in autism should encourage individuals with Autism Spectrum Disorders to focus on the social aspects of the environment, including others' behaviour.

Further research into whether individuals with Autism Spectrum Disorders spontaneously focus on behaviour and how they conceptualise traits would go a long way in helping us to understand the scope of social deficits observed in this disorder. Such an investigation may also provide some insight into strategies used by some high functioning individuals with Autism Spectrum Disorders to function efficiently in the social world. The social deficit observed in Autism Spectrum Disorders may not be the result of a difficulty with processing social information per se, but difficulty with spontaneously attending to the relevant cues or comprehending the social event in all its complexities. This could potentially explain the variations observed in the social abilities in individuals with Autism Spectrum Disorders.

REFERENCE

Aloise, P. A. (1993). Children's use of psychological and behavioral traits: a forced choice assessment. *Social Development, 2,* 36-41.

Asch, S. E. (1946). Forming impressions of personality. *Journal of Abnormal and Social Psychology*, 41, 258-290.

American Psychiatric Association. (1980). *Diagnostic and statistical manual of mental disorders (3rd edition).* Washington, DC: American Psychiatric Association.

American Psychiatric Association. (1987). *Diagnostic and statistical manual of mental disorders (3rd edition, Revised).* Washington, DC: American Psychiatric Association.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders (4th edition, Text Revision).* Washington, DC: American Psychiatric Association.

Bailey, A., LeCouteur, A., Gottesman, I., Bolton, P., Simonoff, E., Yuzda, E., & Rutter, M. (1995). Autism as a strongly genetic disorder: Evidence from a British twin study. *Psychological Medicine, 25,* 63–77.

Baird, G., Simonoff, E., Pickles, A., Chandler, S., Loucas, T., Meldrum, D., & Charman, T. (2007). Prevalence of disorders of the autism spectrum in apopulation cohort in south Thames: The special need and autism project (SNAP). *The Lancet, 368,* 210-215.

Bargh, J. A. (1989). Conditional automaticity: Varieties of automatic influence in social perception and cognition. In J. S. Uleman & J. A. Bargh (Eds.), *Unintended thought* (pp. 3-51). New York: Guilford Press.

Bargh, J. A., Chaiken, S., Govender, R., & Pratto, F. (1992). The generality of the automatic attitude activation effect. *Journal of Personality and Social Psychology, 64,* 753-758.

Barnby, M., & Monaco, A. P. (2004). Strategies for autism candidate gene analysis. In G. Bock & J. Goode (Eds.), Novartis Foundation Symposium on Autism: Neural basis and treatment possibilities (pp. 48-69). Chichester: John Wiley & Sons.

Baron-Cohen, S. (1991). Do individuals with autism understand what causes emotions? *Child Development, 62,* 385-395.

Baron-Cohen, S. (1995). *Mindblindness: An essay on autism and theory of mind.* Cambridge: The MIT Press.

Baron-Cohen, S., Baldwin, D. A., & Crowson, M. (1997). Do individuals with autism use speaker's direction of gaze strategy to crack the code of language? *Child Development, 68,* 48-57.

Baron-Cohen, S., Campbell, R., Karmiloff-Smith, A., Grant, J., & Walker, J. (1995). Are children with autism blind to the mentalistic significance of the eyes? *British Journal of Developmental Psychology, 13,* 379-398.

Baron-Cohen, S., Jolliffe, T., Mortimore, C., & Robertson, M. (1997). Another advanced test of theory of mind: evidence from very high functioning adults with autism or Asperger Syndrome. *Journal of Child Psychology and Psychiatry, 38,* 813-822.

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

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

Baron-Cohen, S., Ring, H. A., Wheelwright, S, Bullmore, E. T., Brammer, M. J., Simmons, A., & Williams, S. C. R. (1999). Social intelligence in the normal and autistic brain: An fMRI study. *European Journal of Neuroscience, 11,* 1891-1898.

Begeer, S., Rieffe, C., Meerum Terwogt, M., & Stockmann, L. (2006). Attention to facial emotion expressions in children with autism. *Autism, 10*, 37-51.

Bennetto,L., Pennington, B. F., & Rogers, S. J. (1996). Intact and impaired memory functions in autism. *Child Development, 67,* 1816-1835.

Bettelheim, B. (1959). Feral children and autistic children. *The American Journal of Sociology, 64,* 455-467.

Bloom, P., & German, T. P. (2000). Two reasons to abandon the false belief task as a test of theory of mind. *Cognition, 77,* 25-31.

Bowler, D.M. (1992). Theory of Mind in Asperger Syndrome. *Journal of Child Psychology and Psychiatry, 33,* 877-893.

Bowler, D. (2006). *Autism spectrum disorders: Psychological theory and research.* New York: John Wiley and Sons.

Bowler, D. M.., Briskman, J. A., Gurvidi, N., & Fornells-Ambrojo, M. (2005). Autistic and non-autistic children's performance on a non-social analogue of the false belief task. *Journal of Cognition and Development, 6,* 259-283.

Bowler, D. M., Matthews, N. J., & Gardiner, J. N. (1997). Asperger's syndrome and memory: similarity to autism but not amnesia. *Neuropsychologia, 35,* 65-70.

Burton, A. M., & Bruce, V. (1992). I recognize your face but I can't remember your name: A simple explanation? *British Journal of Psychology, 83,* 45-60.

Campbell, M., & Shay, J. (1995). Pervasive developmental disorders. In H. I Kaplan., & B. J. Sadock, (Eds.), *Comprehensive Textbook of Psychiatry* (6th ed., pp. 2277–2293). New York: Williams and Wilkins.

Carlston, D. E., & Skowronski, J. J. (1994). Saving in the relearning of trait information as evidence for spontaneous inference generation. *Journal of Personality and Social Psychology, 66,* 840–856.

Carpenter, M., Pennington, B. F., & Rogers, S. J. (2001). Understanding others' intention in children with autism. *Journal of Autism and Developmental Disorders, 31,* 589-599.

Celani, G., Battacchi, M. W., & Arcidiacono, L. (1999). The understanding of the emotional meaning of facial expressions in people with autism. *Journal of Autism and Developmental Disorders, 29,* 57-66.

Courchesne, E. (and 15 others). (2001). Unusual brain growth patterns in early life in patients with autistic disorder: a MRI study. *Neurology, 57,* 245–254.

