Arbitrariness, Attention and Memory: An Investigation into Alternative Explanations for False Belief Failure in Autism

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Declaration

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Abstract

False belief failure is often cited as evidence for a theory of mind-deficit in autism. It is possible to argue though that false belief failure by individuals with autism can be attributed to something other than an inability to understand the minds of other people. Research conducted within this thesis supports this argument in that a non-mental state, purely mechanical analogue of the traditional false belief test was successfully constructed. This allowed for a solid beginning to further explore false belief failure from a non-mental state perspective. Three main areas were explored – arbitrariness, attention and memory.

Investigations into the arbitrariness of false belief tests allowed suggestions that greatly reducing arbitrariness tends to result in improved false belief performance of children with autism. However, typically developing children also showed improvements, thus ruling out arbitrariness as a possible autism-specific explanation for false belief failure.

Attentional requirements of false belief tests were also investigated. It was hypothesised that as the distance between false belief stimuli increased, that, due to the need for added attentional orienting, poorer performance would result for the children with autism. Alterations of distance between false belief stimuli had no effect upon the false belief performance of either children with autism or typically developing children.

Finally, from a memory perspective, false belief tests, where cues were provided to participants, were compared to identical tests but where no cues were given. The cues were either auditory, visual or a combination of the two. Control participants demonstrated no cue effects, whereas for the children with autism, when combined visual and auditory cues were provided, false belief performance improved significantly. These findings are discussed in terms of specific difficulties that individuals with autism have with the encoding and retrieval of information from memory. In addition a new hypothesis to explain false belief failure in autism, as well as autism in general, is provided.

Chapter 1

Introduction

1.1 Preface

In order to be diagnosed with any particular disorder, individual presentation is assessed in terms of specified diagnostic criteria. For some psychopathologies diagnostic criteria are relatively straightforward, however, when considering autism spectrum disorder, diagnostic criteria are not only complex but transcend a range of psychological domains. The autism spectrum is broad, and this breadth is well illustrated in the following excerpts:

> He has never been instructed in music or educated in any way. He learned to play the piano from hearing others, learns airs and tunes from hearing them sung, and can play any piece on first trial as well as the most accomplished performer....One of his most remarkable feats was the performance of three pieces of music at once (Grabs, as quoted in Sacks, 1995, p.179).

> He had virtually no understanding of or interest in the use of language. Other people held no apparent meaning for him except to fulfil some immediate, unspoken need; he used them as objects. He could not tolerate frustration, nor changes in routine or environment, and he responded to any of these with desperate, angry roaring (Cole, as quoted in Sacks, 1995, p.188).

Those unfamiliar with autism may find it hard to believe that both descriptions describe individuals diagnosed with the same psychopathology. The collection of work to be reported here investigates the psychopathology of autism from the perspective of one particular aspect of psychology or more precisely from one particular account of the disorder – the ability or as often referred to in terms of autism, the inability, to understand the minds of other people.

This thesis comprises eight chapters. Chapter One provides an overview of the history of autism, as well as an account of the possible causes and psychological theories that have been put forward to explain this disorder. Chapter Two provides a detailed review of the theory of mind-deficit account of autism and related tests of false belief. Methodological issues related to the studies to be presented here as well as in relation to autism research in general are raised and discussed within Chapter Three. Chapter Four details the first study to be undertaken for this thesis. This study investigates false belief failure from a mechanical, non-mental state perspective whilst in addition explores arbitrariness as a possible factor in explaining false belief failure amongst children with autism. The study presented in Chapter Five extends the work reported in Chapter Four and investigates the effect of auditory signals that vary in terms of arbitrariness. Attention and the impact that lesser or greater expectations of attentional shifting has upon the performance of children with autism on false belief tests is examined in Chapter Six. Chapter Seven reports on the final two studies of this thesis. Within these studies the effect of the inclusion of memory cues upon false belief performance is explored. The first of the studies in Chapter Seven investigates auditory cues in the form of spoken recall whilst in the second study auditory and visual cues independently and combined are utilised. Chapter Eight provides readers with a detailed discussion of the findings of all of the studies of this thesis and relates the findings to existing theories of autism. Chapter Eight concludes with the provision of a new explanation of autism based on a combination of the results of the studies outlined here and previously published theory and research.

1.2 A Brief History of Autism

While it has been speculated that autism has existed throughout the centuries, the first documented evidence of its existence was published in 1943. Written by Leo Kanner, an American physician, this paper entitled "Autistic disturbances of affective contact", reports on the detailed observations made by the author of 11 children. All 11 children included within these observations interestingly possessed features similar to each other, yet quite different from any other previously recognised syndrome (Rutter, 1978). These features as summarized by Happé (1999), included extreme 'autistic' aloneness, excellent rote memory, anxiously obsessive desire for the preservation of sameness, delayed echolalia, over-sensitivity to stimuli, limitations in the variety of spontaneous activity, good cognitive potentialities and highly intelligent families. However as Happé (1999) points out, in a later paper by Kanner & Eisenberg (1956), Kanner highlights only two of these features as being the key features of autism – extreme isolation and the obsessive insistence on the preservation of sameness.

In 1944 on the other side of the world an Austrian physician, Hans Asperger, wrote a paper "Die 'Austistischen Psychopathen' im Kindesalter", detailing observations very close to those of Kanner, yet the two men had never heard of each other, nor read each others work. It may be surprising to some that both authors, despite working and documenting their evidence completely independent of each other, included the term 'autistic' within their description of the children they were reporting on. However, considering the derivation of the word autistic, elements of surprise quickly subsides. The term autistic (from the Greek word 'autos' meaning self) was first used by Bleuler (1908) to describe aspects of social withdrawal witnessed in adult patients diagnosed with schizophrenia (Happé, 1999). Like Kanner, Asperger also regarded one of the two primary elements of autism as being social in nature and as such both men labelled this new disorder similarly, that is, by including the previously used term autistic (Frith, 1989).

Even though considerable similarities exist between Kanner's and Asperger's description of children with autism, there are nevertheless differences. These differences fall into three main areas: language abilities, motor and co-ordination abilities and learning abilities. While Kanner reported that, the children he observed suffered from profound communication and language delays, Asperger on the other hand noted that the majority of his patients spoke fluently. With regard to motor and co-ordination abilities, Asperger described his patients as somewhat clumsy and lacking in fine motor ability. Kanner did not report such difficulties. Rather he concluded that although several of the children he observed may have at times appeared clumsy with regard to gross motor performance, on the whole they were very skilful in terms of fine motor control. Both authors noted differences in learning ability. Kanner felt that the patients he worked with learnt in a rote-type manner while Asperger made suggestions that the children he reported on thought and processed information in more abstract ways (Happé, 1999).

Despite the striking similarities between the descriptions provided by Asperger and Kanner, the fact that considerable differences also exist can be interpreted in two ways. Either the children observed and reported on by Kanner were distinctly different from those patients of Asperger, or all of the children had a similar disorder but they were somehow placed at different positions along a continuum of handicap.

In more recent years these interpretations have been somewhat laid to rest. Wing (1981) first used the term 'Asperger's Syndrome' in describing those people who did not exactly fit Kanner's description of being silent and aloof but nonetheless possessed characteristic features described by both authors. It is accepted today that the children that the two men were describing were in fact suffering from a similar disorder but that the two groups were in fact at different places along an autistic spectrum[1] or indeed, as professionals continue to debate, that the children were in fact suffering distinct disorders in their own right.

[1] Lorna Wing first introduced the concept of a spectrum of disorder in 1988 in an attempt to highlight the huge range of potential disability within autism.

1.3 Autism Today

According to the Diagnostic and Statistical Manual of Mental Disorders IV-R (American Psychiatric Association, 2000), autism is a Pervasive Developmental Disorder that is characterised by three fundamental impairments:

1. Qualitative impairment in social interaction.
2. Qualitative impairments in communication.
3. Restricted repetitive and stereotyped patterns of behaviour, interests and activities.

These three areas of impairment have become known as the 'triad of impairments'. Introduced first by Lorna Wing in 1988, the triad of autistic impairment consists of problems broadly associated with socialisation, communication and imagination. Obviously when considering the diagnosis of autism many more diagnostic criteria come into play (the full diagnostic criteria for autism can be seen in Table 1.1), however these three areas continue to aptly summarise those areas that people with autism have difficulties with. Moreover as suggested by Happé (1999), problems of socialisation, communication and imagination are sufficient and necessary to capture much of the behaviour found to be specific and universal to autism. As well as these core deficiencies with which all children and adults with autism present, there are many other characteristics, which are typical of, but not universal to, autism. Such characteristics are wide and varied, however, Nye (2000) provides a good summary. Within this summary the following possible behavioural indicators are highlighted:

- Display of indifference
- Joins in only if adults insist and assist
- One-sided interaction
- Indicates needs by using an adult's hand

- Lack of creative and pretend play
- Handles or spins objects
- Echolalia – copies words like a parrot
- Does not play with other children
- Talks incessantly about one subject
- Variety is not the spice of life
- No eye contact
- Bizarre behaviour
- Inappropriate laughing or giggling
- Can do some things very well, very quickly but not tasks involving social understanding.

This list of potential indicators is not exhaustive, and as any person who has worked with individuals with autism will confirm there are many more that could be added.

Similar to the differences noted between the accounts provided by Kanner and Asperger, differences still exist between clinical groups of individuals with autism. This is where the previously mentioned notion of a spectrum becomes important. When speaking to physicians, psychologists and other related health professionals concerning autism, one becomes increasingly aware that very rarely can two individuals with autism be considered as having identical disorders. While they will obviously have deficits in the three core areas, the behavioural manifestation of such deficits will more often than not be quite different. It is for this reason that the notion of autism covering a spectrum is crucial, and also why it is important when considering autism from a clinical perspective that professionals are versed in the formal diagnostic criteria, and just how varied the diagnostic criteria allow children to present and yet still be classified as having autism.

Table 1.1

Diagnostic Criteria for Autistic Disorder (taken from DSM-IV-R (2000)).

A. A total of 6 (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 non-verbal behaviours 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 behaviour, interests and activities, as manifested by at least one of the following:

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

(b) apparently inflexible adherence to specific non-functional 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.

1.4 The Cause of Autism

To date no one cause of autism has been pinpointed. Attwood (1998) recognises three potential causes of autism – genetic factors, unfavourable obstetric events and infections during pregnancy or early infancy that affect the brain. Janzen (1996) claims that anything that makes the central nervous system (CNS) develop abnormally can cause autism. Janzen (1996) reports on findings presented by Gillberg (1990), and Gillberg and Coleman (1992), that implicate the following conditions as possible causes of CNS damage and therefore possibly autism:

- Viral infections such as encephalitis or congenital rubella
- Metabolic imbalances such as phenylketonuria
- Exposure to alcohol and drugs (e.g. cocaine-addicted babies)
- Exposure to environmental chemicals such as lead
- Genetic/chromosomal factors such as in Down syndrome, the Fragile-X syndrome and others
- Oxygen deprivation

In addition to the causes of CNS damage and possibly autism listed above, one that has received considerable attention in the United Kingdom of late is the opioid excess theory of autism. This theory was first introduced by Panksepp (1979), expanded upon by Reichelt, Hole, Hamberger, Saelid, Edminson, Braestrup, Lingjaerde, Ledaal, and Orbeck (1981), and more recently taken on board by Shattock and Lowdon (1991). In a paper by Shattock and Savery (1999) it is claimed that autism could be the consequence of the action of peptides of exogenous origin affecting neurotransmission within the CNS. It is suggested that peptides with opioid activity derived predominantly from foods containing gluten and casein, pass through an abnormally permeable intestinal membrane and enter the CNS to exert an effect on neurotransmission consequently affecting perception, cognition, emotions, mood and behaviour. It is also suggested that higher executive functions[2] could be disrupted. From a treatment perspective Whiteley and Shattock (2002) refer to exclusion diets. In their paper Whiteley and Shattock acknowledge that many parents of children with autism and professionals working with the autistic population have found that removal of peptides through exclusion diets can produce some amelioration in some autistic symptoms. Research continues to investigate the possible impact of exclusionary diets upon the symptoms of, and behaviours associated with, autism. The opioid excess theory is far more complex and detailed than can be given justice to here. This brief summary was given however so as to include what has become a *popular* understanding of the cause of autism, and furthermore to give some explanation as to why some parents are now altering the diets of their children who have been diagnosed with autism.

Another recent conjecture regarding the aetiology of autism is centred upon particular immunisation injections that are given to children in their infancy. The debate concerning this conjecture looks at whether or not the combined measles, mumps and rubella injections (commonly referred to as the 'MMR'), given to children in early infancy may cause autism. This debate was sparked by literature presented by Wakefield (2001), that claimed amongst other things that; the rise in autism is linked to the introduction of MMR vaccine in the UK, implying that MMR immunisation causes autism; and that particular adverse effects of immunisation are specific to MMR rather than single measles vaccine because of biological interference between

[2] Executive functions will be discussed in detail in Section 1.4 when the executive function theory of autism is outlined.

the different viral components. He furthermore claimed that this interference increases the risk of gastrointestinal symptoms, leading to inflammatory bowel disease and autism. This debate has been very controversial and considering the possible widespread negative effect upon the uptake of immunisation this could have, has been downplayed by the government and related health authorities.

Debate still exists concerning the possible autism-MMR link, however it would seem that any causality has been, at this point in time, ruled out. Needless to say a considerable number of parents are now opting, if possible, to have their children immunised privately and separately, for measles, mumps, and rubella.

Recently researchers have proposed a new hypothesis accounting for the cause of autism, suggesting a mixed epigenetic and genetic and mixed de novo and inherited (MEGDI) model (Jiang et al. (2004). Folstein & Rutter (1977) published the first twin study in autism and showed that the concordance rate in identical twins was very much higher than in non-identical twins. This finding has since been replicated several times and is now well established. Genetic effects noted in family and twin studies have encouraged investigators to conduct linkage and association studies that have attempted to identify particular susceptibility genes (Szatmari, 2003). Although several promising findings are based on candidate gene studies (particularly in the region 15q11-13[w5 w6]), replication studies are needed in this area to confirm these promising findings.

Researchers, professionals in the field of autism, and parents of children with autism still debate the possible causes of this syndrome. Despite this debate a single cause of autism has not yet been determined. Rather it is still considered to be a pervasive developmental disorder of often, unknown aetiology. Considering the wide spectrum that autism covers, it may be that no single cause of autism will ever be ascertained. Perhaps there are many causes of autism which could well account for the spectrum just alluded to. That is, perhaps there are different types of autism that have different causes. Consequently further research and investigation from an array of disciplines into the cause of autism is needed. Necessarily, this thesis will have as its primary focus the Theory of Mind-deficit account of autism, which will be discussed in detail in Section 1.5.8.

1.5 Theories or Explanations of Autism

While no single cause has been attributed to autism, many attempts have been made to understand this disorder from a range of theoretical paradigms. While the medical explanations are plentiful, only the psychological explanations or theories will be discussed here. This is due to the fact that this document is addressing autism from a psychological perspective, in particular the Theory of Mind-deficit account of autism.

Hill and Kodituwakku (2002) in their words outline "those theories or conceptual frameworks that have generated considerable research since the 1980's" (p.55). The authors categorise these theories into four main areas - theory of mind, executive function, central coherence and social impairments. Even though it was not suggested that what was provided was a comprehensive summary, considering the publication date of their paper, many important and highly regarded theories have been omitted. Jordan (1999) provides a more thorough summary of the most predominant psychological theories of autism. Although the author herself warns readers that what is provided is by no means exhaustive, it is by far one of the most thorough accounts available. Within Jordan's (1999) summary the theories of autism are divided into six main areas: theory of mind; intersubjectivity theories; central coherence; executive function; agency and narrative. Jordan (1999) not only provides readers with references to the central researchers associated with each of these areas, but also details criticisms and follow-on studies within each area. Considering the extent of this document (in excess of fifty pages), such an undertaking will not be included here. Rather these main areas of theorising will be discussed simply in terms of the main and more often than not the first researchers to have put forward seminal ideas. Prior to addressing the main theories that attempt to explain autism today, a short account will be given to the most dominant theory of autism of the 1950-60s.

1.5.1 Psychoanalytic explanations. During the 1950s and 1960s when psychoanalytic theory was prevalent, autism was regarded as being largely caused by poor parenting styles and skills. Proposed by Bruno Bettelheim (1967), such explanations as to the aetiology of autism became colloquially known as the 'refrigerator' parent theory. Bettelheim proposed that the parents, and perhaps more importantly the mothers of individuals with autism, were cold and unloving, and as a result of this lack of affection and caring attention, the children withdrew from the world and necessarily the people within that world (Kendall & Hammen, 1995). These explanations of the cause of autism have been largely discredited today, yet the impact that such theorising has upon those involved remains unknown. Additionally as pointed out by Happé (1999), while psychogenic explanations such as Bettelheim's (1967) are not adopted by the majority of clinicians and researchers in most parts of the world, it does remain, that in some countries and indeed some practitioners even in the United Kingdom and the United States, still utilise such explanations within their understanding and diagnosis of autism.

1.5.2 Intersubjectivity theory. In his response to Leslie's (1987) "nondevelopmental, nonsocial and restrictively cognitive account" (p.114) of autism, Hobson (1990) provides a socially oriented, interpersonal explanation of autism. Viewing autism primarily as an interpersonal disorder, Hobson (1990) considers the inabilities of pretence and mentalising as a direct result of an innate impairment in the ability to emotionally engage with other people.

Hobson (1990) holds that due to this "inborn disturbance of affective contact" (p.250) as described by Kanner (1943), children with autism cannot fully come to terms with the nature of other people. Hobson (1990) believes that this innate disability prevents children with autism from participating in "affectively charged personal relations" (p. 118) therefore resulting in a significantly delayed uptake of information and knowledge of people, and the fact that such people have their own minds. Hobson (1991) clarifies this by explaining his belief that what children with autism actually fail to acquire, is not a theory of minds, but rather knowledge of other people with minds.

These suggestions may well address the difficulties faced by children with autism with regard to understanding others' thoughts, beliefs and desires, but what about pretence? Surely one does not need to understand what someone else believes, feels or desires in order to pretend that a banana is a telephone? Hobson (1990) claims that because children with autism are deprived of social experience they do not receive exposure to alternative orientations to, or understanding of the environment around them. This in turn is suggested to result in children with autism maintaining restricted viewpoints and inflexible, typically solitary orientations to given objects or events. In Leslie's (1987) terminology, it may be said then, that children with autism become 'stuck' at understanding the world by a combination of primary representations, with their lack of social inter-relatedness preventing them from extending these into meta-representations. Hobson (1990) describes this as an "inability to adopt multiple orientations to given objects or events, an inability that stems from primary social-affective incapacities" (p. 118). Hobson (1992) argues that individuals diagnosed with autism have difficulties perceiving and understanding other people's emotions and that it is these problems, not communication difficulties that are at the core of this disorder.