Dawson, G., Meltzoff, A. N., Osterling, J., Rinaldi, J., & Brown, E. (1998). Children with autism fail to orient towards naturally occurring social stimuli. *Journal of Autism and Developmental Disorders, 28,* 479-485.

Dawson, G., Toth, K., Abbott, R., Osterling, J., Munson, J., Estes, A., & Liaw, J. (2004). Early social attention impairment in autism: Social orienting, joint attention, and attention to distress. *Developmental Psychology, 40,* 271-283.

Dozier, M. (1991). Functional measurement assessment of young children's ability to predict future behavior. *Child Development, 62,* 1091-1099.

Ehlers, S., Gillgerg, C., & Wing, L. (1999). A screening questionnaire for asperger syndrome and other high functioning autism spectrum disorders in school age children. *Journal of Autism and Developmental Disorders, 29,* 129-141.

Fein, S., Hilton, J. L., & Miller, D. T. (1990). Suspicion of ulterior motivation and the correspondence bias. *Journal of Personality and Social Psychology, 58,* 753-764.

Ferguson, T.J., Olthof, T., Luiten, A., & Rule, B.G. (1984). Children's use of observed behavioral frequency versus behavioral covariation in ascribing dispositions to others. *Child Development, 55,* 2094-2105.

Fine, C., Lumsden, J., & Blair, R. J. R. (2001). Dissociation between theory of mind and executive functions in a patient with early left amygdale damage. *Brain, 124,* 287-298.

Flavell, J. H. (1999). Cognitive development: Children's knowledge about the mind. *Annual Review of Psychology, 50,* 21-45.

Fletcher, G. J. O. (1984). Psychology and common sense. *American Psychologist, 39,* 203-213.

Fombonne, E. (2003). Epidemiological Surveys of Autism and Other Pervasive Developmental Disorders: An Update. *Journal of Autism and Developmental Disorders, 33,* 365-382.

Frith, C. (2003). What do imaging studies tell us about the neural basis of autism? In G. Bock & J. Goode (Eds.), Novartis Foundation Symposium on Autism: Neural basis and treatment possibilities (pp. 149-165). Chichester: John Wiley & Sons.

Frith, C., & Frith, U. (2005). Theory of Mind. *Current Biology, 15,* 644-645.

Frith, U. (1989). *Autism: Explaining the enigma.* (1st ed.). Oxford: Blackwell.

Frith, U. (2003). *Autism: Explaining the enigma.* (2nd ed.). Oxford: Blackwell.

Frith, U. (1969). Emphasis and meaning in recall in normal and autistic children. *Language Speech, 12,* 29-38.

Frith, U., & Happe, F. (1994). Autism: Beyond theory of mind. *Cognition, 50,* 115-132.

Frith, U., Morton, J., & Leslie, A. M. (1991). The cognitive basis of a biological disorder: Autism. *Trends in Neurosciences, 14,* 433-438.

Frith, U., & Snowling, M. (1983). Reading for meaning and reading for sound in autistic and dyslexic children. *Journal of Developmental Psychology, 1,* 329-324.

Frye, D., Zelazo, P. D., & Palfai, T. (1995). Theory of mind and rule based reasoning. *Cognitive Development, 10,* 483-427.

Fyffe, C., & Prior, M. (1978). Evidence for language recoding in autistic, retarded and normal children: A re-examination. *British Journal of Psychology, 69,* 393-402.

Ghaziuddin, M., Butler, E., Tsai, L., & Ghaziuddin, N. (1994). Is clumsiness a marker for Asperger syndrome? *Journal of Intellectual Disability Research, 38,* 519–527.

Gilbert, D.T., & Malone, P.S. (1995). The Correspondence Bias. *Psychological Bulletin, 117,* 21-38.

Gilbert, D., Pelham, B., & Krull, D. (1988). On cognitive busyness: When perceivers meet persons perceived. *Journal of Personality and Social Psychology, 54*, 733-740.

Gnepp, J., & Chilamkurti, C. (1988). Children's use of personality attributions to predict other people's emotional and behavioral reactions. *Child Development, 59,* 743-754.

Grandin, T. (1995). *Thinking in pictures: and other reports from my life with autism.* New York: Doubleday.

Griffith, E. M., Pennington, B. F., Wehner, E.A., & Rogers, S. J. (1999). Executive functions in young children with autism. *Child Development, 70,* 817-832.

Hadwin, J., Baron-Cohen, S., Howlin, P., & Hill, K. (1997). Does teaching theory of mind have an effect on the ability to develop conversation in children with autism? *Journal of Autism and Developmental Disorders, 27,* 519-537.

Happe, F. G. E. (1994). An advanced test of theory of mind: Understanding of story characters' thoughts and feelings by able autistic, mentally handicapped, and normal children and adults. *Journal of Autism and Development Disorders, 24,* 129-154.

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

Happe, F. G. E. (1996). Studying weak central coherence at low levels: Children with autism do not succumb to visual illusions. A research note. *Journal of Child Psychology and Psychiatry, 37,* 873–877.

Happe, F. G. E. (1997). Central coherence and theory of mind: Reading homographs in context. *British Journal of Developmental Psychology, 15,* 1-12.

Heider, F. (1944). Social perception and phenomenal causality. *Psychological Review, 51,* 358-374.

Heider, F. (1958). *The psychology of interpersonal relations.* New York: Wiley.

Heider, F., & Simmel, S. (1944). An experimental study of apparent behavior. *American Journal of Psychology, 57,* 243-259.

Hermelin, B., & O'Connor, N. (1967). Remembering of words by psychotic and subnormal children. *British Journal of Psychology, 58,* 213-218.

Hermelin, B., & O'Connor, N. (1986). Idiot savant calendrical calculators: rules and regularities. *Psychological medicine, 16,* 885-893.

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

Hill, E. (2004a). Evaluating the theory of executive dysfunction in autism. *Developmental Review, 24,* 189-233.

Hill, E., & Frith, U. (2003). Understanding autism: Insights from mind and brain. *Philosophical Transactions of the Royal Society London, Biological Sciences, 358,* 281–289.

Hirschfeld. L., Bartmess, E., White, S., & Frith, U. (2007). Can autistic children predict behavior by social stereotypes? *Current Biology, 17,* 451-452.

Houston, R., & Frith, U. (2000). *Autism in history.* Oxford: Blackwell.