1.5.3 Central coherence. The Central Coherence theory of autism as proposed by Frith (1989) utilises the ideas of Gestalt psychologists (Koffka, 1935; Kohler, 1929) in so much as in typically developing children there is a drive to process the holistic properties of stimuli before processing the constituent parts. Furthermore if one is to detect parts of stimuli this drive needs to be overcome, otherwise the whole will consistently consume the parts (Plaisted, 2000). Frith (1989) suggests that this drive in autism is weakened therefore resulting in a deficit in the processing of wholes. Similarly due to this weakened drive Frith (1989) suggests that children with autism can immediately process the parts of stimuli. Findings that report children with autism tend to more quickly and accurately detect small target figures embedded within larger figures (Children's Embedded Figures Test – CEFT; Witkin, Oltman, Raskin & Karp, 1971) when compared to control children (Jolliffe & Baron-Cohen, 1997; Shah & Frith, 1983); and perform significantly well on the Block Design subtest of the Wechsler Intelligence Scales, designed by Wechsler (1974) (Shah & Frith, 1993) support this hypothesis. The arguments provided in terms of the central coherence theory for these superior performances relate to the ability of individuals with autism to see parts over wholes – a significant advantage for tasks where such processing is useful.

Frith and Happé (1994) describe central coherence as the ability to "draw together diverse information so as to construct higher-level meaning in context" (p.121). Examples provided by Frith and Happé (1994) of such drawing together are the way in which typically developing, English speaking individuals, can recognise and make contextual sense of the many ambiguous words used in everyday English, for example son-sun, there-their, to-two, pair-pear and so on; and the way in which the overall meaning of a story may be easily retained but the actual prose or surface form is rapidly lost. Frith (1989) suggests that this is a universal feature of human information processing, and furthermore that this ability to process information is deficient in those people diagnosed with autism.

While the central coherence theory can account for superior performance on behalf of individuals with autism it can also account for performances that are certainly not superior, but rather lacking. One such area is the antithesis of that previously described, that is tasks that involve the interpretation of individual stimuli in terms of overall context and meaning (Frith & Happé, 1994). Examples of such tasks include the processing of faces and the disambiguation of homographs where, as described by Frith & Happé (1994), one has to process the final word as part of the whole sentence meaning. An example of such processing is illustrated by the following two sentences: He made a deep bow; He had a pink bow. In examples such as these it has been found that rather than reading the sentences in a contextually appropriate manner, individuals with autism tend to resort to the most common pronunciation of the last word (Frith & Snowling, 1983) therefore failing to interpret the last words within the overall context and meaning of the sentences.

Even though the weak central coherence explanation of autism receives considerable support, results of experiments conducted to test the hypothesis are ambiguous. While the research using the CEFT and Block Design test support the central coherence explanation, other research does not (Ozonoff, Strayer, McMahon, & Filloux, 1994; Plaisted, Swettenham, & Rees, 1999). Using a task initially developed by Navon (1977)[3] that assesses both global (wholes) and local (parts) perception, both Ozonoff et al. (1994) and Plaisted et al. (1999) found that when presented with a large global letter composed of smaller letters and asked to identify a letter (either the large global or a small local letter) both children with autism and controls were quicker at detecting global letters. These findings contradict the weak central coherence explanation of autism, which suggests that children with autism should have been slower at global detection than controls, therefore not showing global interference. Using a similar task to that just outlined but where participants were told to identify and name both the global and a local letter, therefore having to attend at both the global and local level, Plaisted et al. (1999) found that children with autism detected the local targets more quickly than control participants, showing a local interference effect. Plaisted et al. (1999) explained the different responding of the children with autism between the two conditions as a result of priming. That is, Plaisted et al. (1999) suggest that when primed to attend to the global level, as in the first task just described, children with autism do not experience global perception difficulties, but when not primed they show a preference for local level processing. Combining the evidence from the research just outlined and other research that evaluates perceptual weak central coherence (Mottron & Belleville, 1993; Mottron,

[3] In this task participants are presented with a large figure (e.g. a letter) made up of smaller figures (e.g. letters): of either the same kind (compatible condition), for example a capital A composed of multiple small capital A's; or a different kind (incompatible condition), for example a capital A composed of capital H's; and then required to identify the stimuli at the global and/or local level (Plaisted, 2000).

Burack, Strauder & Robaey, 1999), Plaisted (2001) rightfully questions the perceptual evidence (or in fact the lack thereof) for a weak central coherence and in turn provides an alternative explanation for both the perceptual and attentional abnormalities experienced by individuals with autism as well as the superior performance of individuals with autism on tasks such as the CEFT and block design tests. The alternative explanation provided by Plaisted (2001) relates to reduced generalisation abilities. The hypothesis provided by Plaisted (2001) is "that individuals with autism process features unique to a situation or stimulus relatively well and features held in common between situations or stimuli rather poorly" (p.159). If this were to be the case then individuals with autism would display superior performance on tasks involving discrimination and reduced performance on tasks requiring categorisation.

Plaisted, O'Riordan and Baron-Cohen (1998a) provide evidence of superior performance of individuals with autism on tasks involving discrimination. Plaisted et al. (1998a) tested adults with autism and control adults on a perceptual learning task that compared discrimination performance on familiar and novel stimuli. Perceptual learning is the phenomenon whereby two similar stimuli, which when first encountered appear identical, become distinguishable after repeated exposure (Plaisted et al., 1998a). The results of the perceptual learning task were clear in that the adults with autism were better able than the control adults in solving novel discrimination problems involving highly similar stimuli, therefore providing support for the hypothesis that individuals with autism process unique features well and common features poorly when compared to individuals without autism.

Additionally, Plaisted, O'Riordan, Aitken and Killcross (submitted, cited in Plaisted, 2000; 2001) and Plaisted and O'Riordan (submitted, cited in Plaisted, 2000; 2001)[4] provide evidence for reduced performance on behalf of individuals with autism when compared to controls on tasks requiring categorisation. Using a prototype abstraction task both groups of researchers found a deficit in categorisation for the individuals with autism. The individuals with autism showed a deficit in category learning in the initial categorisation stages of both studies as well as displaying a reduced prototype effect. Due to both categorisation and prototype abstraction being associated to the generalisation between the common features of items, Plaisted (2001) uses these findings to provide support for her alternative explanation of the weak central coherence account of autism, that is that individuals with autism process unique features well and common features poorly when compared to individuals without autism.

1.5.4 Executive function. According to Duncan (1986), executive function is the cognitive construct that is used to describe behaviours that are thought to be mediated by the frontal lobes. Executive functions include the neuropsychological abilities of planning, impulse control, inhibition of prepotent but contextually incorrect responses, organised search, and flexibility of thought and action (Ozonoff, 1995). It would also appear that all executive functions share the ability to disengage from the immediate environment, and to rather guide behaviour by mental models, or indeed internal representations (Dennis, 1991). When considering the first of these abilities, planning, another important ability comes to the fore. In order to plan

[4] Findings were taken from a discussion of the results by Plaisted (2001) due to both of these papers being unavailable.

effectively what one must do is retain and order a number of mental representations within working memory and in particular prospective working memory, memory for what will have to be done. Baddeley and Hitch (1974) first proposed the working memory model of memory in a challenge to the idea that short-term memory was a single system. The working memory model comprises multiple and separate components – the central executive, the phonological loop and the visuo-spatial sketch pad. The central executive is responsible for the coordination of attentional resources and for the supervision of the two other components. The phonological loop is responsible for the manipulation of speech-based information while the visuo-spatial sketch pad is responsible for the manipulation of visuo-spatial images (Searleman & Herrmann, 1994). It would be tidy at this point to say that because children with autism are impaired on executive tasks that (due to their very nature) require central executive working memory abilities that children with autism have distinct impairments within the area of working memory. This however cannot be said, not conclusively anyway. The findings of studies investigating the working memory abilities of children with autism are contradictory. For example Bennetto, Pennington and Rogers (1996) and Russell, Jarrold and Henry (1996) compared children with and without autism on a series of memory and executive function tasks. Bennetto et al. (1996) reported impairment in working memory tasks for children with autism while Russell et al. (1996) did not. The disparity between the two studies just mentioned was despite both groups of researchers employing an identical task - the Case-counting task[5] (Case et al., 1982).

[5] For this task participants were instructed to count aloud the yellow dots interspersed with blue dots arranged randomly on pieces of card. After participants had counted the yellow dots on each of a set of cards, they were asked to recall, in order, the number of yellow dots that appeared on each card (Bennetto et al. (1996).

The executive function theory of autism is immediately striking due to a considerable number of features characteristic of autism that are also shared with individuals who have sustained frontal lobe injury. Highlighted by Ozonoff (1995), these characteristics include: rigid and inflexible behaviour; insistence on sameness; preference of routine (and associated stress if routines are altered); perseveration; likelihood to be impulsive (and consequently finding it difficult to withhold or delay responses); and difficulty seeing the 'big picture' (or as Frith (1989) would say, suffering from weak central coherence).

The aforementioned behavioural similarities between autism and executive function deficits are supported by empirical evidence. The most important piece of research conducted in this area was undertaken by Ozonoff, Pennington & Rogers (1991). In this study the authors utilised a comprehensive battery of tests that included measures of executive function, theory of mind, verbal memory, emotion perception and spatial abilities to compare participants with autism and a clinical group matched on IQ, age, sex and socio-economic status. The results of this study indicated that executive function deficits proved to be the most widespread and universal impairment among the sample with autism. Furthermore it was found that an executive function test, the Tower of Hanoi, was best able to discriminate between the groups of participants and moreover predict group membership (Ozonoff, 1995). This study as well as others (McEvoy, Rogers & Pennington, 1992; Prior & Hoffman, 1990) provides readers with empirical support that suggest the existence of executive function deficits in individuals with autism. As a result, the proponents of this argument suggest that executive function impairment may be a central deficit of autism, and consequently that such theories may well explain this enigma.

1.5.5 Attention Hypothesis. Murray, Lesser and Lawson (in press) advocate a focus on the quality of attention, utilising the optical metaphor. They contrast at one extreme attention as a diffused light and a focused torch beam at the other. These authors suggest that attention may be broadly distributed over many interests or may be concentrated on a few interests. The authors propose that the strategies employed for the allocation of attention are normally distributed and to a large degree genetically determined (Murray, Lesser & Lawson, in press).

Murray et al. (in press) propose that diagnosis of autism selects those few individuals at the deep or tight-focus extreme of this distribution of strategies. This approach to understanding autism highlights the importance of exploring the differences between autistic and non-autistic strategies for the utilisation of limited attentional resources. In particular Murray et al. (in press) draw attention to the concepts of monotropic and polytropic tendencies in differentiating this population.

1.5.6 Agency. Russell (1996) boldly states that, "no creature can acquire a theory of mind unless it is an agent" (p.201). Furthermore Russell (1996) makes a conceptualisation that an inadequate understanding of mental states in early childhood could well be attributed to an inadequate sense of agency. Including children with autism into this conceptualisation, perhaps it is inadequate agency in children with autism that results in their inadequate conceptions of mental states. Before continuing with the discussion of agency it is necessary to first clarify what is meant by this term. According to Russell (1996) the experience of agency requires: immediate knowledge that one has acted; control of and over experiences; inherent knowledge of what one is doing rather than having to watch oneself so as to know what one is doing; and knowledge of what one is trying to do. Overall what agency refers to is a degree of self-awareness, a sense of self-awareness that without, one cannot truly grasp mental states.

Russell's (1996) explanation of agency and the role that agency has within mental development is very complex and detailed, so detailed in fact that an entire book was published on just this topic. Jordan (1999) very nicely summarises what it is that Russell (1996) proposes in relation to agency and autism. In his proposal, Russell (1996) links executive function difficulties and agency in as much that the executive function difficulties of children with autism lead to difficulties in initially developing a sense of agency. Without a sense of agency, children with autism subsequently fail to develop a sense of self and similarly fail to understand the agency of others. As a result of not being able to understand the agency of others, children with autism fail to comprehend the mental states of other people, therefore failing theory of mind tasks (Jordan, 2002).

1.5.7 Narrative. Bruner and Feldman (1993) suggest that the theory of mind deficit of autism and the associated impairments of social interaction may be due in part, to an inability or perhaps unwillingness of children with autism "to be able to represent culturally canonical forms of human action and interaction by the vehicle of narrative encoding" (p.267). Focusing upon theory of mind and more specifically intentional states, Bruner and Feldman (1993) identify that typically developing children around the ages of two and three, develop a knowledge of intentional states via the encoding of such states within their story-making. The authors suggest from this that it may be this encoding process that goes 'awry' in autism. However it may well be even more primary than this. In order to encode information within story making, one must initially be able to construct stories. Bruner and Feldman (1993) identify that in autism two crucial elements of productive language are missing. These two elements are both related to narrative, one concerns the use and understanding of dialogue while the other is evident within speech itself. First, when looking at autism, it becomes evident that such individuals tend not to be able to extend upon another person's comment, possibly due to their lack of understanding of where the vocal transaction is moving to, that is they seem to not know where the dialogue is heading. Secondly, it would seem that individuals with autism do not know how to make a story. What becomes obvious and subsequently noted by Bruner and Feldman (1993) is that both of these deficits suggest a common failure in the ability to encode arguments of action into a structure whereby an agent pursues a goal in some particular setting, that is extending upon comments in order to create a meaningful story. It is this failure that in turn prevents individuals with autism from encoding intentional states within and from their use of story making, and therefore that has the effect of individuals with autism not learning via culturally meaningful interactions with others. Subsequently individuals with autism are not exposed to narrative that should inform and teach them about the cultural expectations of how people feel, think and believe. They are, in essence, deprived of the cultural teaching (that occurs quite naturally for typically developing children via the processes of narrative and narrative encoding) that informs typically developing individuals of the minds of other people.

1.5.8 Theory of mind. Perhaps one of the most globally recognised explanations of autism, the theory of mind-deficit account has received, and continues to receive considerable attention in both academic and clinical arenas. Maybe one of the reasons why this explanation continues to receive so much attention is the belief that it has proved very successful at predicting and explaining autism. Baron-Cohen, Leslie and Frith (1985) were the first researchers to explain autism in terms of theory of mind. Basically this theory proposes that children with autism are impaired in mentalising ability - the ability to appreciate mental states (the beliefs and desires of oneself and others) and to understand and predict behaviour in terms of these states (Baron-Cohen & Swettenham, 1997).

Employing an experimental task initially devised by Wimmer and Perner (1983)[6], Baron-Cohen et al. (1985) set out to provide evidence for this impairment by testing the ability of children with autism to understand the false belief[7] of another person. The experimental task commonly referred to as the 'Sally-Anne' test adopted two characters, Sally and Anne. In front of Sally was a basket, and in front of Anne a box. Sally initially placed a marble into her basket and then left the scene, out of sight of both Anne and the participants. In Sally's absence Anne moved the marble from the basket and placed it into her box. At this point Sally returned to the room and the all-important experimental 'Belief' question, "Where will Sally look for her marble?" was asked. Two other questions[8] were also posed to the participants to ensure that

[6] This task known as 'the Maxi story' went along the following lines: Maxi puts some chocolate into a cupboard 'x'. In his absence Maxi's mother moves the chocolate from cupboard 'x' to cupboard 'y'. Maxi would then re-enter the room to retrieve his chocolate. At this point the researchers asked the typically developing participants to indicate which cupboard Maxi would look in so as to get his chocolate.

[7] False belief will be discussed further in Chapter two.

[8] Baron-Cohen et al. (1985) refer to these questions as control questions.

they actually did remember where the marble initially was (the 'Memory' question) and indeed where the marble was presently (the 'Reality' question). Following similar lines of argument to those provided by Wimmer and Perner (1983), the researchers' hypothesis was grounded in the understanding that only when the participants are able to represent Sally's wrong belief (marble is in the basket) apart from what they themselves know to be the case (marble is in the box) will they be able to point correctly to the basket. Furthermore, if and only if, the children indicated the basket as the location that Sally would look for her marble, could it be accepted that the participants have an explicit and definite representation of the other's wrong belief.

Baron-Cohen et al. (1985) tested 20 children diagnosed with autism according to established criteria (Rutter, 1978) ranging in age from 6 years 1 month to 16 years 6 months; 14 Down syndrome children aged between 6 years 3 months to 17 years; and 27 neuro-typical pre-school children with chronological ages ranging from 3 years 5 months to 5 years 9 months. Despite the participants with autism having higher verbal and non-verbal mental ages their performance on the fundamental belief question was remarkably poorer than both the children with Down syndrome and the neuro-typical children. Only 4 of the 20 participants with autism passed the belief question while 12 of the 14 children with Down syndrome and 23 of the 27 neuro-typical children passed. All of the participants answered the control questions correctly. As a result of this Baron-Cohen et al. (1985) were able to conclude that all participants knew that the marble had been moved to a new location, and also that any failure of the belief question was not as a result of not fully comprehending this fact. Considering this and the performance of the participants with autism, it was further concluded that as a group, the children with autism failed to employ a theory of mind.

Put simply the participants with autism, as a group, predicted the doll's behaviour on the basis of their own knowledge rather than on the doll's (false) belief, therefore providing evidence that children with autism do not understand nor appreciate the beliefs of others.

Leslie (1987) proposes that a theory of mind deficit is central to an understanding of autism. Leslie, reasoning from a cognitivist perspective, proposes an information-processing explanation of autism. Leslie's (1987) view of autism stems from his theorising of typical development, and even more so from the development of pretence (or the ability to pretend) in early childhood.

Leslie (1987) holds that typically developing children start life with the ability to form primary representations. In this sense primary representations are those that are factual, or as Leslie describes them, "accurate, faithful and literal" (p.414). Take a banana for example. The primary representations for this object are that it is a yellow food that you have to peel to eat – accurate (this is actually what a banana is); faithful (a banana can always be thought of in this way and this is unlikely to change); and literal (this is a literal understanding of what a banana is).

Having acquired the ability to form primary representations, Leslie (1987) suggests that children, toward the end of infancy, develop the ability to form higher order representations[9] or meta-representations[10] – the ability to represent representations. Leslie (1987) claims that this higher order ability is made possible via the operation of what has been referred to as the decoupling mechanism or more

[9] Leslie (1987) refers to these as both second order representations or meta-representations.

[10] As noted by Leslie (1987) this term was borrowed from Pylyshyn (1978).

simply as the decoupler. The decoupler allows the primary representations to be held constant as truth, but at the same time allows for the same representations to be utilised within pretence. Referring to the banana example the decoupler allows the child to maintain the primary representation that a banana is a soft yellow fruit that you have to peel to eat, but at the same time allows for pretence concerning the banana, for example 'I can pretend that this banana is a telephone'. In this example the pretence that a banana is a telephone can be regarded as a form of meta-representation.

Drawing on his understanding of the development of knowledge and pretence in early typical childhood, and research findings illustrating the severe impairments in pretend play exhibited by children with autism (Baron-Cohen, 1987; Rutter, 1978; Sigman & Ungerer, 1981; Sigman, Ungerer, Mundy, & Sherman, 1987; Ungerer & Sigman, 1981; Wing, Gould, Yeates, & Brierley, 1977; Wulff, 1985), Leslie (1987) constructed his meta-representation theory of autism. This theory generates the hypothesis that children with autism have an absence of, or a faulty decoupler, which in turn prevents them from forming meta-representations. As a result of this inability, it is proposed that children with autism are impaired in the ability to play symbolically, and furthermore are unable to understand mental states, therefore resulting in a "specific deficit in theory of mind" (p.424).

1.6 Summary

From this introductory chapter it is evident there are diverse accounts of autism, but with no single theory wholly accounting for this complex phenomena. As such autism remains an intriguing and complex psychopathology. One theory has in the past twenty years received perhaps more attention than the others – the theory of mind-deficit account of autism. Due to this interest and resulting from concerns with this account, it is considered necessary to further investigate this as an explanation of autism.

Chapter Two

Theory of Mind and Tests of False Belief

2.1 Introduction

The theory of mind-deficit account of autism was discussed briefly in Section 1.5.2. Considering the importance of this account and the related test of false belief (which is so widely adopted as a measure of theory of mind) to this thesis, a more thorough account of both is necessary.

Due to the influence that the theory of mind-deficit account of autism has had upon autism research it now appears in almost every text concerning autism published post 1985. The influence that this has had has been immense, permeating autism research in most fields and domains, across the majority of countries in the world (Prior & Ozonoff, 1998). The theory of mind-deficit account of autism argues that children with autism are unable to perceive and comprehend the thoughts and feelings of others, or as some may say, unable to perceive and comprehend that other people have 'minds'. Baron-Cohen (1990; 1995) and Happé and Frith (1995) refer to this as 'mindblindness'. For Baron-Cohen (1995) mindblindness is not being blind in the physical sense but rather is being blind to the existence of mental things – thoughts, beliefs, knowledge, desires, and intentions. When considering this description one can begin to understand, if children with autism are in fact mindblind, how difficult and confusing daily life must be for these individuals.

2.2 Origins of Theory of Mind

Before continuing the discussion of autism and theory of mind, it is necessary to understand from where this account first originated and how it became so important to the field of autism. Despite now being a driving force into human psychological research, theory of mind research actually began with nonhuman primates. Premack and Woodruff (1978) first utilised the theory of mind model in their exploration into whether or not chimpanzees could use deception to obtain a reward. These researchers were hoping to ascertain whether or not these primates could impute mental states to others, thereby predicting their behaviour -whether or not they possess a theory of mind (Volkmar, Carter, Grossman & Klin, 1997). As the first researchers to undertake such experimentation, they were also the first to coin the phrase 'theory of mind'. Premack and Woodruff (1978) used this term due to their belief:

> ...that the ability to reflect on mental states was theory-like in as much as mental states are *unobservable* entities which we infer to be underlying people's actions; and because reference to mental states allows us to *explain and predict* other people's behaviour with remarkable power (Baron-Cohen & Swettenham, 1997, p.880).

There is some debate though as to the appropriateness of referring to the understanding of mental states as being theory-like. Hobson (1991) for example, suggests when considering the human population, that it is more appropriate "to think in terms of children coming to acquire an understanding of the nature of persons, and acquiring a concept or set of concepts about people's minds" (p.33). Hobson (1991) argues that it is misleading to refer to such understanding as being theoretical in nature due to our very understanding of what a theory is, and what is meant by the ability to theorise. Hobson's (1991) arguments are quite complex and detailed, but the gist of what he holds to is the question of whether it is appropriate to refer to something as a theory, when in fact what we are referring to, precludes so much of what is normally considered to be involved in theorising?

Johnson (1988) also disagrees with the characterisation of children's knowledge as being theory-like. He states that the attribution of a theory to "young children is empty at best and misleading at worst" (p.47). Johnson (1988) rather characterises children's knowledge and early understanding of human action as intuitive. Noting his understanding as being consistent with diSessa's (1985), he explains intuitive knowledge as a "rich, systematic and causal though hardly deductive or theory like collection of knowledge elements" (p.47-48). Despite Hobson (1991) and Johnson's (1988) objections, the term theory of mind is still used widely when referring to the ability of children to understand the minds of others.

The transfer of theory of mind research from non-human to human primates was sparked[11] by yet further (methodological) debate of the research conducted by Premack and Woodruff (1978). In his commentary on this work, Dennett (1978) argues that when investigating theory of mind, a set of minimal requirements must be met, otherwise what one may be investigating is not a theory of mind, but rather some other construction that could just as easily be understood without reference to mentalistic assumptions. Chandler (1988) summarises these minimal requirements:

[11] Albeit five years later.

(1) One should refrain from attributing a theory of mind to any organism whose own way of going about things can be just as easily understood without such mentalistic assumptions;

(2) Any candidate who is suspected of having such a theory of mind but cannot openly persuade us of this fact in his or her own words, must be set some behavioural task that makes the having or not having of such a theory explicit (pp.393-394).

From the minimal requirements just summarised, and perhaps focusing predominantly upon the second of these, Dennett (1978) concluded that only understanding and predicting a character's behaviour based on a 'false' belief could convincingly show the existence of a theory of mind. So from this comes the 'false belief test' – a behavioural task that is widely used to establish the presence or absence of a theory of mind.

Wimmer and Perner (1983) took up Dennet's (1978) suggestion in their investigation of the ability of typically developing children to understand and comprehend another person's wrong belief. This was the first investigation of its kind to target the human population. Adopting a paradigm initially outlined by Bennett (1978), Dennett (1978) and Harman (1978), Wimmer and Perner constructed their now famous Maxi false belief scenario. This scenario went as follows. Maxi, the central character, puts a chocolate into a cupboard (x). In his absence Maxi's mother moves the chocolate from cupboard (x) to cupboard (y). Maxi then returns to get his chocolate. At this point participants were asked to indicate the cupboard in which Maxi would look for his chocolate. This was the crucial element of the scenario, for only if the participants answered by representing Maxi's wrong belief that the chocolate is in cupboard (x), despite their own knowledge that the chocolate was in cupboard (y), could they be attributed with having a representation of another person's wrong belief. Wimmer and Perner (1983) found that while the four-year-old children they tested correctly identified that Maxi would look in the cupboard in which he left it (cupboard (x)), most three-year-olds said that he would look where the chocolate really was (and where they themselves knew the chocolate to be). The three-year-olds failed to take account of Maxi's false belief. These findings have been replicated in a number of studies (Leslie & Frith, 1988; Moore, Pure & Furrow, 1990; Moses & Flavell, 1990; Perner, Frith, Leslie & Leekam, 1989; Perner, Leekam & Wimmer, 1987), all suggesting that a novel cognitive skill, the ability to represent wrong beliefs, emerges within typically developing children between the ages of four and six years.

2.3 Theory of Mind and Individuals with Autism

With a solid and robustly determined test of the ability to represent mental states at hand, Baron-Cohen, Leslie and Frith (1985) set out to investigate their hypothesis that children with autism lack a theory of mind. This hypothesis stemmed predominantly from the authors' belief, that despite autism being characterised by a number of behavioural indicators, that the inability to develop normal social relationships remained as the "pathognomonic symptom" (p.22). Subsequently, considering the importance that the ability to mentalise has upon social skills (that is to make inferences about other people's behaviour and to make predictions concerning other people's behaviour from these inferences), Baron-Cohen et al. (1985) aimed to link the two for this population.

As reported in Section 1.5.2, the initial investigation conducted by Baron-Cohen et al. (1985) involved testing 20 children with autism, 14 children with Down syndrome and 27 typically developing children utilising the paradigm developed by Wimmer and Perner (1983). While the paradigm used by Baron-Cohen et al. (1985) was identical in nature to that devised by Wimmer and Perner (1983) it involved some changes. In the scenario adopted by Baron-Cohen et al. (1985) there were two doll protagonists – Sally and Anne. Prior to beginning the scenario Baron-Cohen et al. (1985) ensured that the children understood which doll was which by asking what they termed a 'Naming' question. For children who were able to correctly identify the dolls, the scenario was then enacted. Recall from Section 1.5.2 that in front of Sally was a basket, and in front of Anne a box. Sally initially placed a marble into her basket and then left the scene. In Sally's absence Anne moved the marble from the basket and placed it into her box. At this point Sally returned to the room and the all-important experimental belief question, “Where will Sally look for her marble?” was asked. After the belief question, memory and reality questions were asked in counterbalanced order to ensure that the participants were able to remember where the marble was initially placed, and indeed where the marble was presently. Baron-Cohen et al. (1985) concluded that because 16 of the 20 children with autism failed the belief question, that such children did not appreciate the difference between their own and the doll’s knowledge - they failed to employ a theory of mind. The results of this research were strengthened by the fact that 12 of the 14 children with Down syndrome passed the belief question. Due to this finding the authors were able to suggest that problems with mind-reading are likely to be specific to autism and not simply a result of developmental delay.

Following Baron-Cohen et al.’s (1985) seminal piece of false belief research with children with autism has been a number of studies that have replicated the findings with the same population, as well as investigating the area of theory of mind from the perspective of other areas not necessarily involving tests of false belief. Baron-Cohen and Swettenham (1997) provide a useful summary of the results of theory of mind research in autism.[12] This summary provides the framework for the review of theory of mind research that is to follow.

Generally the areas covered within theory of mind research within the autistic population include but are not limited to explorations into: first order false belief (similar to that conducted by Baron-Cohen et al. (1985); the principle that seeing leads to knowing; recognition of mental state words; utilisation of mental state words;

[12] Baron-Cohen, Tager-Flusberg and Cohen (1993) provide a detailed review of these studies.

ability to deceive; complex causes of emotion; spontaneous pretend play; and interpretation of gaze in the inference of mental states.

2.3.1 First-order false belief. Several studies (Baron-Cohen et al., 1985, 1986; Leekam & Perner, 1991; Perner, Frith, Leslie & Leekam, 1989; Swettenham, 1996) report that the majority of children with autism fail a range of first-order false belief tasks. Because the initial study conducted by Baron-Cohen et al. (1985) has been discussed previously it will not be revisited here.

To further explore their hypothesis that children with autism show a specific deficit in employing a theory of mind Baron-Cohen et al. (1986) tested 21 children with autism, 15 children with Down syndrome and 27 typically developing children on a series of picture sequencing tasks. The picture sequences were mechanical, behavioural or intentional in nature. The mechanical picture stories depicted physical-causal relations, whereby participants needed to have an understanding of simple cause and effect relationships in order to correctly sequence the pictures. The behavioural sequences depicted people engaging in a range of activities and interactions that could be understood in terms of overt behaviour. The intentional pictures depicted scenarios whereby "an intuitive and immediate understanding necessarily involved considering the mental state (i.e. a false belief) of the protagonist and not just the behaviour" (p.114). All participants were expected to sequence the various picture stories as well as to provide narration relevant to each sequence. The narration was only expected if the participants were both willing and able. Baron-Cohen et al. (1986) hypothesised that the mechanical and behavioural stories would be well understood by the children with autism while the intentional stories would be less well understood by the children with autism due to the associated false belief element. The results supported this hypothesis. For the mechanical condition the children with autism performed significantly better than both the typically developing children and the children with Down syndrome. On the behavioural condition the children with autism and the typically developing children performed identically while the children with Down syndrome performed significantly worse. The results of the intentional condition however were quite different. For the intentional condition the children with autism performed significantly worse than both the typically developing children and the children with Down syndrome. Similarly, for the narration element of the intentional condition, children with autism utilised mental state expressions significantly less than the other two groups. Resulting from the argument that good performance on the intentional stories would require an understanding of the characters' mental states and the subsequent findings, Baron-Cohen et al. (1986) were able to conclude that children with autism show a specific deficit in employing a theory of mind.

Perner, Frith, Leslie and Leekam (1989) adopted the deceptive-appearance paradigm first developed by Perner, Leekam and Wimmer (1987) (referred to commonly as the 'Smarties' paradigm), to further investigate the ability of children with autism to attribute mental states. The Smarties paradigm was originally developed by Perner et al. (1987) in an attempt to make their research participants (three-year-old typically developing children) comprehend another person's mistaken belief by providing the participants with an identical experience of how they themselves could also be misled when confronted with the same situation as the other person. Described by Perner et al (1987) the Smarties paradigm went as follows:

> Subjects together with a friend were shown to the experimenter's room with the promise that the experimenter would show them what she had in her box. The friend, however, was told to wait his turn outside the room. Inside the room with doors closed, the subject was shown a Smartie box, a container of a desirable candy highly familiar to all subjects. Asked what they thought was in that box they all said 'Smarties'. They were then shown that they were wrong and that the box actually contained a pencil. The pencil was then put back into the box and the box closed again. Subjects were then asked a control question about the actual content of the box and a test question about their own previous belief about the content of the box. They were then told that it was their friend's turn. She would be shown the closed box as the subject had seen it initially and asked what was in the box. Subjects had to indicate what they expected their friend would think is in the box (p.133).

Perner at al. (1989) tested 26 children with autism and 12 children with specific language impairment (SLI). Of the children with autism the results of three of the participants were excluded due to the need for excessive levels of prompting. Only 4 of the remaining 23 children with autism were able to correctly predict that their peer would think that the container contained Smarties while 11 of the 12 children with SLI made correct predictions. From these results it can be seen that Perner at al. (1989) successfully confirmed and in addition extended the conclusions drawn on the basis of research conducted by Baron-Cohen et al. (1985, 1986) and Leslie and Frith

(1988)[13] that claim that children with autism are severely impaired in their theory of mind when compared to other groups of children. The extension of conclusions was possible because the Smarties task was different in principle to the unexpected transfer false belief task and also because a different comparison group was used. The fact that different comparison groups were used strengthens the argument that theory of mind impairment is specific to children with autism and not as a result of general mental retardation.

In order to investigate whether children with autism could be taught to understand false belief and consequently generalise the understanding to other conditions and over time, Swettenham (1996) developed[14] and utilised a specially designed computer version of the Sally-Anne false belief task. Eight children with autism, eight children with Down syndrome and eight typically developing three-year-old children were included in the study. Participants were selected on the basis that they had failed a series of four separate false belief tasks: the conventional doll version of the Sally-Anne task and three other false belief tasks involving different scenarios. In order to teach the children how to understand false belief, instruction was provided via the computerised version of the false belief task. Once learning criterion was met participants were tested on two close transfer and three distant transfer tasks. Close and distant transfer tasks were used so that differentiation could be made between those participants that had learnt the concept of false belief and those participants that had not. The distinction between the close and distant tasks was

[13] The research conducted by Leslie and Frith (1988) will be discussed in detail within the section on research that has investigated the principle that seeing leads to knowing.

[14] Swettenham developed the computer version in 1992 where it was found that children with autism and control groups performed the same on the computerised version of the false belief task and the conventional Sally-Anne task.

the contents of the scenario. The close transfer tasks used the same scenario as the instruction task, but different materials and therefore as a result of teaching could be passed without necessarily understanding false belief. That is it could be that children acquired a strategy from the teaching process to enable them to pass false belief tests that were identical in nature to the teaching task. The three distant transfer tasks however utilised different scenarios to the teaching task, therefore ruling out the likelihood that success could be attributed to a strategy learnt during the teaching task. In order to pass the distant transfer tasks participants would have to truly understand false belief rather than employing a possibly non-mentalistic learnt strategy. The two close transfer tasks and three distant transfer tasks were also given to the participants three months after the end of teaching. Results of the instruction task revealed that all three groups of children showed a steady rate of learning. The results of the post-teaching and three month follow up were interesting. The children from all three groups successfully passed the two close transfer tasks in both the post-teaching and follow up conditions. None of the children with autism passed the post-teaching distant transfer tasks while five of the typically developing children and five of the children with Down syndrome passed at least one of the three distant transfer tasks. For the follow up condition all eight children with autism again failed all of the distant transfer tasks. Similarly there was no significant change in performance for the children with Down syndrome for the distant transfer tasks while the typically developing children showed a significant improvement in performance. Despite the small sample sizes used in this study the results nevertheless suggest that while it is possible to teach children with autism to understand false belief, this ability is unlikely to be generalised to other situations that are different in nature to the way in which the ability was initially taught.

2.3.2 The principle that seeing leads to knowing. It has been reported that children with autism fail tests that assess whether they understand the principle that seeing leads to knowing, another important piece of theory of mind knowledge (Baron-Cohen & Goodhart, 1994; Leslie & Frith, 1988; Perner, Frith, Leslie & Leekam, 1989).

Leslie and Frith (1988) conducted research comprising five aims: to replicate the findings of Baron-Cohen et al. (1985) with different children with autism; to investigate whether the same results as those obtained by Baron-Cohen et al. (1985) could be obtained using real people acting out a real scenario rather than using dolls; to refine the sample of children with autism with respect to mental age in that only children with mental ages that exceeded four years, five months would be included (the mean chronological age of the typically developing children in the original theory of mind experiments); to extend theory of mind investigations beyond false belief and into the area of knowledge and ignorance; and to test the ability of children to understand the concept of seeing/not seeing. Leslie and Frith (1988) tested 18 children with autism and 12 children with specific language impairment (SLI). Four tasks were conducted: line of sight, memory for position, limited knowledge and false belief. Children with SLI were only tested on the false belief task. The line of sight task tested the ability of the participants to correctly identify whether a doll could see or could not see a counter that was either in view of the doll and the participant or only in view of the participant. The memory for position task involved the use of three differently coloured hiding places. Experimenter two would put a marble in one of these places asking the participant if they would help them remember where the marble was put and then preceded to leave the room. Experimenter one would take the marble, play with it briefly and then ask the participant to replace the marble where experimenter two had initially left it. Experimenter two was then called back into the room at which point the participants were asked where experimenter two had left the marble. The limited knowledge task involved the use of different hiding places (a round brown container, a square yellow box and a red purse) and a counter. Experimenter one would show the participant the counter and then hide the counter under the yellow box ensuring (by exclaiming "Can you see me hiding this counter under here?") that both experimenter two and the participant could see. Experimenter two was then asked to leave the room. While out of the room it was stressed to the participant that experimenter two was no longer present and therefore could not see what they were doing. A second counter was then produced at which point the participant was asked if they could put that counter somewhere different to the previous one - control question one. Experimenter one then asked the participant where experimenter two saw him hide the first counter - control question two. After a correct response experimenter one would then point to where the participant had hidden the second counter asking the participant if experimenter two knew that there was a counter under there. This was the knowing question. Finally the participant was asked where experimenter two would look for the counter when they came back into the room – the prediction question. The false belief task used the same hiding places as the limited knowledge task with the exception that the brown container was replaced with a basket accompanied by a handkerchief to cover it. A pound coin replaced the counters. Experimenter two would hide the coin in the basket making this apparent to the participant and then would leave the room. Experimenter one would then ensure that the participant was aware that experimenter two had left the room and could not see them. The participant was then asked where experimenter two hid the coin. After a correct response experimenter one, apparent to the participant, relocated the coin to the red purse. A collection of questions was then asked. The knowing question "Does [experimenter two] know that the coin is in here?" was asked while experimenter one was pointing to the red purse. A prediction question "When [experimenter two] comes back where will she look for the coin?" was also asked. In addition two control questions "Where did [experimenter] two put the coin in the beginning?" and "Where is the coin now really?" and a think question, "Where does [experimenter two] think the coin is?" were asked. For the line of sight and memory tasks all children with autism tested passed. Eight of the children with autism passed the limited knowledge task while 10 failed. On the false belief task, 5 children with autism passed both the prediction and thinking questions while 13 failed. Of the 12 children with SLI all passed the prediction question and 11 passed the thinking question. These results support those of Baron-Cohen et al. (1985) in that only 28 % of the children with autism passed the test of false belief despite the test being delivered with actual people enacting an actual false belief scenario. Furthermore Leslie and Frith (1988) were able to show that children with autism have a specific difficulty in understanding the principle that seeing leads to knowing. That is only 44 % of the children with autism understood the link between seeing and knowing. The results reported by Leslie and Frith (1988) also provided evidence that children with autism understand the concept of seeing/not seeing and that the same children had no difficulty with memory for location.