Jarrold, C., Butler, D. W., Cottington, E. M., & Jimenez, F. (2002). Linking theory of mind and central coherence bias in autism and in the general population. *Developmental Psychology, 36,* 126-138.

Jemel, B., Mottron, L., & Dawson. M. (2006). Impaired face processing in autism: Fact or artifact? *Journal of Autism and Developmental Disorders, 36,* 91-106.

Jolliffe, T., & Baron-Cohen, S. (1999). A test of central coherence theory: Linguistic processing in high functioning adults with autism or asperger's syndrome: Is local coherence impaired? *Cognition, 71,* 149-185.

Jones, E. E., & Davis, K. E. (1965). From acts to dispositions: The attribution process in social psychology, in L. Berkowitz (ed.), *Advances in experimental social psychology* (Volume 2, pp. 219-266), New York: Academic Press.

Jones, E. E., & Harris, V. A. (1967). The attribution of attitudes. *Journal of Experimental Social Psychology, 3,* 1-24.

Just, M. A., Cherkassy, V. L., Keller, T. A., & Minshew, N. J. (2004). Cortical activation and synchronization during sentence comprehension in high-functioning autism: evidence of underconnectivity. *Brain, 127,* 1811-1821.

Just, M. A., Cherkassky, V. L., Keller, T. A., Kana, R. K., & Minshew, N. J. (2007). Functional and anatomical cortical underconnectivity in autism: Evidence from an fMRI study of an executive function task and corpus callosum morphometry. *Cerebral Cortex, 17,* 951-961.

Kana, R. K., Keller, T. A., Minshew, N. J., & Just, M. A. (2007). Inhibitory control in high functioning autism: Decreased activation and underconnectivity in inhibition networks. *Biological Psychiatry, 62,* 198-206.

Kanner, L. (1943). Autistic disturbances of affective contact. In L. Kanner (1973), Childhood psychosis: Initial studies and new insights (pp. 1-43). Washington, D. C: V. H. Winston & Sons.

Kanner, L., & Eisenberg, L. (1957). Early Infantile Autism, 1943-1955. In L. Kanner (1973), Childhood psychosis: Initial studies and new insights (pp. 91-101). Washington, D. C: V. H. Winston & Sons.

Kelly, H. (1973). The process of causal attribution. *American Psychologist, 28,* 107-128.

Klin, A. (2000). Attributing social meaning to ambiguous visual stimuli in higher-functioning autism and asperger syndrome: The social attribution task. *Journal of Child Psychology and Psychiatry, 41,* 831-846.

Klin, A., Sparrow, S. S., de Bildt, A., Cicchetti, D. V., Cohen, D. J., & Volkmar, F. R. (1999). A normed study of face recognition in autism and related disorders. *Journal of Autism and Developmental Disorders, 29,* 499-508.

Klinger, L. G., & Dawson, G. (2001). Prototype formation in autism. *Development and psychopathology, 13,* 111-124.

Koshino, H., Kana, R. K., Keller, T. A., Cherkassky, V. L., Minshew, N. J & Just M. A. fMRI investigation of working memory for faces in autism: Visual coding and underconnectivity with frontal areas. *Cerebral Cortex.* Advance Access published May 20, 2007, doi:10.1093/cercor/bhm054.

Le Couteur, A., Lord, C., & Rutter, M. (1994). The autism diagnostic interview - revised: A revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders, 24,* 659-685.

Leslie, A. M., & Frith, U. (1988). Autistic children's understanding of seeing, knowing, and believing. *British Journal of Developmental Psychology, 6,* 315-324.

Leslie, A. M., & Thaiss, L. (1992). Domain specificity in conceptual development: Evidence from autism. *Cognition, 43,* 225-251.

Livesley, W. J., & D. B. Bromley (1973). *Person perception in childhood and adolescence.* London: John Wiley.

Lopez, B., & Leekam, S. R. (2003). Do children with autism fail to process information in context? *Journal of Child psychology or psychiatry, 44,* 285-300.

Lotter, V. (1966). Epidemiology of autistic conditions in young children. *Social Psychiatry and Psychiatric Epidemiology, 1,* 124-135.

McIntosh, H. (1998, November). Autism is likely to be linked to several genes. *APA Monitor*, 29. Retrieved July 19, 2007, from http://www.apa.org/monitor/nov98/gene.html

McWeeny, K. H., Young, A. W., Hay, D. C., & Ellis, A. W. (1987). Putting names to faces. *British Journal of Psychology, 78,* 143-149.

Meltzoff. A. N. (1995). Understanding the intentions of others: Re-enactment of intended acts by 18-month-old children. *Developmental Psychology, 31,* 1-16.

Minshew, N. J., Goldstein, J., Muenz, L R., & Payton, J. B. (1992). Neuropsychological functioning in nonmentally retarded autistic individuals. *Journal of Clinical and Experimental Neuropsychology, 14,* 741-761.

Minter, M., Hobson, R. P., & Bishop, M. (1998). Congenital visual impairment and theory of mind. *British Journal of Developmental Psychology, 16,* - 183-196.

Miyahara, M., Tsujii, M., Hori, M., Nakanishi, K., Kageyama, H., & Sugiyama, T. (1997). Brief report: Motor incoordination in children with asperger's syndrome and learning disabilities. *Journal of Autism and Developmental Disorders, 27,* 595–603.

Mottron, L., & Belleville, S. (1993). A study of perceptual analysis in a high-level autistic subject with exceptional graphic abilities. *Brain and Cognition, 23,* 279-309.

Mottron, L., Dawson, M., Soulieres, I., Hubert, B., & Burack, J. (2006). Enhanced perceptual functioning in autism: An update, and eight principles of autistic perception. *Journal of Autism and Developmental Disorders, 36,* 27-43.

Ozonoff, S., & Jensen, J. (1999). Brief report: Specific executive dysfunction profiles in three neurodevelopmental disorders. *Journal of Autism and Developmental Disorders, 29,* 171-177.

Ozonoff, S., & Miller. J. N. (1995). Teaching theory of mind: A new approach to social skills training for individuals with autism. *Journal of Autism and Developmental Disorders, 25,* 415-433.

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

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

Ozonoff, S., & Strayer, D. L. (1997). Inhibitory function in nonretarded children with autism. *Journal of Autism and Developmental Disorders, 27,* 59-77.