Perner, Frith, Leslie and Leekam (1989) also investigated the principle that seeing leads to knowing and autism by including knowledge-formation tasks within their study. Because this study was previously discussed within the section on first-order false belief only a summary of the knowledge-formation task and the results obtained for this task will be given here. There were two knowledge-formation conditions: Other Ignorant and Subject Ignorant. For both conditions the participant and the cooperating experimenter were shown a box containing several objects. The main experimenter would then explain that she would choose one of the objects and put it into a cup without anyone being able to see it. For the Other Ignorant condition the main experimenter would then let the participant look into the cup explaining to the participant that the other experimenter would not be shown. In the Subject Ignorant condition the opposite occurred. That is the experimenter was allowed to look into the box while it was emphasised that the participant would not have the same chance. For both conditions a collection of test questions were then asked:

- "Does [cooperating experimenter] know which thing I put into the cup?" (Other-Knows question);
- "Why does [cooperating experimenter] not know that?" (Justification question);
- "Did I let [cooperating experimenter] look into the cup?" (Other-Seen question – this was omitted if the participant already included this information within their response to the justification question);
- "Do you know which object I put into the cup?" (Self-Knows question);
- "Why do you know that?" (Justification question);
- "Did I let you look into the cup?" (Self-Seen question – this was omitted if the participant already included this information within their response to the justification question).

Of the 23 children with autism tested, eight provided adequate justifications for other and self on both knowledge-formation conditions, allowing Perner et al. (1989) to conclude that approximately 35 % of the children with autism tested made a clear connection between visual access and knowledge. That is, only 35 % (in comparison to the 44 % found by Leslie & Frith, 1988) of the sample of children with autism understood the connection between seeing and knowing. Perner et al. (1989) compared the knowledge-formation results to the results of their false belief task[15] reporting that the contingency between belief and knowledge attribution revealed a clear picture. That is, all four false belief passers were able to attribute knowledge on the basis of visual access and furthermore were able to justify their attribution. This was in contrast to the false belief failers who were all unable to attribute the same knowledge. Perner et al. (1989) additionally concluded from their research that children with autism "are grossly delayed in their acquisition of a theory of mind" (p.698).

To further investigate whether children with autism have a specific difficulty in understanding the principle that seeing leads to knowing, Baron-Cohen and Goodhart (1994) used a simpler procedure than both Leslie and Frith (1988) and Perner et al. (1989), a version of the Pratt and Bryant (1990) probe. Basically the Pratt and Bryant probe involves two characters – one that looks into a box and one who does not. The child being tested is then asked, "Which person knows what is in the box?" Baron-Cohen and Goodhart (1994) used dolls instead of actual people. Showing the participant two boxes began the experimental paradigm. The participant was told that each of the boxes had something in them. Two dolls were then introduced. One doll would simply pick up one of the boxes while the other doll would open the alternative box and look into it. The participant would then be asked,

[15] The false belief task used by Perner et al. (1989) was described in detail on page 55.

"Who knows what is in the box?" All the while the participant remained ignorant as to the contents of the box. Twelve children with autism and 12 children with mental handicap[16] but without autism were tested. Of the children with autism four passed the experimental task while eight failed. Of the children with mental handicap nine passed and three failed[17]. These results were consistent with those of Leslie and Frith (1988) and Perner et al. (1989) that only (approximately) a third of the children with autism were able to pass a test that involves an understanding of the simple principle that seeing leads to knowing – an important piece of theory of mind knowledge. Because Baron-Cohen and Goodhart (1994) used a comparison group of children with mental handicap they were able to add strength to the claim that this inability may well be autism specific and not due to a general developmental delay.

2.3.3 Recognition of mental state words. Baron-Cohen, Ring, Moriarty, Schmitz, Costa and Ell (1994) investigated the ability of children with autism, known to have theory of mind deficits, to recognise mental state terms. Fifteen children with autism and 15 children with moderate mental handicap but not autism were included in the study. Prior to commencing the experiment all participants were asked two control questions. Firstly participants were asked, "Do you know what is inside your head?" If the participant responded "No" or provided a response that did not involve the word 'mind', they were given this information. Secondly participants were asked, "Do you know what the mind can do?" Again if the participants did not volunteer the

[16] This term along with other outdated terminology is reported in order to maintain faithful reference to the sources of origin. The author of this thesis recognises the discriminatory potential of such language.

[17] There is however an error in the reporting of these findings within the paper by Baron-Cohen and Goodhart (1994). When viewing Tables 2 and 3, it becomes evident that in one table the number of children with mental handicap passing is 9, while in the other only 8 are reported as passing.

concept of 'thinking' or any related mental activity, the experimenter gave this information. The experiment was then begun. For the experiment participants were given two word lists – Word List A comprising eight mental state words and eight non-mental state words and Word List B comprising eight words describing what the body could do and eight words that were neither body- nor mind-related. Participants were asked to read aloud the words on each list (but obviously separately, List A first and then List B, and given assistance to read if this proved difficult). For each word on List A participants were asked, "Can the mind do this?" For each word on List B they were asked, "Can the body do this?" Clearly the scores for both lists were out of 16. To pass, participants had to be correct on six of the eight target words and six of the eight non-target words. Of the children with autism only 26.7 % passed on List A, while 93.3 % passed on List B. All of the children with mental handicap passed on both lists. As predicted by Baron-Cohen et al. (1994) the children with autism were significantly impaired in their ability to recognise mental-state words when compared with non-autistic mentally handicapped children, providing further evidence for an autism-specific impairment in theory of mind abilities.

2.3.4 Utilisation of mental state words. The results of research conducted by Baron-Cohen, Leslie and Frith (1986) have been discussed previously within the section on first order false belief so only a description of the narration element of this research will be given here so as to exemplify these particular findings. Recall from the previous discussion of this research that participants were expected to sequence a series of three differing types of picture stories – behavioural, mechanical and intentional. After the sequences were ordered by the participants they were asked, "Can you tell the story?" While some of the participants never responded verbally to this request, 10 of the 21 children with autism and 7 of the 15 children with Down syndrome and all of the typically developing participants did. Narrations for the three types of picture stories were scored as either causal, mental state or descriptive. For the mechanical sequences, the children with autism used significantly more causal terms in their narration than the other two groups, who did not differ from each other. For the behavioural sequences all participants utilised more descriptive utterances. For the intentional condition the children with autism used significantly fewer mental state expressions than both the children with Down syndrome and typically developing children. Overall the majority of children with autism favoured descriptive explanations of the stories, while the other children readily provided mental state explanations, again providing evidence (especially when considered along with the other results of this study) that children with autism may be deficient in theory of mind abilities.

2.3.5 Ability to deceive. Russell, Mauthner, Sharpe and Tidswell (1991) were the first researchers to study systematically the ability of children with autism to deceive. Prior to the research conducted by Russell et al. (1991) the most popular technique used to assess whether young children understood the role of false beliefs in action, involved understanding how the state of being misinformed influences behaviour and judgments – namely the Sally-Anne type tests of false belief in which items are unexpectedly transferred without the knowledge of one of the dolls, and tests where the children themselves are misinformed (Russell et al., 1991). However the other main criterion for whether children understand the role of false beliefs requires an understanding of deception. It was for this reason that Russell et al. (1991) devised a test of deception – the 'windows task'. The windows task involved the participant and an experimenter in a competitive game. In this game either the participant or the experimenter could win sweets that were hidden in one of two boxes. In the training phase of this game the participant, without the knowledge of where the sweets were, would tell the experimenter where to look for the sweets. Every time the experimenter chose the correct box he would keep the sweet. If the experimenter chose the wrong box then the participant would get the sweet. Therefore within the training phase the participants would learn that it was in their interest to tell the experimenter to look in the empty box. In the testing phase the two boxes both had windows in them that faced the participant but that were not in view to the experimenter. Again, if the participant encouraged the experimenter to look in the empty box then the participant would win the sweet, if not the experimenter would get the sweet. Clearly it was advantageous to the participant to deceive the experimenter. Russell et al. (1991) tested 17 three-year-old typically developing children, 16 four-year-old typically developing children, 11 children with autism and 14 children with mental handicap but not autism on both the windows task and a false belief task. The false belief task was modelled on that used by Leslie and Frith (1988)[18]. For the windows task most of the four-year-old typically developing children and most of the children with Down syndrome pointed to the empty box. However most of the typically developing three-year-old children and nine of the 11 children with autism pointed to the full box and continued doing so for all test trials, despite not winning a sweet. When comparing success on the windows task with success on the false belief test for all participants, Russell et al. (1991) found an association. Despite this

[18] The false belief task used by Leslie and Frith (1988) is described in detail on pages 58-59.

significant association Russell et al. (1991) offer an explanation for the association that does not involve knowledge of how mental states relate to the world. Rather the authors suggest that what makes the two tasks difficult for the children with autism and the typically developing three-year-old children is the fact that both tasks require participants to inhibit reference to a salient object. Therefore in order for the participants to play the windows game deceptively, and similarly to answer the question about belief in the test for false belief mentalistically, it is necessary for them to "suppress the tendency for physical knowledge to overwrite mental knowledge" (Russell et al., 1991, p.341).

Following the research conducted by Russell et al. (1991), Sodian and Frith (1992) wanted to further investigate the inability of children with autism to deceive and in particular were interested in just how profound this inability was. In order to accomplish this Sodian and Frith (1992) tested 19 children with autism, 29 children with mental retardation and 39 typically developing children on two deception tasks – the 'one box' and 'two boxes' tasks, and a false belief task. One of the deception tasks was modelled on that used by Woodruff and Premack (1979) and involved deceptive pointing similar to Russell et al. (1991) while the other required telling a lie. The standard false belief task was modelled on that used by Leslie and Frith (1988). For both the one box and two boxes tasks the experimenter firstly introduced the characters – puppets. One puppet was a seal and was introduced as the nice Smartie friend that gave Smarties to children whenever he found them; the other was a wolf and was introduced as the nasty Smartie eater who takes Smarties away from children. It was explained to the children that what was going to happen was a game and that to win lots of Smarties they had to help the nice Smartie friend find Smarties but at the same time prevent the nasty Smartie eater getting any. The one box and the two boxes tasks had both sabotage and a deceptive condition. In the one box sabotage condition participants hid the Smartie in the box and were able to either lock the box or keep it open, therefore either preventing the eater getting the Smartie or allowing the friend to find it. In the one box deceptive condition the participants still hid the Smartie but the box could not be locked. Here the participants had the option of lying to the eater telling him that the box was locked, therefore preventing losing it themselves or telling the truth to the eater and losing it. Similarly if they told the friend the truth they would receive an additional Smartie reward. In the two boxes sabotage condition each of the two boxes could be locked with a padlock. The participant was still expected to hide a Smartie however this time the participant was asked which box they wanted to lock – the one with the Smartie or the one without. The same rule still applied to the two puppets. That is help the friend find the sweet and do not let the eater find the sweet. In the two boxes deception condition the procedure was the same however there was no padlock. Instead the eater/friend asked the participant "Where is the Smartie?" The experimenter then asked the participant which box they wanted to point to, reminding the participant to again help the friend; do not let the eater find the Smartie. For the standard false belief task the children with autism performed significantly worse than both the typically developing children and the children with learning disabilities. On the one box deception task the children with autism performed significantly less well than both groups of controls. However for the one box sabotage task the performance of the children with autism was as good as controls. The results of the two boxes sabotage and deception tasks failed to isolate a specific impairment of the children with autism. Rather both the children with autism and the children with learning disabilities performed significantly worse than the typically developing children. Finally it was found for the children with autism that there was no significant difference in difficulty between the false belief test and either of the two deception tasks. In summary what Sodian and Frith (1992) found was that when required to tell a lie, children with autism performed significantly worse than typically developing and learning disabled controls. Despite this inability to lie the children with autism readily sabotaged situations physically to prevent their competitor gaining a reward. Sodian and Frith (1992) suggest that the ability to sabotage on behalf of the children with autism effectively rules out an inability to understand the task as an explanation for the failure to deceive. Similarly Sodian and Frith (1992) were able to conclude that performance on deception was predicted by performance on a false belief attribution task. The results presented by Sodian and Frith (1992) add strength to the argument that children with autism have a specific deficit in understanding and manipulating beliefs.

Baron-Cohen (1992) tested 15 children with autism, 15 children with mental handicap but not autism and 15 typically developing children on a penny hiding game and a false belief test, so as to further explore the ability of children with autism to deceive. The penny hiding game used was a two-person game in which the participant was actively involved as either a guesser or as a hider. Participant as guesser was one condition while participant as hider was another. The hider would hide a penny in one of their hands and then ask the guesser to guess which hand the penny was in. This was repeated over a succession of trials after which the participant and the experimenter changed roles. In condition one, participant as guesser, there were 12 trials divided into 3 blocks of 4. In the first block the participant always won, as there was always a penny in both hands (unknown to the participant). In the second block the participant always lost as neither hand had a penny in it (again unknown to the participant). In the third condition the experimenter played properly, using only one coin and hiding it unpredictably. In condition two the participant acted as hider. For this condition the experimenter emphasised to the participant to make it as difficult as possible. Scoring for the penny hiding tasks had three separate criteria. First was a traditional measure that looked at hand-use strategies (repetition, switching or irregular) whereby the use of irregular patterns for hiding and guessing were perceived as more mature. Secondly was an object-information occlusion measure whereby as hider, keeping the penny from view of the guesser showed successful object occlusion. However the higher order occlusion involved preventing the guesser from getting information about where the penny was. Baron-Cohen (1992) called this 'information occlusion'. Finally there was a misinformation criterion whereby attempting to mislead the guesser was looked at. For the false belief test, participants were shown a milk carton and asked what they thought was inside it. All participants replied "milk". The carton was then opened to reveal that it actually contained a ball. Participants were then asked again what they thought was in the carton. All participants replied " a ball". The test question "When I first asked you, before we opened the carton, what did you think was inside?" – the correct response being "milk", was then asked. If they did not respond the participants were asked, "Did you think there was a ball inside, or did you think there was milk inside?" To control for memory being a possible factor in false belief failure all participants were first tested in a control condition. In this condition participants were shown a black box. The lid was taken off to reveal a green brick. The lid was put on and the participants were asked, "What is inside the box?" Participants replied "a green brick" The participants then, with the experimenter, changed the green brick to a yellow brick. The participants were then asked, "Now what is in the box?" Participants replied "a yellow brick" Participants were then asked, "When I showed you the box, before we opened it, what was inside then?" If participants did not reply they were prompted by asking them, "Was there a yellow brick or a green brick?" The results of the hand-use strategies revealed that the majority of participants from all three groups utilised the intermediate strategy of switching, while none of the children with autism or children with mental handicap used irregular hand-use. Similarly there was no significant difference in the number of participants that succeeded in object occlusion while the children with autism utilised information occlusion on significantly fewer occasions. In terms of misinforming or cheating, only one of the participants with autism did this, while six of the participants with mental handicap and four typically developing participants cheated. The results of the false belief test revealed that only 4 of the 15 children with autism passed while 10 with mental handicap and 11 typically developing children passed. Baron-Cohen (1992) successfully replicated findings that suggest that children with autism fail to employ deceptive strategies. These findings were from both traditional measures of strategic hand-use but also from new measures as developed by Baron-Cohen (1992). The new measures successfully identified that children with autism played the penny hiding game as if it were simply about object occlusion rather than information occlusion or indeed misinformation. Baron-Cohen (1992) related the ability to utilise object occlusion to previous findings that children with autism do not have difficulty with the concept of seeing (Leslie & Frith, 1988) and the inability to utilise information occlusion to findings that suggest that children with autism have difficulty in understanding that seeing leads to knowing (Perner, Frith, Leslie & Leekam, 1989). Because there was a correlation between tests of deception and tests of false belief, Baron-Cohen (1992) suggested that deception impairment is an example of how the theory of mind deficit in autism affects behaviour in real-life situations. Baron-Cohen (1992) concluded from this study that deception in terms of manipulating what people know or believe, rather than manipulating what people can see, does not appear in typically developing children less than three-and-a-half-years-old and rarely develops in children with autism.

2.3.6 Complex causes of emotion. While children with autism do not appear to be deficient in understanding simple causes of emotion it has been reported they have difficulty understanding more complex causes of emotion, for example beliefs (Baron-Cohen, 1991).

Baron-Cohen (1991) tested 17 participants with autism, 16 participants with mental handicap and 19 typically developing children on the ability to understand some causes (situations, desires and beliefs) of two basic emotions (happiness and sadness). Participants were given a situation test, first desire test, belief test and second desire test. In the situation test a doll, Jane, was having a birthday party. Participants were firstly asked a situation question, "How does she feel?" the correct answer being "happy", and then a justification question, "Why?" the correct response being "birthdays are nice, you get presents etc." It was explained to the participants that on her way home from the party, Jane fell and cut her knee. Participants were then asked a second situation question, "How did she feel?" the correct response being "sad", and a second justification question, "Why?" the correct answer being "because she hurt herself". In the first desire test Jane was having breakfast. It was explained that Jane liked rice crispies but did not like coco-pops. The first desire question “If we give her this box (indicating rice crispies) how will she feel?” was then asked, the correct response being “happy”. The justification question, “Why?” followed, for which a correct answer was “because she likes rice crispies”. The alternative situation was then provided, that is, coco-pops>”No”>”because she does not like coco-pops”. In the belief test Jane goes for a walk so makes an exit. While Jane is out the experimenter opens both the rice crispies and coco-pops boxes showing the participants that the rice crispies box is empty and that the coco-pops box contains rice crispies. Jane then comes back at which point belief question one, “If we give her this box (indicating rice crispies) how will she feel?” is asked. Clearly a correct response would be “happy” with a correct response for the justification question being “because she thinks rice crispies are in the box and she likes them”. The alternative situation was then given, that is, coco-pops>”sad”>”because she think there are coco-pops in the box and she does not like coco-pops”. In the second desire test it was suggested that Jane is given the rice crispies box and subsequently looks into it. “How does she feel?” being the third desire question was asked to which a correct response would be “sad”. This was followed by a justification question for which the children to be correct would have to reply “because there aren’t any and she likes them”. Again the alternative situation was then given, that is coco-pops>”happy”>”because there are rice crispies in it and she likes them”. Baron-Cohen (1991) included memory control questions to rule memory failure out as a factor. These questions were: “What does Jane like – rice crispies or coco-pops?” (correct answer being rice crispies); “What’s in the rice crispies box?” (correct answer being nothing); “What’s in the coco-pops box?” (correct answer being rice crispies). In understanding situational causes of emotion the children with autism were unimpaired, performing at ceiling. For desire based causes of emotion there was no significant difference between the performance of the children with autism (9 passed) and the children with mental handicap (8 passed), although both groups made more errors than the typically developing children (17 passed). However when considering beliefs as a cause of emotion the children with autism performed significantly worse than the other two groups, with only 3 of the 17 passing the test in comparison to 9 children with mental handicap and 14 typically developing children.

2.3.7 Spontaneous pretend play. Children with autism are reported to be impaired in the production of spontaneous pretend play (Baron-Cohen, 1987; Jarrold, Boucher & Smith, 1996; Lewis & Boucher, 1988). Pretend play is an important ability when considering theory of mind due to the inherent mental state requirement of pretending.

Even though Baron-Cohen (1987) recognised that the ability of children with autism to engage in pretend play had been studied previously, he rightly questioned the definition of pretend play that had been used in the past. As a result Baron-Cohen (1987) conducted a study investigating autism and pretend play with the understanding that:

> Pretend play can be said to occur if there is evidence that:
>
> 1. The subject is using an object as if it were another object and/or
> 2. The subject is attributing properties to an object which it does not have, and/or
> 3. The subject is referring to absent objects as if they were present (p.140).

Baron-Cohen (1997) compared three groups of children: 10 children with autism, 10 children with Down syndrome and 10 typically developing children. Each participant was seated at a table and provided with three different sets of toys, one at a time (stuffed animals and wooden bricks; a toy kitchen stove with related pieces and a telephone; and a set of play people in a playground setting). Once given the toys, the children were told that they could play with them any way they liked. The children were videotaped playing with each set of toys for five minutes. The videotapes of the play sessions were then analysed by judges according to whether they consisted of sensorimotor play, ordering play, functional play or pretend play. While it was found that the spontaneous functional play of the children with autism was similar to that of controls, significantly fewer children with autism produced spontaneous pretend play when compared to the children with Down syndrome and typically developing children.

Lewis and Boucher (1988) assessed three different play conditions (spontaneous, instructed and elicited) for three groups of 15 children (children with autism, children with learning impairments and typically developing children) so as to clarify existing findings concerning the spontaneous play of children with autism, and to test hypotheses about the cause of possible impairments of spontaneous play in relatively able children with autism. The hypotheses Lewis and Boucher (1988) set out to test were the symbol deficit hypothesis (impaired play results from an inadequate symbol system) and the conative hypothesis (impairment is due to a failure to use a relatively adequate symbol system as a result of some conative abnormality). The main experiment conducted by Lewis and Boucher (1988) utilised four sets of toys (a car and junk accessories; a car and conventional accessories; a doll and junk accessories; and a doll and conventional accessories) and consisted of two sessions, each comprising 30 minutes. In session one all of the toys were spread around the room and the participant was allowed to play spontaneously. After five minutes of spontaneous play, elicited and instructed play tests were begun using the two sets of car toys. The participant would be handed a car and an accessory and asked "What can these do? Show me what you can do with these?" This was the elicited condition. After the child responded or it was clear that a response would not be given the instructed condition was commenced. The instructed condition involved the experimenter telling the child to do something with the car and the accessory, for example "Put the car in the garage". Session two began with the elicited and instructed conditions using the two sets of doll materials. This was followed by five minutes of spontaneous play. Both sessions were video- and audio-taped. From the observations of the spontaneous play sessions it was found that:

- the children with autism spent less time playing functionally than controls
- there was no difference in the amount of time the groups played symbolically
- relatively able children with autism have a potential for functional play which is underused in spontaneous play situations
- children with autism have unimpaired potential for symbolic play.

Lewis and Boucher (1988) tested the symbol deficit hypothesis by the inclusion of instructed play conditions into their sessions. According to the symbol deficit hypothesis "the capacity for symbolic play in autism is reduced relative to controls whereas the capacity for functional play is not" (Lewis & Boucher, 1988, p.335). Therefore Lewis and Boucher (1988) concluded from this hypothesis that if children with autism are asked to carry out instructions for symbolic play with junk materials they will be impaired relative to controls, but if asked to carry out instructions for functional play with conventional toys they would be unimpaired. This however was not the case. Even though instructed functional play could not be assessed it was found that instructed symbolic play is unimpaired in children with autism therefore casting doubt on the symbol deficit hypothesis. Comparing the spontaneous play of children with autism to their elicited play tested the conative hypothesis. When comparing the relatively unimpaired amount of good quality symbolic and functional play that the children with autism produced in the elicited condition to their lack of functional play in the spontaneous play condition, strong evidence for the conative hypothesis mounted. Overall Lewis and Boucher (1988) provided evidence that:

- Children with autism produce very little spontaneous pretend play
- The ability of children with autism to play symbolically as well as functionally is better than often reported
- The lack of pretend play exhibited by children with autism is likely to have a conative as well as a cognitive cause.

Jarrold, Boucher and Smith (1996) also investigated pretend play in autism. Jarrold et al. (1996) conducted three experiments: one compared production of pretence in spontaneous versus elicited conditions; one assessed pretend play abilities within highly structured conditions; and the third investigated the generation of pretend acts in cued versus non-cued play conditions. The first two experiments mentioned were similar to that conducted by Lewis and Boucher (1988) but involved some changes. For the investigation into spontaneous versus elicited pretend play, Jarrold et al. (1996) like Lewis and Boucher (1988), utilised a set of dolls and a set of dolls plus junk materials. The junk materials differed. Where the junk materials utilised by Lewis and Boucher (1988) were conducive to functional play, the junk materials used by Jarrold et al. (1996) were not. The spontaneous and elicited conditions were similar to those implemented by Lewis and Boucher (1988) in that the spontaneous play condition involved leaving the toys on a table, available to the participants, while the experimenter did some writing; while the elicited play condition had the experimenter ask participants what could be done with the toys and to subsequently show what could be done with the toys. Within this experiment participants with autism spent less time engaging in pretence and furthermore showed a trend towards fewer pretend acts suggesting impairment in the production of spontaneous pretend play for this group. It was also found that pretend play was not aided by elicitation. The latter finding concerning elicitation contradicts the findings of Lewis and Boucher (1988) that showed that when elicited, children with autism produce pretend play as readily as controls. It is possible that the use of different junk props, as discussed previously, resulted in these contradictory findings.

In the second of their studies, Jarrold, Boucher and Smith (1996) tested the ability of children with autism to engage in acts of pretend play within highly structured situations. This study was similar to the instructed play condition used by Lewis and Boucher (1988), but again involved changes. Changes were made so as to overcome criticism that guessing may have successfully performed some of the instructed play tasks within the Lewis and Boucher study (1988). An example of criticism by Baron-Cohen (1990) is provided by Jarrold et al. (1996) where because in one instance participants were only provided with two props, a car and a shoebox and were subsequently asked to 'park the car in the garage', there was little else participants could do apart from respond appropriately. To avoid similar methodological concerns, Jarrold et al. (1996) used a number of props if object substitution was the experimental goal.

Jarrold, Boucher and Smith (1996) compared three types of instructed play: instructions that were physical in nature; instructions that were social; and instructions that were emotional. These different types of instructions were used so as to possibly elicit: pretend object substitution; imagination of objects that were not present; and attitudes respectively. In the physical instructed play condition participants were given a gender-appropriate doll and junk items (tissue, blue-tac, a plastic rod, a freezer bag tie, a picture hook and a bicycle pump adapter) and asked to make the doll perform certain actions (jump over a puddle, throw a stone, sit on a chair and eat a biscuit). In the social instructed play condition participants were given the same gender-appropriate doll, a mother doll and a baby character and asked to perform particular actions (mummy feeding the baby, mummy giving the boy a sweet, doll throwing a ball to mummy, doll looking at a book with mummy). Finally in the emotional instructed play condition participants were given the gender-appropriate doll, a toy dog, a matchbox covered in foil representing a present and a child figure and asked to present the doll in different emotional situations (scared of dog, excited about present, sad for losing the present, angry with someone). In this experiment children with autism were unimpaired, compared to controls, in the ability to engage in pretence when instructed to do so. Additionally no differences were found between the different types of pretence contexts (physical, social or emotional)

For the third experiment, Jarrold, Boucher and Smith (1996) investigated the possible effects of cues on pretend play, examining the likelihood, as a generativity impairment would suggest that "children with autism show little spontaneous pretend play because of an impaired ability to generate the retrieval strategies necessary for producing pretend acts" (p.290). To investigate cued versus non-cued pretend play two conditions were used. In one condition props (candle, football scarf, plastic colander, plastic serving spoon, plastic ruler, card index box, small metal tub and a cake tin) were used while in the other no props were present. For both conditions the experimenter initially modelled three pretend acts: cleaning teeth; washing windows; and putting on a hat. Participants were then asked what they could pretend to do. The participants with autism were shown to be equally impaired on conditions, where props were present and where props were absent. Jarrold et al. (1996) make two suggestions from these findings. Firstly that the problems with pretend play in autism are not due to inefficient retrieval strategies as if this were the case cues should have proved beneficial. Secondly that providing props may not be an effective way of cueing the generation of pretend acts.

Overall, from the three studies, Jarrold et al. (1996) provide evidence that children with autism are impaired in spontaneous pretend play but are unimpaired when instructed to pretend. From this the authors suggest that individuals with autism are not deficient in the production of pretend acts but rather are impaired in the generation of pretend acts. Jarrold et al. (1996) add to these suggestions that individuals with autism (because they were not aided in the third experiment by cues), are not deficient in the generation of strategies necessary for retrieving pretend ideas, but instead are generally deficient in the generation of pretend ideas.

2.3.8 Interpretation of gaze in the inference of mental states. Baron-Cohen et al. (1995) conducted research investigating gaze comprehension in autism. Four experiments were conducted with the same three groups of children – 20 children with autism, 30 children with mental handicap and 20 typically developing children. Experiment one involved participants choosing from pairs of cartoon faces as to: which face was looking at them (one face would be looking directly in front of them while the other would be looking away) – this was the experimental condition; which face is the silly face (where one of the faces had eyes placed in impossible positions); and which face is the sad/happy face. In addition since the experimental condition involved participants drawing imaginary straight lines, children were presented with a picture with a black arrow pointing to just one of an array of black dots and asked, "Which dot is the arrow pointing at?" Using the cartoon faces Baron-Cohen et al. (1995) found no group differences for all four conditions, providing evidence that children with autism are not impaired in judging when someone is looking at them and furthermore that children with autism do in fact attend to eyes and faces and can trace imaginary straight lines. Experiment two tested whether for the three groups of participants that eyes communicate information about the mental states of desire, goal and intention to refer. For this experiment participants were shown a piece of card with four pictures of well-known confectionary items in the four corners. In the desire condition participants were asked, "Which one do you want?" A transparency was then overlaid with a cartoon face (Charlie) looking at one of the sweets (a different sweet than chosen by the participants). The participants were then asked, "Which one does Charlie want?" In the goal condition participants were asked, "Which one will you take?" A transparency was again laid over the card with Charlie looking at one of the other three sweets. Participants were asked, "Which one will Charlie take?" The refer condition used a different display. The refer display had two nonsense shapes in the bottom two corners of the card. The experimenter then told the participants "One of these shapes is a beb, which one is a beb?" A transparency was then laid over with Charlie looking at the shape that the participants did not identify. The experimenter then said "Charlie says 'there's the beb', which one does Charlie say is the beb?" As well as the three mental state conditions, a control condition was included to test whether the participants were simply identifying where Charlie's eyes were pointing rather than attaching meaning to the eye direction. For this condition there were two differently sized boxes on a piece of card. Charlie always looked at the bigger of the two. The control question was, "Which box can go inside the other?" Clearly participants were required to identify the box that Charlie was NOT looking at, that is the smaller of the two boxes. For all three mental state conditions (desire, goal and refer) the children with autism scored significantly lower than both the typically developing children and children with mental handicap, typically choosing in an egocentric manner by pointing to the sweet that they wanted or that was their favourite. However all participants scored similarly on the control condition allowing Baron-Cohen et al. (1995) to conclude that when compared to controls, the majority of children with autism fail to utilise eye-direction for inference of the mental states of desire, goal and refer. Experiment three was conducted using the same materials as experiment two, except that on the transparency, along with Charlie's face was an arrow pointing to one of the sweets. Desire and goal were tested as well as a control condition. The control condition was included to check: whether participants could ignore both eye-direction and arrow pointing; as well as to check whether participants could follow instructions that involved neither Charlie's eyes or mental states. For the control condition Charlie's face was centred amongst four differently coloured boxes.

Charlie's eyes were pointing to one box and an arrow to another. Questions were then asked for which the correct answer involved ignoring both where Charlie and the arrow was indicating. The participants with autism performed significantly worse than the other two groups on both desire and goal but not on the control task. Not only did the participants with autism fail to utilise eye-direction to infer desire and goal but also tended to favour the arrow over the eyes, suggesting that as Baron-Cohen et al. (1995) state, children with autism are blind to the mentalistic significance of the eyes. Experiment four was conducted to test the ability of the three groups of children to infer from photographs and pictures of people and cartoon characters respectively the mental state of thinking. Pairs of photographs of people's faces and drawings of cartoon faces were presented in pairs. One of the faces looked straight ahead while the other looked upward to one side, representing thinking. Results provided highly significant group differences with the children with autism performing worse than controls. The children with autism could not infer from eye-direction, which people or characters were thinking. Overall, from the results of all four experiments, Baron-Cohen et al. (1995) concluded that children with autism are severely deficient in the identification of the mental states of desire, goal, refer and think from the eyes.

2.4 Challenging the Theory of Mind-deficit Account of Autism

Despite the reference to the findings reported in the preceding section as evidence for a theory of mind-deficit in autism, certain areas remain insufficiently investigated. For the purpose of the studies to be reported here, there are four areas identified as requiring further investigation: non-mental state analogues of the unexpected transfer false belief task; the role that arbitrariness has in relation to either the success or failure of children with autism on tests of false belief; attentional requirements of tests of false belief; and memory.

While the evidence suggesting that children with autism are impaired in their ability to understand mental states is strong, the abundance of research, particularly that investigating first order false belief by use of the Sally-Anne test or variants of this, mushroomed before adequately exploring alternative possible causes of failure of children with autism on such tests and furthermore before investigating what else first order false belief tests may be tapping into for children with autism (and controls for that matter). Due to the mentalistic nature of the Sally-Anne test (and variants) it was assumed, perhaps too quickly, that children with autism fail these tests as a result of not understanding mental states. However it is conceivable that children with autism fail tests of false belief due to factors other than false belief. Before embarking upon multiple investigations into false belief failure and indeed the considerable number of associated areas just outlined, it may have been prudent to ensure that first order false belief failure in children with autism is in fact due to an inability to comprehend another person's false belief. Having said that, some researchers did investigate the difference between the performances of children with autism on tests that require understanding of mental representations versus tests that do not, but that involve similar scenarios (Leslie & Thaiss, 1992; Baron-Cohen & Charman, 1992; Peterson & Siegal, 1998).

Leslie and Thaiss (1992) compared the abilities of children with autism and typically developing four-year-old children to understand both mental representations and non-mental representations. To do this false belief tests were compared to false photograph tests[19]. Leslie and Thaiss (1992) used two false belief tasks: a variant of the task used by Baron-Cohen et al. (1985) and the Smarties task (Perner et al. 1989) and two false photograph tasks. One of the false photograph tasks was based on the Sally-Anne test and involved a photograph being taken of an object in one location, then the object being moved to a new location. In the other false photograph task a photograph was taken of an object in a particular location, then the object featured in this photograph was swapped for a different object. In total, participants were tested in four conditions – place change, false belief; place change, photograph; identity change, false belief; and identity change, photograph. In the place change, false belief condition Billy, a doll, had a ball that he placed on his dressing table before going to breakfast. While at breakfast, Billy's mother moved the ball from the dressing table to the toy box. Participants were asked four questions:

- Control question one – "Where did Billy leave his ball?"
- Know question – "Does Billy know where his ball is?"
- Think question – "Where does Billy think his ball is?"
- Control question two – "Where is the ball really?"

[19] The false photograph tasks were modelled on those used by Zaitchik (1990) in her investigation into typically developing children's ability to reason about mental representations (false belief tests) in comparison to non-mental representations (false photograph tasks). Zaitchik replicated previous findings that children around the age of four years acquire the ability to correctly attribute false belief. Furthermore Zaitchik found that preschoolers have an even harder time reasoning about photos than beliefs.

In the place change photograph condition a puppet, Polly the horse, took a photograph of the other character, a cat, on the chair. The cat was then moved from the chair to the bed. Participants were asked three questions:

- Control question one – "When Polly took the photograph, where was the cat sitting?"
- Photograph question – "In the photograph, where is the cat sitting?"
- Control question two – "Where is the cat now?"

In the identity change false belief condition, participants were shown a Smarties box and asked what it contained. Participants replied "Smarties". The container was then opened to reveal a pencil. The container was then closed and participants were asked three questions:

- Other question – "Now [name of child's friend] has not seen this box before. When I show this box to [name of friend] – just like this (box held up), before I take the top off, what will [name of friend] say is in here?"
- Self question – "When I showed you this box in the beginning, what did you say was in here?"
- Control question – "What is really in here?"

In the identity change, photograph condition the cat took a photograph of the horse sitting on the toy box. The horse was then taken off the box and replaced with a mouse. Participants were asked three questions:

- Control question one – "Who was sitting on the toy box when the cat took the photograph?"
- Control question two – "Who is sitting on the toy box now?"
- Photograph question – "In this photograph, who is sitting on the toy box?"