Pellicano, E., Maybery, M., & Durkin, K. (2005). Central coherence in typically developing preschoolers: does it cohere and is it related to mindreading and executive control? *Journal of Child Psychology and Psychiatry, 46,* 533-547.

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

Phillips, W., Baron-Cohen, S., & Rutter, M. (1998). Understanding intention in normal development and in autism. *British Journal of Developmental Psychology, 16,* 337-348.

Plaisted, K., Swettenham, J., & Rees, L. (1999). Children with autism show local precedence in a divided attention task and global precedence in a selective attention task. *Journal of Child Psychology and Psychiatry, 40,* 733-742.

Plaisted, K., O'Riordan, M., & Baron-Cohen, S. (1998). Enhanced visual search for a conjunctive task in autism: A research note. *Journal of Child Psychology and Psychiatry, 39,* 777-783.

Pratto, F. & John, O.P., (1991). Automatic vigilance: The attention-grabbing power of negative social information. *Journal of Personality and Social Psychology, 61*, 380-391.

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

Prior, M., Dahlstrom, T. L. & Squires, T. L. (1990). Autistic children's knowledge of thinking and feeling states in other people. *Journal of Child Psychology and Psychiatry, 31,* 587-601.

Quill, K. A., (1997). Instructional considerations for young children with autism: The rationale for visually cued instructions. *Journal of Autism and Developmental Disorders, 27,* 697-714.

Rahman, R. A., Sommer, W., & Olada, E. (2004). I recognize your face but I can't remember your name: A question of expertise? *The Quarterly Journal of Experimental Psychology, 57,* 819-834.

Rajendran, J., & Mitchell, P. (2007). Cognitive theories of autism. *Developmental Review,* doi:10.1016/j.dr.2007.02.001

Rapacholi, B. M., & Gopnik, A. (1997). Early reasoning about desires: Evidence from 14- and 18-month olds. *Developmental Psychology, 33,* 12-21.

Rinehart, N. J., Bradshaw, J. L., Moss, S. A., Brereton, A. V., & Tonge, B. J. (2000). Atypical interference on local detail on global processing in high functioning autism and Asperger's syndrome. *Journal of Child Psychology and Psychiatry, 41,* 769-778.

Rinehart, N. J., Bradshaw, J. L., Brereton, A. V., & Tonge, B. J. (2001). Movement preparation in high-functioning autism and asperger's syndrome: A serial choice reaction time task involving motor reprogramming. *Journal of Autism and Developmental Disorders, 31,* 79-88.

Rimland, B. (1964). *Infantile autism: The syndrome and its implications for a neural theory of behavior.* New York: Appleton-Century-Crofts.

Rodier, P. M., & Hyman, S. L. (1998). Early environmental factors in autism. *Mental Retardation and Developmental Disabilities Research Reviews, 4,* 121-128.

Romando, N., & Milech, D. (1984). The nature and specificity of language coding deficit in autistic children. *British Journal of Psychology, 75,* 95-103.

Ropar, D., & Mitchell, P. (1999). Are individuals with autism and Asperger's syndrome susceptible to visual illusions? *Journal of Child Psychology and Psychiatry, 40,* 1283-1293.

Ropar, D., & Mitchell, P. (2001). Susceptibility to illusions and performance on visuo-spatial tasks in individuals with autism. *Journal of Child Psychology and Psychiatry*, 42, 539-549.

Rosati, A. D., Knowles, E. D., Kalish, C. W., Gopnik, A., Ames, D. R., & Morris, M. W. (2001). The rocky road from acts to dispositions: Insight for attribution theory from developmental research on theory of mind. In B. F. Malle., L. J. Moses., & D. A. Baldwin (Eds.), *Intentions and Intentionality: Foundations of social cognition* (pp 287-303). London: Bradford books/MIT Press.

Ross, L. (1977). The intuitive psychologist and his shortcomings: Distortions in the attribution process. In L. Berkowitz (ed.), *Advances in experimental social psychology* (Volume 10, pp. 173-240), Orlando, FL: Academic Press.

Russell, J., & Hill, E. L. (2001). Action-monitoring and intention reporting in children with autism. *Journal of Child Psychology and Psychiatry, 42,* 317–328.

Russell, J., Mauthner, N., Sharpe, S., & Tidswell, T. (1991). The 'windows task' as a measure of strategic deception in preschoolers and autistic subjects. *British Journal of Developmental Psychology, 9,* 331-349.

Rutter, M. (1978). Diagnosis and definition of childhood autism. *Journal of Autism and Developmental Disorders, 8,* 139-161.

Rutter, M. (2003). Introduction: autism – the challenges ahead. In G. Bock & J. Goode (Eds.), Novartis Foundation Symposium on Autism: Neural basis and treatment possibilities (pp. 1-9). Chichester: John Wiley & Sons.

Sacks, O. (1995). *An anthropologist on mars.* London: Picador.

Scanlan, C. S., & Johnston, R. A. (1997). I recognize your face but I can't remember your name: A grown up explanation. *The Quarterly Journal of Experimental Psychology, 50,* 183-198.

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

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

Sigman, M., Mundy, P., Ungerer, J., & Sherman, T. (1986). Social interactions of autistic, mentally retarded, and normal children and their caregivers. *Journal of Child Psychology and Psychiatry, 27,* 647-656.

Skuse, D. (2003). X-linked genes and the neural basis of social cognition. In G. Bock & J. Goode (Eds.), Novartis Foundation Symposium on Autism: Neural basis and treatment possibilities (pp. 84-97). Chichester: John Wiley & Sons.

Skuse, D.,Warrington, R., Bishop, D., Chowdhury, U., Lau,J., Mandy, W., & Place, M. (2004) The developmental, dimensional and diagnostic interview (3di): a novel computerized assessment for autism spectrum disorders. *Journal of the American Academy of Child and Adolescent Psychiatry, 43,* 548 -558.

Szatmari, P., Jones, M. B., Zwaigenbaum, L., & MacLean, J. E (1998). Genetics of autism:Overview and new directions. *Journal of Autism and Developmental Disorders, 28,* 351-368.

Semin, G, R., & Fiedler, K. (1991). The linguistic category model, its bases, applications and range. *European Review of Social Psychology, 2,* 1-30.

Skuse, D., Warrington, R., Bishop, D. V. M., Chowdhury, U., Mandy, W., & Place, M. (2004). The Developmental, Diagnostic and Dimensional Interview (3di): a novel computerised assessment for autistic spectrum disorders. *Journal of the American Academy of Child and Adolescent Psychiatry, 43,* 548-558.