The results of the four conditions clearly showed that while the performance of the typically developing children did not differ between the false belief and false photograph tasks, this was not the case for the children with autism. Only 23 % of the children with autism passed the false belief tasks, while their performance on the false photograph tasks was at or near ceiling, providing evidence that when it comes to representing non-mental representations, children with autism are unimpaired. Leslie and Thaiss (1992) also investigated the understanding of children with autism and typically developing children of a false map or diagram. Modelled on the place change photograph task, this ability was also found to be less difficult for the children with autism. From their combined findings Leslie and Thaiss (1992) concluded that false belief and representation tasks tap different cognitive mechanisms, one relating to mental representations and the other to non-mental representations with children with autism showing impairment on the former but not the latter.

Baron-Cohen and Charman (1992) further tested the claim that children with autism are impaired in tasks involving mental representations but not in tasks that involve non-mental representations. Baron-Cohen and Charman (1992) compared performance on false belief tests with false drawing tests for children with autism, children with mental handicap and typically developing children (three and four-year-old children). The false drawing test involved participants being presented with an object and being asked what it was. At this point either the experimenter or the participant drew the object. The picture was then turned face down and the object removed. A new object was put out in its place. Participants were then asked to name the new object and were then asked what was there before and finally, what was in the picture. No group differences were found between the children with autism, children with mental handicap or the typically developing four-year-old children. However, the typically developing three-year-old children performed significantly worse than the four-year-olds. For the false belief test the children with autism and the typically developing three-year-old children performed significantly worse than the other two groups. Overall the results provided by Baron-Cohen and Charman (1992), like the results of Leslie and Thaiss (1992) suggest that children with autism show a clear dissociation between performances on mental state (false belief) versus non-mental state tests (false photographs, false maps and false drawings).

Peterson and Siegal (1998) conducted two experiments to investigate the ability of children with autism, deaf children and typically developing children on tests of false belief and false photograph tests. In their first experiment, Peterson and Siegal (1998) tested 30 signing severely and profoundly deaf children, 21 children with autism, 19 typically developing three-year-old children and 16 typically developing four-year-old children on the false belief test as used by Baron-Cohen et al. (1985) and a false photograph test modelled on that used by Zaitchik (1990). Peterson and Siegal (1998) found that the children with deafness performed similarly to the children with autism with the majority of both groups passing the false photograph task but less than half of both groups passing the false belief test. The typically developing four-year-old children did equally well on the two tasks while the typically developing three-year-old children found the false photograph task easier than the false belief test[20]. In their second experiment Peterson and Siegal (1998) used a modified version of Leekam and Perner's (1991) procedure to test 24 deaf children, 21 children with autism, 23 typically developing three-year-old children and 24

[20] This was in contrast to the findings reported by Zaitchik (1990).

typically developing four-year-old children. This procedure was modified so as to reduce the conversational demands of the tasks to an absolute minimum. Despite these alterations the results of the first experiment were replicated, providing no statistical difference between the deaf children and the children with autism, both groups displaying a poorer understanding of false beliefs in comparison to false photographs. However the typically developing three-year-old children did no better on photo versus belief tasks[21]. The results of both of these experiments conducted by Peterson and Siegal (1998) indicate that children with autism and deaf children perform better on tests that involve non-mental understanding (false photographs) than they do on tests that require an understanding of mental states (tests of false belief).

Despite the investigations just outlined into the difference between the performances of children with autism on tests that require understanding of mental representations versus tests that do not but that involve similar scenarios, two immediate criticisms arise. First, so wide was the acceptance of Baron-Cohen et al.'s (1985) account of the difficulties experienced by children with autism on tests of false belief, it was some seven years before investigations aimed at testing alternative hypotheses began to emerge. Second, for false photographs, maps and drawings to be used as appropriate and adequate non-mentalistic controls for tests of false belief, they would have to be identical to tests of false belief in every cognitive domain, with the obvious exception of mental state understanding. There is debate as to whether this claim can be justified.

[21] Peterson and Siegal (1998) suggest procedural factors for the discrepancy between the performance of the typically developing three-year-old children over the two experiments that will not be discussed here.

Bowler, Briskman, Gurvidi and Fornells-Ambrojo (in press) raise questions as to the validity of the argument that the impairment seen in children with autism on tasks of false belief must be specific to mental states. The authors point out that for such an argument to be compelling the false belief test would have to be taken unequivocally as a measure of mental state understanding. Furthermore Bowler et al. (in press) state that for the mental state specificity argument to hold true that the false photograph, map and drawing tasks just outlined would have to be considered to be a proper control for the false belief test, that is that false photograph tasks tax the cognitive system in all respects similarly to the false belief test, except that of mental states. Bowler et al. (in press) do not deny that tests of false belief can be utilised so as to measure mental state understanding; rather they argue that such a test can be considered from an alternative perspective, which makes no reference to mental states. Considering the classic unexpected transfer test of false belief, Bowler et al. (in press) describe Sally as an agent who behaves towards a particular goal, a marble, which can be in either of two locations, in a box or in a basket. Additionally each of these locations are registered by a signal, Sally's belief, which then forms the basis of the agent's, Sally's behaviour towards the goal, the marble that is subsequently determined by the location of the goal. Bowler et al. (in press) explain that similar to Sally's belief, the signal is usually, but not necessarily, an accurate representation of the location of the goal. Consequently when the signal and the location of the goal are in conflict, a signal dependent agent should obey the signal and not the location of the goal. From this, Bowler et al. (in press) claim that children who predict the agent's behaviour on the basis of the signal provided to them rather than the location of the goal, should be performing analogously to children who pass the test of false belief by identifying that Sally will look where she thinks the marble is, rather than where the marble is currently located. In their paper, Bowler et al. (in press) provide a non-mental state test that was highly correlated with, and analogous to, the classic unexpected transfer false belief task. This non-mental state analogue was mechanical in nature and involved the use of an electrical train apparatus. To be successful on this test children with and without autism were expected in Bowler et al.'s (in press) words "to predict the behaviour of a mechanical system that used signal information about an event on which that system had to act" (p.7). To clarify this, what the children were expected to do was to predict the destination that an automatic (driverless) train would travel to when given appropriate signals. This was made similar to the unexpected transfer within the Sally-Anne test of false belief by including a discrepancy between the signal provided and the location of a plane that the train would typically travel. It was explained to the participants that what the train actually did was unload materials from a plane that landed at either of two landing points but importantly, that the train, because it was automatic, would only ever travel to the destination that was indicated by the corresponding light signal. After the plane landed on one landing point ('x') the signal for landing point ('y') would be highlighted. The experimenters would at this point exclaim surprise in the presence of the participants, noting that despite the plane being at 'x' the light was indicating 'y'. The belief question, "Where will the train go?" was then asked. The correct response for this question was in fact 'y' as the light suggested, and not 'x' where the plane landed. For the three groups of children included in the research conducted by Bowler et al. (children with autism, children with moderate mental retardation and typically developing children), the mechanical analogue was shown to correlate highly with the standard false belief task and furthermore was shown to be of equal difficulty to this task.

Bowler et al. (in press) conclude that not only is it possible to construct experimental scenarios void of any metal state content that are strongly correlated with tests of false belief, but that manipulating certain factors of these non-mental state analogues may provide some answers to questions concerning the failure of children with autism on such tests. Drawing on arguments put forward by Russell (1998b) that individuals with autism are particularly impaired on executive tasks that require arbitrary rules to be held in mind while at the same time eliciting prepotent responses to salient reality, Bowler et al. (in press) suggest that manipulating the salience of the plane or the signal, as well as altering the level of arbitrariness of the link between the signal and the location of the plane should alter consequent success rates of the children with autism. This is just one possibility with regards to possible manipulations. The important point raised by Bowler et al. (in press) is that the manipulation of certain factors of their newly constructed non-mental state false belief analogue, may begin to provide some answers as to why children with autism fail tests of false belief.

It is interesting that Baron-Cohen and Swettenham (1997) note that because control questions (what have been referred to previously as Memory and Reality questions) were utilised within the original procedure conducted by Baron-Cohen et al. (1985) that memory, language difficulties and inattention can be ruled out as potential causes of false belief failure in autism. While this may be true of very basic memory, attentional and language abilities it is felt that the inclusion of Memory and Reality questions can by no means entirely rule out such abilities as possible causes of false belief failure within the autistic population. Leslie and Frith (1988) also contend that because of the inclusion of a memory for location task in their research, that memory failure cannot be blamed for the failure of children with autism on tests of false belief. However this is considered to be a generalised statement for an area of cognition that clearly deserves more attention and in-depth investigation. Baron-Cohen (1992) also claims that due to the use of a memory control condition that false belief failure could not be attributed to difficulties in memory. However within this condition Baron-Cohen (1992) fails to take account of the memory principle of encoding, in that what the children with autism could have encoded, is information concerning what 'was' somewhere versus what was 'thought' to be somewhere. Baron-Cohen (1992) distinguishes these terms by reference to mental-state terms whereas the same terms may be distinguished simply by how they are encoded into memory.

The collection of studies to be reported here derives from the foregoing analysis and has several aims, the generic aim being to further and more fully investigate the false belief performance of children with autism so as to explore possible accounts of why it is that such children fail tests of false belief. Prior to the discussion of particular aims and an elaboration of the studies conducted for this thesis, it is necessary to point out several methodological issues, concerns and debates that arose prior to, during and after conducting the studies to be reported here. These issues fall into the following areas: comparison groups; matching criteria; ratio of false belief passers to failers with autism; attentional requirements of repeated trials; and sample sizes. All of these areas will be discussed in further detail within the next chapter.

Chapter Three

Methodological Issues

3.1 Introduction

Considering the behavioural symptomatologies associated with the condition of autism, as well as the diverse and atypical skills and deficiencies that such individuals display, many issues arise when both working with, and studying this population. These issues and difficulties are exacerbated when the chronological ages of children with autism (and comparison groups of children) is necessarily low. For this thesis, because the primary area of interest is theory of mind and in particular tests of false belief, it is necessary to ensure that the ages (operationally verbal mental age) of the participants with and without autism, are close as possible to four years – the age of typical transition from failing to passing tests of false belief. Maintaining ages as near to four is important so as to be able to relate the results of the experiments to be detailed within this thesis to other experiments in the same area by other authors.

Matching procedures for research into autism and which groups of individuals to compare children with autism to, are neither straightforward nor universally agreed upon. This is highlighted by the fact that an entire special edition of the Journal of Autism and Developmental Disorders (JADD) was published in 2004 dealing with just these two areas. Within this particular 2004 edition of JADD, researchers in the field of autism discuss: the problems with current matching strategies within autism research; the relevance of specific comparison groups in the matching process within studies concerning autism; and possible alternative matching practices to those used already. The contents of this special edition of JADD are heavily drawn upon for the discussion presented in this chapter.

In addition, issues concerning attention and sample sizes are pertinent when considering research within the autistic population. A pre-requisite for successfully conducting research is to have participants attending to you. This is often difficult when including children with autism as participants in research, for as Siegal (1996) points out, children with autism are sometimes not merely distractible, like a child with attention deficit hyperactivity disorder, but rather actively seek ways to avoid interaction. This pre-requisite is even more difficult when it is necessary for children with autism to respond on a significant number of repeated trials.

Sample size within research is a long and widely debated subject and one that is not ignored within research concerning autism. While it is important to include adequate numbers of participants within research so as to allow for statistical comparisons to be made between different groups, difficulties with locating, recruiting and testing certain populations need to be acknowledged.

3.2 Comparison Groups

It is widely accepted that the use of comparison groups is essential when conducting research especially if the outcome of the research is to be informative about any given population (Burack, Iarocci, Flanagan & Bowler, 2004; Burack, Iarocci, Bowler & Mottron, 2002; Hobson, 1991). When considering research with children with autism it is important to include comparison groups so that the performances of such children can be understood as being either typical or atypical and furthermore that if performances are atypical to determine if such performances are unique to the autistic population (Burack et al., 2002). Despite the wide consensus concerning the need to include comparison groups when conducting research with children with autism there is less consensus as to which kinds of individuals comparison groups should comprise. There are those who believe that there is no substitute for repeating experiments with comparison participants from multiple and different diagnostic groups (Hobson, 1991); those who hold to the notion that comparison group choice is often determined by whether the research aims to investigate normalcy or uniqueness (Burack et al., 2002; Wagner, Ganiban & Cicchetti, 1990); and others who suggest the notion of multiple matching whereby multiple comparison groups are enlisted from the same population but matched on specific measures (for example typically developing comparison groups matched on different measures such as receptive language ability, expressive language ability and visuo-spatial ability) (Burack et al., 2002). Burack et al. (2002) also suggest that comparison groups can be matched on precise measures that are more pertinent to the research question at hand. This however takes the topic from one of comparison groups to one of matching strategies. While these two topics are somewhat intertwined a separate section will address the issue of matching strategies.

For this thesis it was decided to include typically developing children as the comparison group in all experiments until the tenet of normalcy was violated. That is to say, it was not until findings suggested a statistically significant difference between how children with autism and typically developing children respond that a second comparison group was recruited. When this notion of normalcy was violated a second comparison group, children with learning disabilities (LD) was recruited. Children with LD were included so that the question of what Burack et al. (2002) call uniqueness could begin to be addressed. That is: do children with autism only respond differently when compared to typically developing children or is the pattern of responding also different when compared to children with other learning disabilities? Clearly the entire notion of uniqueness could not be addressed in this thesis as to do so would involve recruiting comparison groups from a wide range of groups of children with different psychopathologies.

In addition to the normalcy-uniqueness explanation for including typically developing children as the primary comparison group for the studies in this thesis, selection was also based on considerations of ethics, time constraints and logistics. Until credible alternative explanations for the false belief failure of individuals with autism were determined, it was felt that including a third group of participants would violate important ethical considerations, in particular consideration was given to 'over-researching' or 'overuse', whereby because samples may be convenient, they are often heavily relied upon (Brewer & Hunter, 1989). To include children with LD within research when their inclusion may not be necessary or informative, may in this sense be regarded as unethical, not only in terms of overuse, but also in relation to some basic human rights - for example, the right to education and privacy. Removing children with LD from learning environments unnecessarily, could be considered a violation of their right to an education, whilst impinging on their time. Equally the assessment of their abilities and deficits could also be in violation of their right to privacy.

In terms of time constraints it was considered that until empirical rationale was provided to include a second comparison group that doing so would unnecessarily delay experimental explorations. Only if theoretically meaningful differences between children with autism and typical controls emerged was a second comparison group recruited so as to begin to explore whether or not such results were specific to children with autism, or universal to individuals with learning disabilities.

From a logistical perspective, it cannot be disputed that typically developing children are more widely accessible than children with LD. This has always been the case but has been exacerbated recently with the new inclusion education policies. Typically, the more able children with LD are being included into mainstream schools, and because of this, removing such students from mainstream classrooms violates the principles underlying their inclusion, once again segregating them from the typically developing children. The only way to avoid this breach of inclusion policy would be to test all children in the classes, yet again adding to the time required to conduct research as well as possibly raising the ethical concerns mentioned previously. This led to the pragmatic strategy of recruiting participants with LD from special needs schools only, as discussed more fully in Section 3.8.

3.3 Matching

In any research that involves the use of comparison groups matching is a necessity. The aim of matching is to rule out noncentral explanations of group differences (Jarrold & Brock, 2004). In autism research matching procedures are neither standardised nor consistent. Jarrold and Brock (2004) cite general ability measures as one of the most commonly employed. Despite being one of the most common measures of matching, general ability measures may not be the most appropriate. Given that autism is characterised by what Burack et al. (2004) term peaks and valleys of abilities, matching on general ability measures or overall IQ measures is problematic. Due to the strengths and weaknesses so often observed within the autistic population matching on full-scale IQ or global mental age is likely to either under- or overestimate the level of functioning in the particular area of research interest. Furthermore while such measures may ensure that comparison participants are matched on average ability, there is the real and documented risk that participants will not be matched for any single ability (Hobson, 1991). It is for these reasons that Burack et al. (2004) offer matching on measures that are intended to assess specific areas of functioning as one alternative. For example, Burack et al. (2004) suggest the use of a language matching measure when the experimental task requires language abilities so as to ensure that any differences that are found are attributable to the experimental task, rather than being due to group discrepancies in language ability. While the matching alternative just described also has shortcomings (rarely do tasks involve only one area of ability) the matching of groups according to language abilities has often been used in theory of mind studies. Considering that language and communication impairments are core-defining areas in the diagnosis of autism, comprising a third of the triad of impairment, it would seem that such variables are critical when considering the matching of groups in autism research (Charman, 2004). It is for these reasons that the studies to be outlined in this thesis veer away from full-scale IQ or global mental age matching and rather focus upon matching according to a specific language measure – the Test for the Reception of Grammar (TROG) (Bishop, 1982).

3.4 The Test for Reception Of Grammar (TROG)

Despite the Peabody Picture Vocabulary Test-Revised (PPVT-R) (Dunn & Dunn, 1997) and the British Picture Vocabulary Scale (BPVS) (Dunn, Dunn, Whetton & Pintillie, 1982) being the most commonly used measures for matching in studies of theory of mind, neither of these tests are to be employed as matching measures for the studies to be discussed in this thesis (Burack et al., 2004; Boucher, 1989). The TROG was chosen over the PPVT-R and the BPVS as the measure to match groups by for two reasons. Firstly considering that tests of false belief typically require comprehension of sentences and reasonably complex questions, it seemed inadequate to match participants with tests that focus predominantly on single word vocabulary. The TROG addresses this in that the grammatical structures tested ranges from singular noun, verb and adjective comprehension through singular/plural noun inflections to "neither X nor Y" embedded sentences. The second rationale for the use of the TROG as a matching measure was that due to the extensive use of the alternative tests, the majority of children with autism recruited for the studies had already completed, for research or clinical purposes, one or both of the tests, therefore increasing the likelihood of confounding learning effects.

3.5 Matching Criteria: Chronological Age, Mental Age, Both or Neither?

As suggested by the heading there are four possibilities when considering the matching of children with autism with their comparison counterparts: matching on chronological age, matching on global mental age, matching on both chronological age and global mental age or matching on some different variable. The decision as to what to match according to is determined largely by the comparison group/s that are to be employed and in addition what the research question is.

3.5.1 Matching on chronological age. Considering that the research to be outlined in this thesis involves children with autism and furthermore that the comparison group relied on most heavily was typically developing children, matching solely on chronological age was not a feasible choice. This is due to the vast differences in ability that would so evidently be present. That is one group is typically developing while the other is developmentally delayed. If the mean chronological ages of the two groups are not significantly different then what would result would be two very different groups of children – one with typical skills and abilities and one with possibly severely delayed abilities – or a range of abilities from supra- to sub-normal. Comparing such groups of children on experimental tasks would be meaningless as one group would clearly be more able than the other.