Snowling, M., & Frith, U. (1986). Comprehension in hyperlexic readers. *Journal of Experimental Child Psychology, 42,* 392-415.

Tager-Flusberg, H. (1991). Semantic processing in free recall of autistic children: Further evidence for a cognitive deficit. *British Journal of Developmental Psychology, 9,* 417-430.

Tager-Flusberg, H. (1992). Autistic children's talk about psychological states: Deficits in early acquisition of a theory of mind. *Child Development, 63,* 161-172.

Tager-Flusberg, H., & Sullivan, K. (1994). Predicting and explaining behavior: A comparison of autistic, mentally retarded and normal children. *Journal of Child Psychology and Psychiatry, 35,* 1059-1075.

Tan, J., and Harris, P. L. (1991). Autistic children understand seeing and wanting. *Devlopmental Psychopathogy, 3,* 163–174.

Todorov, A., & Uleman, J. S. (2004). The person reference process in spontaneous trait inference. *Journal of Personality and Social Psychology, 87,* 482-493.

Toichi, M., & Kamio, Y. (2001). Verbal association for simple common words in high functioning autism. *Journal of Autism and Developmental Disorders, 31,* 483-490.

Trope, Y. (1986). Identification and Inferential Processes in Dispositional Attribution. *Psychological Review, 93,* 239-257.

Tuchman, R., & Rapin, I. (2002). Epilepsy in autism. *The Lancet Neurology, 1,* 352-358.

Tulving, E., & Thomson, D. M. (1973). Encoding specificity and retrieval processes in episodic memory. *Psychological Review, 80,* 352–373.

Uleman, J. S. (1988). [Trait inference norms]. Unpublished raw data. New York University, New York.

Uleman, J.S. (1999). Spontaneous versus intentional inferences in impression formation. In S. Chaiken & Y. Trope (Eds.). *Dual-process theories in social psychology* (pp. 141-160). New York: Guilford.

Uleman, J.S., Hon, A., Roman, R.J., & Moskowitz, G.B. (1996). On-line evidence for spontaneous trait inference at encoding. *Personality and Social Psychology Bulletin, 22,* 377-394.

Uleman, J. S., Newman, L.S., & Moskowitz, G.B. (1996). People as flexible interpreters: Evidence and issues from spontaneous trait inference. *Advances in Experimental Social Psychology, 28,* 211-279.

Wellman, H. M. (1990). *The child's theory of mind.* London: Bradford books/MIT Press.

Wellman, H. M., Cross, D., & Watson, J. (2001). Meta-analysis of theory-of mind development: The truth about false belief. *Child Development, 72,* 655-684.

Wellman, H. M., & Woolley, J. D. (1990). From simple desires to ordinary beliefs: The early development of everyday psychology. *Cognition, 35,* 245-275.

Whaley, C. P. (1978). Word-nonword classification time. *Journal of Verbal Learning and Verbal Behavior, 17,* 143-154.

Williams, E. (2004). Who really needs a theory of mind? *Theory and Psychology, 14,* 704-724.

Williams D. L., Goldstein. G., & Minshew N. J. (2005). Impaired memory for faces and social scenes in autism: Clinical implications of the memory disorder. *Archives of Clinical Neuropsychology. 20*, 1–15.

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

Wing, L. (1981), "Asperger's syndrome: A clinical account". *Psychological Medicine, 11,* 115-130.

Wing, L., & Gould, G. (1979). Severe impairments of social interaction and associated abnormalities in children: Epidemiology and classification. *Journal of Autism and Developmental Disorders, 9,* 11-29.

Winter, L., & Uleman, J. S. (1984). When are social judgements made? Evidence for the spontaneousness of trait inferences. *Journal of Personality and Social Psychology, 47,* 237-252.

Winter, L., Uleman, J. S., & Cunniff, C. (1985). How automatic are social judgments. *Journal of Personality and Social Psychology, 49,* 904-917

Woodruff, G., & Premack, D. (1979). Intentional communication in the chimpanzee: The development of deception. *Cognition, 7,* 333-362.

Woolfe, T., Want, S.C. & Siegal, M. (2002). Signposts to development: theory of mind in deaf children. *Child Development,* *73*, 768–778.

World Health Organisation (1977). *International Classification of Diseases (9th edition).* WHO Press.

World Health Organisation (1994). *International Classification of Diseases (10th edition).* WHO Press.

Young, A. W., Hay, D. C., & Ellis, A. W. (1985). The faces that launched a thousand slips: Everyday difficulties and errors in recognizing people. *British Journal of Psychology, 76,* 495-523.

Yuill, N. (1992). Children's production and comprehension of trait terms. *British Journal of Developmental Psychology, 10,* 131-142.

Yuill, N., & Pearson, A. (1998). The development of bases for trait attribution: Children's understanding of traits as causal mechanisms based on desire. *Developmental Psychology, 34,* 574-586.

Zelazo, P. D., Jacques, S., Burack, J. A., & Frye, D. (2002). The relationship between theory of mind and rule use: Evidence from persons with autism spectrum disorders. *Infant and Child Development, 11,* 171-195.

Appendix A

Diagnostic criteria for Autistic Disorder/Childhood autism

Diagnostic and Statistical Manual of Mental disorders (4th edition, Text Revision)

A. A total of six (or more) items from (1), (2), and (3), with at least two from (1), and one each from (2) and (3):

(1) qualitative impairment in social interaction, as manifested by at least two of the following:

(a) 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

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

(c) 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)

(d) lack of social or emotional reciprocity

(2) qualitative impairments in communication as manifested by at least one of the following:

(a) delay in, or total lack of, the development of spoken language (not accompanied by an attempt to compensate through alternative modes of communication such as gesture or mime)

(b) in individuals with adequate speech, marked impairment in the ability to initiate or sustain a conversation with others

(c) stereotyped and repetitive use of language or idiosyncratic language

(d) lack of varied, spontaneous make-believe play or social imitative play appropriate to developmental level

(3) restricted repetitive and stereotyped patterns of behavior, interests, and activities, as manifested by at least one of the following:

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

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

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

(d) persistent preoccupation with parts of objects

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

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

International Classification of Diseases (10^{th} edition)

At least 8 of the 16 specified items must be fulfilled.

a. Qualitative impairments in reciprocal social interaction, as manifested by at least three of the following five:

1. failure adequately to use eye-to-eye gaze, facial expression, body posture and gesture to regulate social interaction.

2. failure to develop peer relationships.

3. rarely seeking and using other people for comfort and affection at times of stress or distress and/or offering comfort and affection to others when they are showing distress or unhappiness.

4. lack of shared enjoyment in terms of vicarious pleasure in other peoples' happiness and/or spontaneous seeking to share their own enjoyment through joint involvement with others.

5. lack of socio-emotional reciprocity.

b. Qualitative impairments in communication:

1. lack of social usage of whatever language skills are present.

2. impairment in make-believe and social imitative play.

3. poor synchrony and lack of reciprocity in conversational interchange.

4. poor flexibility in language expression and a relative lack of creativity and fantasy in thought processes.

5. lack of emotional response to other peoples' verbal and non-verbal overtures.

6. impaired use of variations in cadence or emphasis to reflect communicative modulation.

7. lack of accompanying gesture to provide emphasis or aid meaning in spoken communication.

c. Restricted, repetitive and stereotyped patterns of behaviour, interests and activities, as manifested by ate least two of the following six:

1. encompassing preoccupation with stereotyped and restricted patterns of interest.

2. specific attachments to unusual objects.

3. apparently compulsive adherence to specific, non-functional routines or rituals.

4. stereotyped and repetitive motor mannerisms.

5. preoccupations with part-objects or non-functional elements of play material.

6. distress over changes in small, non-functional details of the environment.

d. Developmental abnormalities must have been present in the first three years for the diagnosis to be made.

Appendix B

Table B1

Experimental stimuli used in experiment 1 (*Pilot Test 1*). The numbers in the bracket are the frequency/syllable count/word length.

Sentences	Trait cue	Distracter (Trait)	Semantic cue	Distracter (Semantic)
He won first prize in the countrywide high school general knowledge quiz.	clever (292/2/6)	full (300/1/4)	question (19/2/8)	keyboard (19/2/8)
He defeated the world boxing champion in the very first round.	strong (224/1/6)	fair (230/1/4/)	gloves (49/1/6)	church (49/1/6)
He tripped on the bearskin rug and twisted his ankle.	clumsy (41/2/6)	extra (41/2/5)	floor (314/1/5)	lion (314/2/4)
He picked out the best chocolates for himself before the guests arrived.	selfish (3/2/7)	deepest (3/2/7)	milk (289/1/4)	years (289/1/5)
He told the cashier that he was given too much change.	honest (14/2/6)	central (14/2/7)	money (365/2/5)	paper (365/2/5)
He invited his new neighbour to his house for tea.	friendly (38/2/8)	cracked (38/1/7)	cup (216/1/3)	ship (214/1/4)
He dusted and vacuumed his house everyday.	tidy (62/1/4)	damp (59/1/4)	rooms (78/1/5)	pocket (78/2/6)

He took the <u>garbage</u> out on the wrong day.	forgetful (14/3/10)	thinner (14/2/7)	dustbin (87)	torch (87/1/5)
He laid around the house all day watching <u>television</u>.	lazy (16/2/4)	darker (16/2/6)	channel (16/2/7)	battery (14/3/7)
He could not bring himself to <u>greet</u> his new classmate.	shy (32/1/3)	furry (32/2/5)	hello (292/2/5)	job (292/1/3)
He always <u>drove</u> a little slower than the speed limit.	careful (68/2/7)	nearby (68/2/6)	wheel (51/1/5)	soup (51/1/4)
He scored a 100 percent in his <u>maths</u> A level.	clever (292/2/6)	full (300/1/4)	numbers (16/2/7)	scissors (16/2/8)
He carried the heavy <u>stereo</u> with one hand up three floors.	strong (224/1/6)	fair (230/1/4/)	music (122/2/5)	toys (127/1/4)
He bumped into the closet door and hurt his <u>nose</u>.	clumsy (41/2/6)	extra (41/2/5)	face (262/1/5)	pond (268/1/4)
He would not share the <u>biscuits</u> with his brother.	selfish (3/2/7)	deepest (3/2/7)	tea (503/1/3)	eyes (498/1/4)
He told the teacher that he broke the <u>window</u>.	honest (14/2/6)	central (14/2/7)	glass (211/1/5)	frog (211/1/4)
He chatted with the stranger next to him on the <u>bus</u>.	friendly (38/2/8)	cracked (38/1/7)	ticket (11/2/6)	sweater (22/2/7)
He was always seen in a spotless and well ironed <u>shirt</u>.	tidy (62/1/4)	damp (59/1/4)	collar (11/2/6)	knife (11/1/5)

He left his groceries on the bus when he got off.	forgetful (14/3/10)	thinner (14/2/7)	shop (311/1/4)	grass (306/1/5)
He drove to the bakery just half a block away.	lazy (16/2/4)	darker (16/2/6)	bread (224/1/5)	forest (227/2/6)
He sat quietly in a corner at the party.	shy (32/1/3)	furry (32/2/5)	birthday (233/2/8)	rainbow (230/2/7)
He double checked that all the doors and windows were locked before leaving home.	careful (68/2/7)	nearby (68/2/6)	keys (58/1/4)	pizza (68/2/5)

Note: Both forms of the experiment contained all the 22 sentences but the cues were different. The cues in red were used in one form and the cues in blue in the other. Each cue was matched for frequency, syllable and word length with its distracter. The frequency was based on Children's printed word database (Version 1.3, 2002), available online. The semantic cues were taken from the Edinburgh Associative Thesaurus, available online.

Appendix C

Table C1

Experimental stimuli used in experiment 1 (*Pilot Test 2*) and experiment 2. The numbers in the bracket are the frequency/syllable count/word length.