3.5.2 Matching on global mental age. It was discussed previously that matching on global mental age is often not appropriate when conducting research with children with autism. This is due to IQ profiles not being flat in autism. Rather, as a result of the peaks and valleys of ability so often witnessed in individuals with autism, such individuals show peaks and troughs of performance across the various areas of intelligence testing (Jarrold & Brock, 2004). What this results in are skewed average ability measures whereby what actually may result are groups that are not really matched on any one single area of ability. It was for this reason that global mental age matching is not utilised within the studies to be outlined in this thesis.

3.5.3 Matching on both chronological age and mental age. In an attempt to more fully control for variables, researchers often match children with autism to groups of comparison participants according to both chronological age and mental age. If one is investigating the notion of normalcy then this is possible only if one is conducting research with higher-functioning children with autism. For if the children with autism are not high functioning then such combined matching strategies are impossible, unless of course the typically developing counterparts are at the severely lower end of being typically developing and even still this would be very unlikely. The options for conducting research with children with autism, who are less able, in this combined matching scenario, become extremely limited. Basically the only option is to utilise comparison groups that comprise children with mental retardation, so that both chronological age and mental age can be matched (Burack et al., 2004). However this option is only an option if what one is investigating is uniqueness, NOT normalcy! Due to the predominant area of interest of this thesis concerning normalcy, matching on both chronological and mental age was not an option.

Combined chronological and mental age matching was also not an option due to the specific research area of this thesis – tests of false belief. Because the typical age of transition from failing to passing false belief tasks is four years, if investigating the notion of normalcy, therefore requiring typically developing children as comparison participants, then the mean chronological age of the typically developing participants would have to be around 48 months. If the mean age of the comparison participants was much higher than 48 months, then the numbers of false belief passers would be too high to give statistically meaningful results in the studies conducted within this thesis. These studies predominantly focus on the effects of altering aspects of the standard tests of false belief with the aim of increasing success rates. Therefore if all, or a large majority of participants initially pass, then altering the test will not prove to be effective as there is no scope for improvement. Furthermore for children with autism to be matched according to chronological age, that is to have a mean chronological age of 48 months, in itself is problematic. Because children with autism are developmentally delayed, such children around the ages of four years are really only beginning their (typically slow) cognitive development. As a result, children with autism with chronological ages at or around 48 months will invariably have mental ages (whatever the ability measure is) that are considerably lower than those of typically developing children of the same chronological age. This again removes the possibility of matching children with autism and typically developing children on both chronological age and mental age.

Some authors, for example Perner (1993), argue that because children with autism and typically developing children are not matched on chronological age, as a consequence children with autism often have higher chronological ages than comparison participants. This means that the results obtained in many experiments need to be examined with caution. Perner (1993) uses such an argument when criticising his own work and that of others (Leekam & Perner, 1991; Leslie & Thaiss, 1992; Charman & Baron-Cohen, 1992) that explores or demonstrates superior performance by children with autism on tests of understanding of non-mental representations, such as false photographs or maps. Perner (1993) argues that because the children with autism are generally older than the typically developing controls within these studies, that they have had more exposure to, and experience of cameras and photographs, and as a result display superior performance. However, when considering autism, and indeed how children with autism respond to exposure to, and experience of their environments, this argument, while being intuitively plausible, is at the same time questionable. It is often documented that children with autism rarely learn incidentally, especially at a young age, and also that the way that such children experience the world is quite different from the way you and I experience it (Powell & Jordan, 1997). So while they may well at times learn indirectly via the environment and those around them, often what children with autism absorb, will be quite different from what one would expect. Powell and Jordan (1997) highlight and add to this when they state clearly that there appears to be a definite difficulty in the manner in which individuals with autism experience the world. Powell and Jordan (1997) do not deny that such individuals experience the world but rather as I suggest, that often what is experienced lacks a certain quality and level of consciousness, and if one is not conscious of what one is learning or experiencing, then surely those events or experiences will not translate into usable information.

When considering exposure to certain objects, for example a camera, what is actually perceived by typically developing children and children with autism may be, and often is, two completely different things. Again the evidence indicating this is considerable. Wing (1996), suggests that children with autism tend to make use of the peripheral part of the retina that attends to movement and outline, rather than using the central vision for details. So as Wing (1996) discusses, when children with autism seem to recognise people and objects, they do so by the general outline, instead of details of the individual or object's appearance. So when being exposed to a camera, what the child with autism may well be experiencing, could simply be an outline of the object, a shape – surely not meaningful and useful information?

Many children with autism also appear to be visually inattentive and over-attentive at the same time. Lovaas, Schreibman, Koegel and Rehm (1971) initially explained this phenomenon in terms of stimulus overselectivity. Stimulus overselectivity suggests that people with autism tend to choose one stimulus in the environment as the focus of their attention to the exclusion of all other stimuli (Mesibov, Adams & Klinger, 1997). For example, instead of paying attention to the teacher when he or she is teaching the class about cameras, the child with autism may be concentrating on the small particles of dust behind the teacher, that are so clearly visible in front of the sun-streamed window. Or maybe instead of attending to the details of the camera that assist with understanding its function and subsequent purpose, what the child with autism may be focusing on could be the strap that flaps every time the teacher turns the camera to explain the object more fully to the class.

These points are given further impetus by Frith (2000) suggesting that when individuals with autism are provided with choice as to what to attend to, they consistently focus on narrow aspects of their environment. Relating this phenomenon to selective attention processes, Frith (2000) maintains that individuals with autism attend to idiosyncratic stimuli. This is in contrast to what typically developing individuals would attend to in identical situations and contexts, due to those idiosyncratic stimuli being more salient for the individuals with autism. Again these assertions do not imply that individuals with autism are inattentive, but rather that what such individuals attend to is a more narrow and circumscribed aspect of the environment (Mesibov, Adams & Klinger, 1997).

Considering the aforementioned points regarding the visual attention, selection of salient stimuli and consequence of non-directed exposure of objects and situations to children with autism, it becomes increasingly unlikely that the increased exposure and experience of cameras and photographs, due to higher chronological ages, could have a serious impact upon the performance of these children on tests that utilise these stimuli. Although conceivable that if such children were taught directly about these items they may have developed a knowledge of them, it nevertheless needs to be adhered to, that simply because children with autism are often chronologically older than control children, and therefore have added exposure to the world, that this need not affect performance on particular tests or tasks. Additionally, one would expect that if such added exposure did have a positive effect on the performance of individuals with autism, that such effects would also be reflected by performance on psychometric tests, as such tests typically utilise stimuli and concepts witnessed in the everyday world. These observations form the basis of the argument developed here that it is more beneficial for participants with autism and their counterparts to be matched on MA rather than CA, if such a choice has to be made.

3.5.4 Matching on neither chronological age nor mental age. For the studies conducted within this thesis, as previously mentioned, a decision was made to match children with autism and typically developing children using the language measure – the TROG. The TROG is a partial measure of mental age, in particular Verbal Mental Age (VMA). This measure was adopted because the TROG is considerably more appropriate to the experimental task (tests of false belief) than measures typically employed (the PPVT-R or the BPVS) by other researchers for very similar and often identical experimental tasks. To understand this more fully one must consider what it is that tests of false belief require in terms of abilities. Clearly in order to pass tests of false belief one would assume simply by the title that one would require an understanding of false belief. This is not problematic as passing and failing tests of false belief and variants of such tests is inherent to the research questions posed within this thesis. Secondly, one requires visual processing abilities and basic memory skills. Fundamentally participants are automatically matched for these abilities by the inclusion of reality and memory questions, delivered in counterbalanced order after the belief question. In essence the reality question, “Where is x now?” acts as a visual processing measure (the child’s ability to follow the scenario through to the end and see where the item in question has been relocated to) while the memory question

“Where did a leave x?” serves as a memory measure. Finally, tests of false belief require receptive comprehension abilities that are obviously matched for by use of the TROG. For tests of false belief no expressive language skills are required as all children can answer non-vocally by pointing if necessary. Therefore matching on an expressive language measure was not necessary. For all of these reasons it is felt that matching according to Verbal Mental Age by use of the TROG is not only appropriate but in fact more sound than those who use global mental age matching measures, those that deny less able children with autism to participating in research so that both chronological and mental age can be used as matching measures, or indeed those that utilise verbal mental age matching measures that are less related to the respective experimental tasks.

In the final study to be reported within this thesis, children with learning disabilities and typically developing children were recruited as comparison groups. While the typically developing children were matched to the children with autism solely on VMA, children with learning disabilities were matched to the children with autism on both VMA and IQ, therefore ruling out IQ as a possible factor in potential differential responding. IQ was determined by the formula defined by Terman (1916) (IQ = 100 [MA / CA]). In order to avoid significant differences in IQ in the children with autism and the children with learning disabilities, it was necessary to keep chronological age within an appropriate range for the two groups of participants.

3.6 Tests of False Belief and the Ratio of Passers to Failers

Success rates of children with autism on tests of false belief are typically within the range of 20% to 40% (Baron-Cohen et al. 1985 – 20%; Baron-Cohen, 1992 – 26.7%; Bowler & Briskman, 2000 – 30.8%; Charman & Baron-Cohen, 1992 – 29.4%; Leslie & Frith, 1988 – 27.8%; Leslie & Thaiss, 1992 – 23%; Russell, Saltmarsh & Hill, 1999 – 40%; Sodian & Frith, 1992 – 28.6%). Happé (1995), in a review of false belief studies, noted wider variability in the proportion of children with autism found to pass first-order false belief tests, within a range of 15% to 60 %. For all but one of the experiments to be presented here (Experiment Two) the percentage of false belief passers with autism falls within the typically reported ratios of passers to failers. For one experiment (Experiment Four) the percentage is slightly higher. Although the percentage of false belief passers with autism is less than 20% in Experiment Two, at 17.65%, it is still greater than the 15% minimum cited by Happé (1995). Furthermore, a low percentage of false belief passers with autism was not deemed problematic because the aim of most of the work to be presented here was to show how manipulations of tests of false belief might improve false belief performance for children with autism. In this context, a low percentage of initial false belief passers can be considered to be an advantage because it avoids ceiling effects.

3.7 Repeated Trials, Attention and Satiation

Throughout the research to be discussed here, studies typically involve repeated trials so as to allow for counterbalancing in order to rule out possible order effects, or condition preferences. When experiments have multiple conditions the counterbalancing requirements can have the effect of increasing the number of experimental trials to levels that would tax typically developing children's attentional abilities. This problem is compounded in children with autism. When working with children with autism it is crucial to remember the difficulties that they face. This is important not only from the perspective of the individuals with autism, but also from that of the researchers. If experimental sessions are long and repetitive then it is likely that participants will satiate, and consequently shift their attention, and possibly guess the answers to questions. While counterbalancing the order of presentation of conditions across participants may attenuate the effects of such guesswork, one needs to maximise the usefulness of all data collected from every individual, and to utilise methodologies that overcome these problems from the outset. However the constraints of research often do not allow this to happen. If one is to simplify research methodology, then what is often the case is that sample sizes need to be increased considerably, which is not always possible when conducting research within small populations such as children with autism.

3.8 Sample Sizes

Due to the great amount of interest in the area of autism, special needs schools receive very large numbers of research applications. Apart from the ethical issues that this gives rise to, if special needs schools were to accept all proposals for research, then very little teaching would actually be achieved. Regardless of researchers' efforts to minimise the impact of their work on children's schoolings, having visitors repeatedly disrupting classes and daily routines inevitably results in a cost to children's schooling. As a consequence schools are rightly becoming increasingly selective as to how many (in some cases if any) researchers they accept. This makes recruiting adequate numbers of participants difficult.

Difficulties in recruitment of children with moderate learning difficulties are similar to those within autism research. Recall that this has been exacerbated recently by the implementation of an inclusionary education policy. Known as "Inclusion for all", this policy aims to do integrate wherever possible, children with 'moderate' learning difficulties into mainstream schools. Resulting from this is an annex that implies that such children, so as to maximise feelings of inclusion, are not segregated in any way[22]. Consequently schools find it difficult to remove children with moderate learning difficulties from classrooms for the purpose of research. Additionally, to distribute permission slips to parents of children with moderate learning difficulties that attend mainstream schools may seem to be segregational. One possible way to remove this barrier would be to test all children from respective classes. This strategy however, would have significant ethical and resource implications.

[22] Such an annex is not written but is widely understood by Head Teachers to be the case.

Added to the problem of locating participants with autism and/or children with moderate learning difficulties for the purpose of research, are the methodological arguments for adequate sample sizes. Depending on the methodology employed, the necessary sample sizes will vary. There are those however who hold to the belief that there can never be too many participants, and because of this shun research with low sample sizes. Similarly there are some people for example Hays (1973), that provide opposing arguments by claiming, "virtually any study can be made to show significant results if one uses enough participants, regardless how nonsensical the content may be" (p.415).

Albeit informative, the preceding discussion on sample size is at best theoretical. In order to move the discussion into the empirical realm, three well-known studies investigating false belief with children with autism, all of which have been referred to previously, will now be analysed according to effect size, power and sample size. In the classic Baron-Cohen et al. (1985) study, children with autism were compared to children with Down syndrome on tests of false belief. After conducting post hoc analysis of the data provided in this paper, effect size *d* when comparing the two groups was estimated at .64, yielding a power level of .96. From an a priori perspective a sample size of 32 would be needed to get an effect size of .64 with a power of .95. Leslie and Frith (1988) compared children with autism and children with specific language impairment on tests of false belief. For this study, effect size *d* when comparing the two groups was estimated at .72, yielding a power level of .98. After conducting a priori analyses it was found that a sample size of 26 would be needed to get an effect size of .72 with a power of .95. Perner, Frith, Leslie and Leekam (1989) also compared children with autism and children with specific language impairment on tests of false belief. For these results effect size *d* was estimated at .73, yielding a power level of .99. A priori analyses revealed that a sample size of 25 would be required to get an effect size of .73 with a power of .95[23]. From the power analysis of these three studies a range of required sample sizes to yield similar effect sizes with a power of .95 is from 25 to 32. For all of the studies to be reported here sample sizes fall within this range or indeed are greater than 32. So despite difficulties with recruitment, adequate sample sizes were achieved.

[23] Analyses were conducted using the sample of 23 children with autism. Originally there were 26 children with autism, however as explained before, because 3 children required so much prompting they were dropped from the final analysis. Even so including the 3 children that were dropped does not alter the required sample size of 25 mentioned here.

3.9 Conclusion of Methodological Issues

Probably the most difficult decision to make when conducting research within the autistic population is to determine what criteria to match the differing populations of interest. While there are few, if any, formal guidelines to follow, this decision should be made according to what it is that you are investigating and whether or not, with regards to studying children with autism, you are investigating the notion of uniqueness or normalcy. If these notions are considered then the decision not only of matching criteria but also comparison groups becomes more straightforward.

As a researcher in the field of autism, if one is interested in identifying elements of this disorder that are unique to that population then what is required are comparison groups comprising children with differing psychopathologies. This will allow any significant findings between the different groups to be isolated to those with autism, allowing an argument that the experimental task affected the sample of children with autism in a way that is specific to that population. On the other hand, if one is interested in identifying whether or not one or more specific areas of functioning among individuals with autism are similar to, or indeed different from that of typically developing individuals then what one is interested in is the question of normalcy. Because the dominant area of interest of the thesis to be presented here was normalcy, typically developing children were recruited as a comparison group for the children with autism. The decision was made that until experimental findings suggested atypical patterns of responding by children with autism, the question of uniqueness would not be investigated and therefore that the recruitment and inclusion of a second comparison group (children with learning disabilities) would not take place. If and when the tenet of normalcy was violated, only then would a comparison group be recruited so as to explore the notion of uniqueness.

Because typically developing children were included as the comparison group for the majority of studies to be discussed here, the matching criterion was verbal mental age by use of a standardised measure deemed appropriate to the experimental tasks. In the final study (Experiment Five), both typically developing children and children with learning disabilities (ranging from mild to severe) were included as comparison participants. Because the children with learning disabilities showed a range of impairment from mild to severe, matching was again determined by verbal mental age, rather than both mental age and chronological age. While this was the case, the chronological ages of the children with autism and the children with learning disabilities were kept within an appropriate range so that the IQs of the two groups would not be significantly different, therefore allowing the children with autism and children with learning disabilities to be matched on both verbal mental age and IQ.

3.10 General Aims of Thesis

As reported at the conclusion of Chapter Two the studies to follow have several aims. First and foremost is to replicate Bowler, Briskman, Gurvidi and Fornells-Ambrojo's (in press) construction of a mechanical non-mental state analogue of the classic unexpected transfer false belief. This will provide a sturdy and robust arena to allow investigations to take place into alternative (other than mental state) explanations of false belief failure in children with autism. If a valid and reliable analogue of the false belief test is constructed elements of this analogue will be altered to test for the possible role of arbitrariness as an explanation for the failure of children with autism on tests of false belief. Following this, additional alterations will be made and further tests will be constructed so as to enable the investigation of attention and memory as possible causes of false belief failure.

Chapter Four

Experiment One: False Belief Failure of Children with Autism– A Question of Arbitrariness?

4.1 Introduction

Failure of tests addressing the concept of false belief by children diagnosed with autism spectrum disorder have been repeatedly cited as evidence that such children lack a theory of mind (Baron-Cohen, 1989; Baron-Cohen, Leslie & Frith, 1985; Perner, Frith, Leslie & Leekam, 1989; Nunez & Riviere, 1990; Riviere & Castellanos, 1988). Within these tests, to pass, the children must judge that a protagonist will search for an item on the basis of a false belief regarding its location, rather than on their own knowledge of the actual location of the item.

Wimmer and Perner (1983) first developed tests of false belief in order to investigate typical children's ability to represent another person's belief, which differed from what the children themselves knew to be true. Baron-Cohen, Leslie and Frith (1985) replicated the use of false belief tests with the autistic population. Adopting a variant of the test introduced by Wimmer and Perner (1983), Baron-Cohen et al. (1985) concluded that because children with autism were less able than both typically developing children and children with Down syndrome at predicting another person's behaviour, that children with autism lacked a theory of mind and furthermore were characterised by "...an inability to represent mental states" (p.43).

Since this initial work showing that children with autism lack a theory of mind, a great deal of research has been carried out in this and related areas. Some of this research continues along similar lines of thought, contending that due to false belief failure and other related theories that children with autism do in fact lack this ability to understand the minds of others (Leslie and Frith, 1988; Perner, Frith, Leslie and Leekam, 1989; Happé, 1989; Baron-Cohen, Leslie and Frith, 1986). However it is not universally accepted that failure of false belief tests is necessarily attributable to a failure to understand either the representational nature of beliefs or a failure to understand others' minds. From the title of these tests, one could be forgiven for assuming that the understanding or lack thereof being tested is that of false belief. Recall from page 84, there is debate as to what is being measured when utilising such tests with children with autism. In other words, it is possible that the children with autism who fail these tests, fail them not because they do not understand false belief, but rather fail them as a result of some other variable or variables (Biro & Russell, 2001; Hughes & Russell, 1993; Russell, 1998a; Russell, 1998b; Russell, Saltmarsh & Hill, 1999).