Sentences	Trait cue	Distracter (Trait)	Semantic cue	Distracter (Semantic)
He won first prize in the high school quiz competition.	clever (292/2/6)	full (300/1/4)	question (19/2/8)	scissors (16/2/8)
He gets the first rank in his class examinations every year.				
He carried the office chair with just one hand up three floors.	strong (224/1/6)	fair (230/1/4)	gloves (49/1/6)	bead (3/1/4)
He defeated the world boxing champion in the very first round.				
He slipped on the bearskin rug and twisted his ankle.	clumsy (41/2/6)	extra (41/2/5)	mat (32/1/3)	fan (32/1/3)
He bumped into the cupboard door and hurt his nose.				
He picked out the best biscuits for himself before the guests arrived.	greedy (76/2/6)	useful (73/2/6)	tea (503/1/3)	eyes (498/1/4)
He ate all the scones without				

leaving any for his younger brother.				
He took the sick puppy that he found on the road to his house. He took some hot dinner to his ill neighbour.	kind (192/1/4)	deep (187/1/4)	pills (3/1/5)	coins (5/1/5)
He invited the newcomers to his house for coffee. He smiled and said hello to everyone at the tea party.	friendly (38/2/8)	cracked (38/1/7)	cup (216/1/3)	ship (214/1/4)
He dusted and vacuumed his house every morning. He wore a spotless and well ironed shirt each day.	tidy (62/1/4)	frozen (65/2/6)	night (725/1/5)	car (714/1/3)
He left his mobile phone on the shelf in the supermarket. He left his bag of groceries on the bus.	forgetful (14/3/10)	thinner (14/2/7)	food (925/1/4)	fox (919/1/3)
He drove to the park that was just half a block away. He laid around the house all day watching television.	lazy (16/2/4)	itchy (16/2/5)	garden (663/2/6)	town (681/1/4)

He could not bring himself to greet his new class mate.	shy (32/1/3)	furry (32/2/5)	teacher (249/2/7)	country (249/2/7)
He sat alone in a corner at his school Christmas party.				
He always drove a little below the speed limit.	careful (68/2/7)	mixed (68/1/5)	road (398/1/4)	bag (393/1/3)
He checked that everyone's seatbelts were fastened before starting the car.				

Note: Both forms of the experiment contained all the 22 sentences but the cues were different. The first sentence of each sentence pair was presented with the trait cue and the second with the semantic associate cue in form 1. In form 2 it was the opposite. Each cue was matched for frequency, syllable and word length with its distracter. The frequency was based on Children's printed word database (Version 1.3, 2002), available online. The semantic cues were taken from the Edinburgh Associative Thesaurus, available online.

Appendix D

Experimental stimuli used in experiments 3 and 4.

Table D1

Trait implying sentences and their corresponding neutral sentences and semantic associate cues. The numbers in the bracket are the frequency/syllable count/word length.

Trait implying	Neutral	Semantic	Distracter
He smiled and said hello to everyone at the tea party.	He met all his friends at the tea party.	cup (216/1/3)	bus (219/1/3)
He told the teacher that he broke the window.	He was asked by the teachers to close the window.	curtain (32/2/7)	shirt (32/1/5)
He takes the bus to the park that is just two streets away.	He goes to play in the park at the end of his street.	swing (108/1/5)	kitten (105/2/6)
He checked that everyone's seatbelts were fastened before starting the car.	He removed his seatbelt and got out of the car.	road (398/1/4)	sound (419/1/5)
He defeated the world boxing champion in the very first round.	He watched the world boxing championship on television.	gloves (49/1/6)	chicks (49/1/6)
He did not offer his seat to the old lady on the crowded bus.	He sat next to an old lady on the bus.	ticket (11/2/6)	cookie (11/2/6)

He took the <u>sick</u> puppy that he found on the road to his house.	He found his puppy <u>sick</u> when he reached his house.	pills (3/1/5)	coins (5/1/5)
He slipped on the <u>blue</u> rug and twisted his ankle.	He rolled up the <u>blue</u> rug that was in the hall.	colour (70/2/6)	page (70/1/4)
He picked out the best <u>chocolates</u> for himself at the party.	He had <u>chocolate</u> cake for dessert at the party.	milk (289/1/4)	nose (297/1/4)
He gets the first rank in his class <u>exams</u> every year.	He sat down to write the first <u>exam</u> of the year.	questions (32/2/9)	engines (32/2/7)
He dusted and vacuumed his <u>house</u> every morning.	He dusted and vacuumed his <u>house</u> for the party.	garden (663/2/6)	king (698/1/4)
He sat alone in a corner at the <u>school</u> Christmas party.	He placed the tree in a corner for the <u>school</u> Christmas party.	teacher (249/2/7	country (249/2/7)

Table D2

Trait implying sentences with trait and action cues. The numbers in the bracket are the frequency/syllable count/word length.

	Trait implying	Trait	Distracter	Action	Distracter
13	He called the newcomers to his house for dinner.	friendly (38/2/8)	powerful (38/3/8)	invited (27/3/7)	boiled (27/1/6)

14	He did not wipe off the sauce he dropped on his shirt.	messy (11/2/5)	bossy (8/2/5)	spill (14/1/4)	bend (22/1/4)
15	He just sat in front of the television the whole day long.	lazy (16/2/4)	cruel (19/1/5)	watched (22/1/7)	pushed (219/1/6)
16	He always drove a little below the speed limit.	careful (68/2/7)	brilliant (92/2/9)	slowly (203/2/6)	working (208/2/7)
17	He carried the office chair with just one hand up three floors.	strong (224/1/6)	clean (276/1/5)	climbed (373/1/7)	flew (368/1/4)
18	He left the dinner party without thanking the hostess.	rude (16/1/4)	fussy (22/2/5)	went (3678/1/4)	like (3578/1/4)
19	He took some hot dinner to his ill neighbour.	kind (192/1/4)	brave (211/1/5)	visited (11/3/7)	leaped (11/1/6)
20	He bumped into the cupboard door and hit his nose.	clumsy (41/2/6)	cheeky (22/2/6)	hurt (160/1/4)	threw (160/1/5)
21	He ate all the scones without leaving any for his younger brother.	greedy (976/2/6)	nasty (116/2/5)	finished (157/2/8)	decided (157/3/7)

22	He usually got all the answers correct in the math class.	clever (292/2/6)	funny (379/2/5)	solved (19/1/5)	burnt (19/1/5)
23	He wore a spotless and well ironed shirt each day.	tidy (62/2/4)	proud (65/1/5)	dressed (62/1/7)	lifted (62/3/6)
24	He looked at the floor when he said hello to his new classmate	shy (16/1/3)	crazy (16/2/5)	greeted (5/2/7)	crawl (16/1/5)

Note: Both forms of the experiment contained 24 sentences, six each from the following four sentence-cue pairs; trait implying sentence-semantic associate cue pair, neutral sentence-semantic cue pair, trait implying sentence-trait cue pair and trait implying sentence-action cue pair. All the semantic associate cues, presented in table C1 were presented in both forms but in one form only the sentences in red was used and in the other only the sentences in blue. All eleven sentences in table C2 were presented in both forms. But in one form the cues in red were presented and in the other the cues in blue. Each cue was matched for frequency, syllable and word length with its distracter. The frequency was based on Children's printed word database (Version 1.3, 2002), available online. The semantic cues were taken from the Edinburgh Associative Thesaurus, available online.

Appendix E

Experimental stimuli used in experiment 5

Table E1

Trait implying sentences and their corresponding neutral sentences and action cues

Trait implying	Neutral	Action	Distracter
He called the new neighbours to his house for dinner.	He was called for dinner at his friend's new house.	invited	poured
He dusted and vacuumed his house every morning.	He dusted and vacuumed the house for the party.	cleaned	folded
He took the old lady's bag of groceries to her car.	He took his bag of groceries to the car.	carried	increased
He left the dinner party without thanking the hostess.	He left for the dinner party with his friend.	leave	tell
He sat in front of the television the whole day long.	He sat in front of the television for the football match.	watched	spread
He started off in his car without wearing his seatbelt.	He started off in his car for his work place.	drive	hear
He took some hot dinner to his ill neighbour.	He went over to his neighbour's house in the evening.	visited	choose

He told the teacher that he broke the window.	He told the teacher about the window that was stuck	reported	appeared
He usually gets the correct answers in the math class.	He looked whether the answers he got in the math class were right.	solve	packed
He finished the scones without leaving any for his younger brother.	He was so hungry he finished off all the scones.	ate	bend
He was often seen looking around for his car keys.	He looked for a good car deal on the net.	search	faced
He looked at the floor when he said hello to his new classmate.	He went over to say hello to his mate at the party.	greeted	assist

Table E2

Trait implying sentences and their corresponding neutral sentences and semantic associate cues

Trait implying	Neutral	Semantic	Distracter
He smiled and said hello to everyone at the tea party.	He met all his class mates at the tea party.	cup	dog
He wore a spotless and well ironed shirt each day.	He spotted a nice shirt at the shop the other day.	night	car

He spent many hours showing his cousin how to use his new computer.	He had to spend an hour waiting for his new computer to be delivered.	clock	pound
He did not offer his seat to the old lady on the crowded bus.	He sat next to an old lady on the crowded bus.	ticket	forests
He drove to the park that was just at the end of his street.	He goes to play in the park that is at the end of his street.	swing	guitar
He forgot to check whether the widows were shut before leaving the house.	He went to shut the window because the room was getting cold.	curtain	apples
He took the sick puppy he found on the road to his house.	He found his puppy sick when he reached his house.	pills	beans
He returned the lost wallet with all the money in it.	He returned the damaged wallet back to the store.	pocket	birds
He gets the first rank in his class exams every year.	He sat down to write his first exam for the year.	questions	months
He picked out the best biscuits for himself before the guests arrived.	He picked up some biscuits to have in the evening.	tea	mail
He left his mobile phone on the shelf in the supermarket.	He topped up his mobile phone at the	food	college

	supermarket.		
He sat alone in a corner at the school Christmas party.	He placed the tree in the corner for the school Christmas party.	teacher	coffee

Note: Both forms of the experiment contained 24 sentences, six each from the following four sentence-cue pairs; trait implying sentence-semantic associate cue pair, neutral sentence-semantic associate cue pair, trait implying sentence-action cue pair and neutral sentence-action cue pair. In one form the sentences in red were presented and in the other the sentences in blue. Each cue was matched for frequency, syllable and word length with its distracter. The frequency was based on MRC Psycholinguistic Database (1987). The semantic cues were taken from the Edinburgh Associative Thesaurus. Both are available free on the internet.

Appendix F

Experimental stimuli used in experiments 6 and 7

Table F1: Facts, fact implying sentences and face stimuli

Fact implying sentence	Fact	Actor	Fact implying sentence	Fact	Actor
This is Charles who carried the lunch ordered by the customer to their table.	waiter		This is Thomas who does a full time course at the local college.	student	
This is George who checked the soup packet to make sure that it does not contain any meat.	vegetarian		This is Edward who plays the role of Romeo in 'Romeo and Juliet'.	actor	
This is Ben who does not ever smoke a cigarette or a pipe.	non-smoker		This is Fred who has to bend down to enter most doors.	tall	
This is Robert who cannot hear much even with his hearing aid.	deaf		This is David who did not have an umbrella and had to walk home in the rain.	wet	
This is Andrew who went to bed with a sore throat and a bad cold.	sick		This is Mathew who can afford to buy only from sales at charity shops.	poor	

This is Harry who came over from Australia to work here.	foreigner		This is Jack who has a two year old son.	father	

Table F2: Traits, trait implying sentences and face stimuli used

Trait			Trait		
This is Ross who usually gets the correct answers in the math class.	clever		This is Mike who smiled and said hello to everyone at the party.	friendly	
This is Neil who is going to learn skydiving over the summer holidays.	daring		This is Paul who was cool standing in front of the huge crowd and giving his speech.	confident	
This is Victor who ignored his injuries and completed the race.	determined		This is Gordon who always drove a little slower than the speed limit.	careful	
This is Carl who suddenly decided to go away for the weekend.	impulsive		This is John who does not know who the current American president is.	ignorant	

This is Duncan who sat alone in a corner at the party.	shy		This is Walter who left his bag of groceries on the bus.	forgetful	
This is Bill who sat in front of the television the whole day long.	lazy		This is Pat who made many errors doing math problems he knew how to do.	careless	

Table E3: Trait and fact implying sentences presented with names

This is Alex whose jokes make everyone laugh so hard they hold their sides.	Alex		This is James who took the sick puppy he found on the road to his house.	James	
This is Steve who watches his neighbour's house to see who comes and goes.	Steve		This is Dick who refused to eat the peas that had gotten into his gravy.	Dick	
This is Martin who picked out the best biscuits for himself before the guests arrived.	Martin		This is Henry who did not offer his seat to the old lady on the crowded bus..	Henry	

This is Peter who bought the plane in for a smooth landing.	Peter		This is Nick who works at the local salon cutting hair.	Nick	
This is Ian who owns two mansions and many cars.	Ian		This is Sam who weighs about ten stone.	Sam	
This is Larry who was born and bought up in Edinbugh.	Larry		This is Will who is about four and a half feet tall.	Will