Bowler, Briskman, Gurvidi and Fornells-Ambrojo (in press) questioning the validity of the argument that the impairment seen in children with autism on tasks of false belief must be specific to mental states, successfully constructed a non-mental state mechanical analogue of the classic unexpected transfer test of false belief. This test was demonstrated to be analogous to the false belief test for children with autism, children with moderate retardation and typically developing children[24]. The Bowler et al. (in press) analogue, as discussed previously, was mechanical in nature and involved the use of an electrical train apparatus. To be successful on the mechanical train task children with and without autism were expected to predict the destination that an automatic (driverless) train would travel to when given appropriate signals. This was made similar to the unexpected transfer within the Sally-Anne test of false belief by engineering a discrepancy between the signal provided and the location of a plane to which the train would typically travel.

[24] The complete details of this study have been provided on pages 90-91so will not be given again here.

From their research Bowler et al. (in press) concluded that it is possible to construct experimental scenarios void of any metal state content that are strongly correlated with tests of false belief for children with autism ($\Phi = .56$, $p<.006$), for children with retardation ($\Phi = .72$, $p<.002$) and for typically developing children ($\Phi = .73$, $p<.001$). Furthermore Bowler et al. (in press) suggest that the manipulation of certain factors of these non-mental state analogues may begin to provide some alternative answers to questions concerning the failure of children with autism on such tests. One area that Bowler et al. (in press) suggest manipulating is the salience of the plane or the signal, as well as altering the level of arbitrariness of the link between the signal and the location of the plane so as to potentially alter the consequent success rates of the children with autism. These suggestions stem from arguments put forward by Russell (1998b) that individuals with autism are particularly impaired on executive tasks that require arbitrary rules to be held in mind while at the same time inhibiting prepotent responses to salient reality.

Russell, Saltmarsh and Hill (1999) also contest that children with autism fail these tests due to an inability to attribute false belief. Russell et al. (1999) make the point that while the false belief task addresses the understanding of the link between action and belief, it also makes what they term significant 'executive' demands. Within the same paper the authors operationalised their interpretation of what constitutes an executive task as one where participants must suppress a prepotent but incorrect response, while at the same time retaining action-relevant information within working memory. In order to investigate the possible contribution that executive factors have in relation to false belief failure by children with autism, Russell et al. (1999) conducted two experiments with children with autism and children with moderate learning difficulties. The first experiment compared two tasks, a conflicting desire task and a conflicting belief task. It was hypothesised that for the children with autism the conflicting desire task would prove to be as difficult as the belief task, providing preliminary evidence that it is the executive nature of the tasks that make them challenging for the children with autism. This was shown to be the case, however because both of the tasks were mental-state tasks, executive factors alone could not be attributed to the aforementioned difficulty. As a result, the second experiment compared children with autism and children with moderate learning difficulties on the non-mentalistic false photograph task, a modified false photograph task and a false belief task. The modified false photograph task was modified in such a way so as to make it more taxing in terms of executive function. This was achieved by taking the photo of an empty backdrop with no character present, but as soon as the photograph emerged from the camera, and whilst it was developing face down, a character was introduced and sat in view of the participants. When tested as to what was in the photo, in order to be successful, the participants had to inhibit the prepotent response of the newly arrived character. For this experiment the children with autism performed significantly worse on the modified false photograph task and the false belief task than the children with moderate learning difficulties. The two groups of children performed identically on the standard false photograph task. While Russell et al. (1999) are cautious in concluding from their studies that children with autism fail executive tasks because of the executive demands they make, they nevertheless point out that what their findings do, is bring into question the assumption that failure of false belief tasks "is an acid test for possessing a theory of mind in a clinical group" (p.866).

In a later paper by Biro and Russell (2001), a somewhat simplified explanation of what constitutes an executive task is provided: "Executive tasks typically contain a prepotent lure. In addition, they require individuals either to (a) follow arbitrary procedures or (b) update their model of the physical world" (p. 97). Biro and Russell (2001), working from the position that children with autism may only be impaired on executive tasks that contain arbitrary rules, conducted research to investigate whether these participants would continue to be challenged when the element of prepotency was removed. Thirty children and adolescents with autism, 30 children with moderate learning difficulties and 30 typically developing children participated in the study. The three groups of participants were compared on a task that included arbitrariness but without prepotency, a task that included both arbitrariness and prepotency, and a task that included neither. All three tasks required similar responses on behalf of the participants - all participants were required to retrieve a ball from a box by reaching through a hole. In the first task, arbitrariness without prepotency, the hole was blocked by an opaque screen that could be removed by the inversion of a cup that was placed separate from, but in front of the box. In the second task, arbitrariness and prepotency, a switch needed to be thrown so as to retrieve the ball. If the participants simply reached through the hole infrared beams would be broken and the ball would drop out of sight. In the final task, neither arbitrariness nor prepotency, participants had to depress a lever attached to the side of the box in order to remove the opaque screen, so as to be able to reach through the hole and subsequently retrieve the ball. It was found that the participants with autism performed significantly less well than comparison groups on the first two tasks but not the third. On the basis of these findings Biro and Russell (2001) suggested the possibility of an autism-specific difficulty in tasks that have no prepotency but that necessitate the following of arbitrary rules.

There are counter arguments however to executive function accounts. The proponents of such arguments make the case that for such criticism to hold true, that children with autism would have to be equally impaired on tasks that require similar levels of executive functioning to the false belief tests, but that make no mentalising demands (Zaitchik, 1990; Leekam and Perner, 1991; Leslie and Thaiss, 1992). The current study aims to replicate the findings of Bowler et al. (in press) in providing further evidence that such tests, are in fact, possible. This study aims to show that tests do exist that possess the following characteristics:

- Place no mentalising demands upon participants and therefore are highly unlikely to address an understanding or conception of mind
- Require similar levels of executive functioning to the standard false belief test
- Are strongly correlated and therefore analogous to the standard false belief test
- Remain equally and uniquely as difficult for the children with autism to pass.

Furthermore the study to be reported here aims to test the proposition provided by Biro and Russell (2001) that failure of false belief tasks may in fact be due to a failure to follow arbitrary rules and not, as so widely thought, result from an inability to understand the minds of others.

Put simply, the study to be reported here aims to show that it is not an inability to understand the minds of others that leads to children with autism failing to understand false belief, but rather that such failure is due to an inability to understand scenarios that embody arbitrary rules. The mentalising component is removed in this study by adopting tests designed to eliminate any such content.

In the study to be reported here participants are presented with a standard false belief task similar to that used by Baron-Cohen et al. (1985) and Wimmer and Perner (1983) and three versions of a mechanical, non-mental state task based on that used by Bowler et al. (in press). In the latter, participants are required to predict the destination of a train that is to collect goods from a plane according to either lights that are presented in the middle of a straight piece of track, at the end of a straight piece of track or indeed a sound. The three versions of this task can be seen in Figures 4.2 - 4.4 and are labelled: Landing Pad Light condition; Central Light condition; and Sound condition respectively. In all three conditions a plane lands at either a blue landing pad or a yellow landing pad. At this point either a yellow or blue light is shown or a sound is heard. The plane and the landing pad are then covered and the child has to predict the destination of the train, with the knowledge that the train is automatic (driverless) and that only the light or the sound, relays to the train the location to which it should travel. It is hypothesised that the Landing Pad Light condition (LPLC) will be the least arbitrary and therefore the easiest of the three for children with autism to pass. This hypothesis is made due to the fact that the destination of the train is not only shown by the colour of the light but also by the fact that the light is positioned at the location where the train is to travel. Additionally it is hypothesised that the Central Light condition (CLC) will be more arbitrary than the LPLC but not as arbitrary as the Sound condition (SC). With the lights situated in the middle of the track only the light indicates to the child the destination that the train will take. There is no causal link between the position of the light and the landing pad to which the train will travel, therefore being more arbitrary than the LPLC. Accepting this proposition, it is hypothesised that the SC will be the most arbitrary of the three conditions as only the sound indicates to the participants where the train is to travel. This condition can be considered more arbitrary than the CLC as the sound is the only link to a correct prediction of the destination of the train. Although the lights in the CLC are not positioned at the landing pads, the colour of the light is nevertheless identical to the colour of the landing pad to which the train should travel.

A further hypothesis is that the LPLC will be the most analogous to the standard Sally-Anne test and therefore of equal difficulty, and that the other two conditions, due to their increased arbitrariness, will be more difficult for children with autism. In other words it is hypothesised that the LPLC and the false belief test will be of equal difficulty, the CLC will be more difficult than both the LPLC and the false belief test, leaving the SC as the most difficult to pass.

4.2 Method

4.2.1 Participants. A group of 24 children diagnosed with autism spectrum disorder and a group of 24 typically developing children participated in this study. The 24 children with autism (21 boys and 3 girls) were all diagnosed with autism as recorded within Statements of Special Educational Needs and school records, and recruited from special needs schools within the London area. The 24 typically developing children (18 boys and 6 girls) attended nursery schools within London. For each participant, written consent was obtained from a parent or guardian. Letters of consent, detailing both the nature and expected duration of the study were written by the author and distributed by the school. An example of a consent letter is provided in Appendix 1.

The 48 children who participated in the study came from a total of 64 who were assessed using the Test for the Reception of Grammar (TROG) (Bishop, 1982). Children were recruited only if their Verbal Mental Age (VMA) was a minimum of 48 months. The mean VMA of the children with autism was 58.1 months (n=24, SD=17.4 months) and the mean of the typically developing children was 51.8 months (n=24, SD=3.3 months). Participants' VMA and Chronological Age (CA) are set out in Table 4.1. Analysis of these data using a Mann-Whitney test[25] revealed a significant difference for CA ($U = 0$, $N1 = 24$, $N2 = 24$, $p<.001$, two-tailed), but not for VMA ($U = 260$, $N1 = 24$, $N2 = 24$, $p = .56$, two-tailed).

[25] Mann-Whitney test was used instead of Independent Samples t-test due to unequal variances.

Table 4.1

Chronological and Verbal Mental Ages of Participants in Experiment One

	With Autism (N=24)	Typically Developing (N=24)
Chronological**** Age (months)		
Mean	115.4	45.0
SD	31.1	5.4
Range	61-173	34-59
Verbal Mental Age (months)		
Mean	58.1	51.8
SD	17.4	3.3
Range	45-120	48-57

* p<.05 ** p<.01 *** p<.005 **** p<.001 (Mann-Whitney)

4.2.2 Materials. The equipment used in this experiment consisted of Sally-Anne test type materials and an electrical train apparatus.

The Sally-Anne (SA) test of false belief was administered using two small dolls and a box, cup and marble. The train task used the equipment illustrated in Figure 4.1. This apparatus measured 168 cm long and 14 cm wide and consisted of a straight piece of zero gauge train track attached to a piece of timber, two mobile lights (one yellow and the other blue), a control panel, a wooden plane and a locomotive engine. Incorporated into the control panel was an auditory signalling device eliciting either a high or low-pitched sound. At either end of the track was a landing pad for a plane, which also acted as a possible destination for a train. Similar to the lights, one landing pad was yellow and the other blue.[26]

The apparatus was fully automated. The train when directed by the light (which would either be located immediately next to each other in the middle of the track or at the corresponding end of the track) or sound would travel to the appropriate landing pad in order to collect goods. The train, prior to the plane landing on either landing pad, was positioned in the centre of the track and was returned to this point after each trial. The train was covered so that no indication of direction was visible to the participants apart from the appropriate signal (light or sound). The experimenter manually orchestrated the landing of the plane in clear view of the participants. The experimenter also regulated the train movements and signals using the control panel. This was carried out discreetly underneath the table out of view of the child.

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[26] These colours were chosen over red and green due to the cultural convention that red means 'stop' and green means 'go'. This was highlighted in previous research conducted by Bowler, Briskman, Gurvidi & Fornells-Ambrojo (in press).

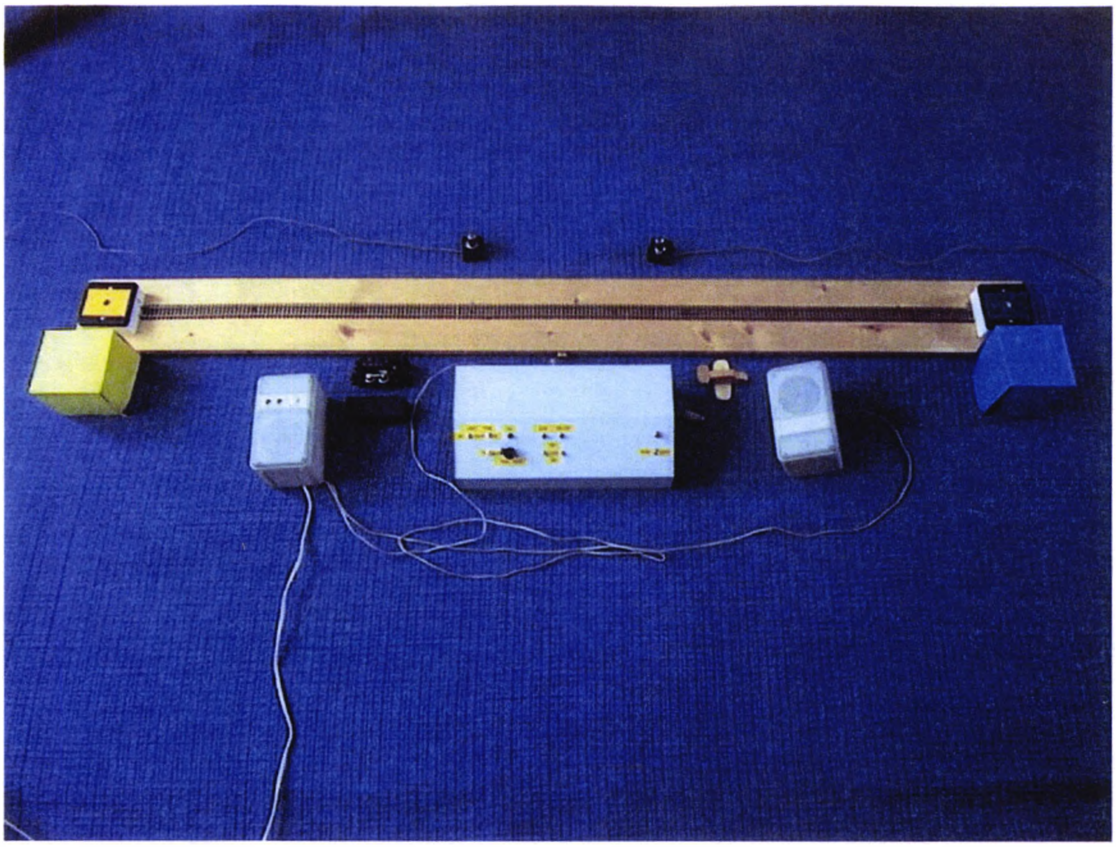

Figure 4.1. Train task experimental materials.

4.2.3 Design and procedure. All children were exposed to two trials of the SA task and two trials of three different train tasks. In total, each participant undertook eight experimental trials. The order of presentation was varied using Latin Squares (see Appendix 2). Participants were chosen on the basis of when they became available to the experimenter.

Train task. The Train task consisted of three different conditions. In one condition, labelled the Central Light condition (CLC), the signal lights were presented immediately in the middle of the track, side by side. The actual location of the light signal was counterbalanced across children so that the light did not always favour the corresponding coloured landing pad. This layout is illustrated in Figure 4.2.

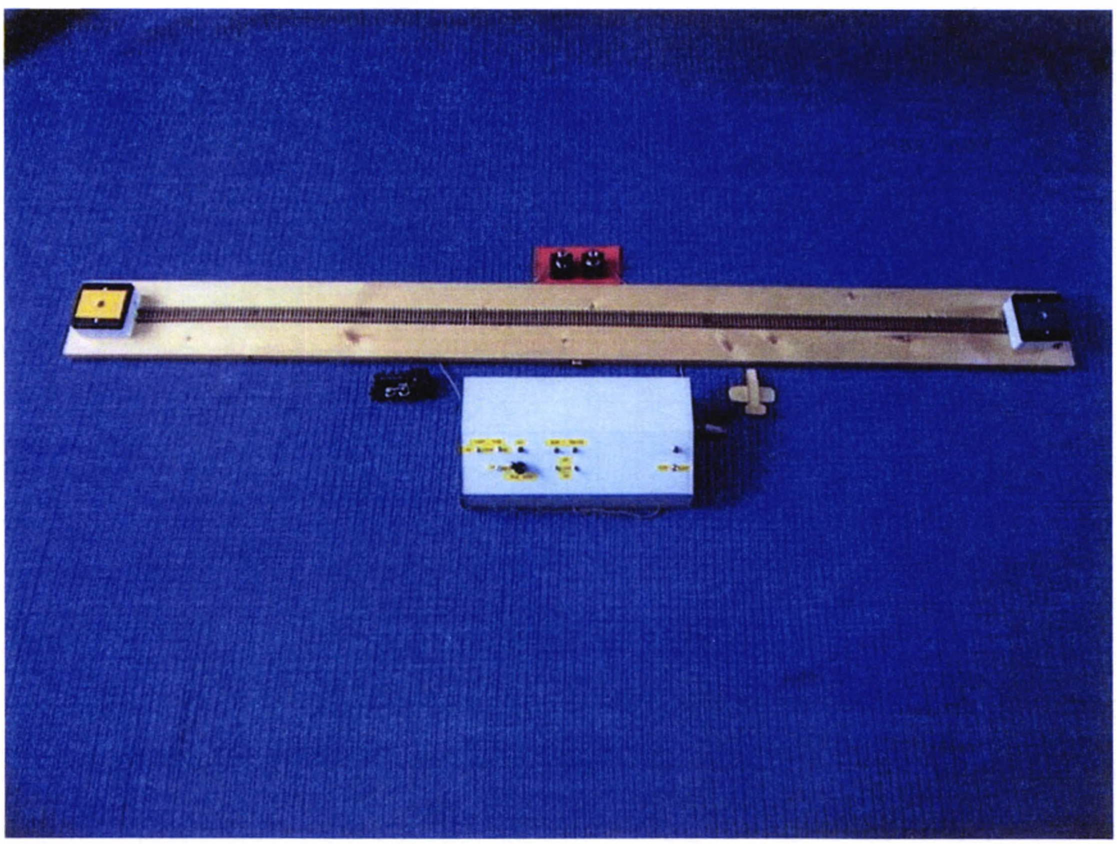

Figure 4.2. Central light condition.

In the second condition, the Landing Pad Light condition (LPLC), the signal lights were located at either end of the track. As to what end the light was placed was determined by the colour of the lights and landing pads. The yellow signal light was positioned by the yellow landing pad, while the blue signal light was placed by the blue landing pad. The LPLC is depicted in Figure 4.3.

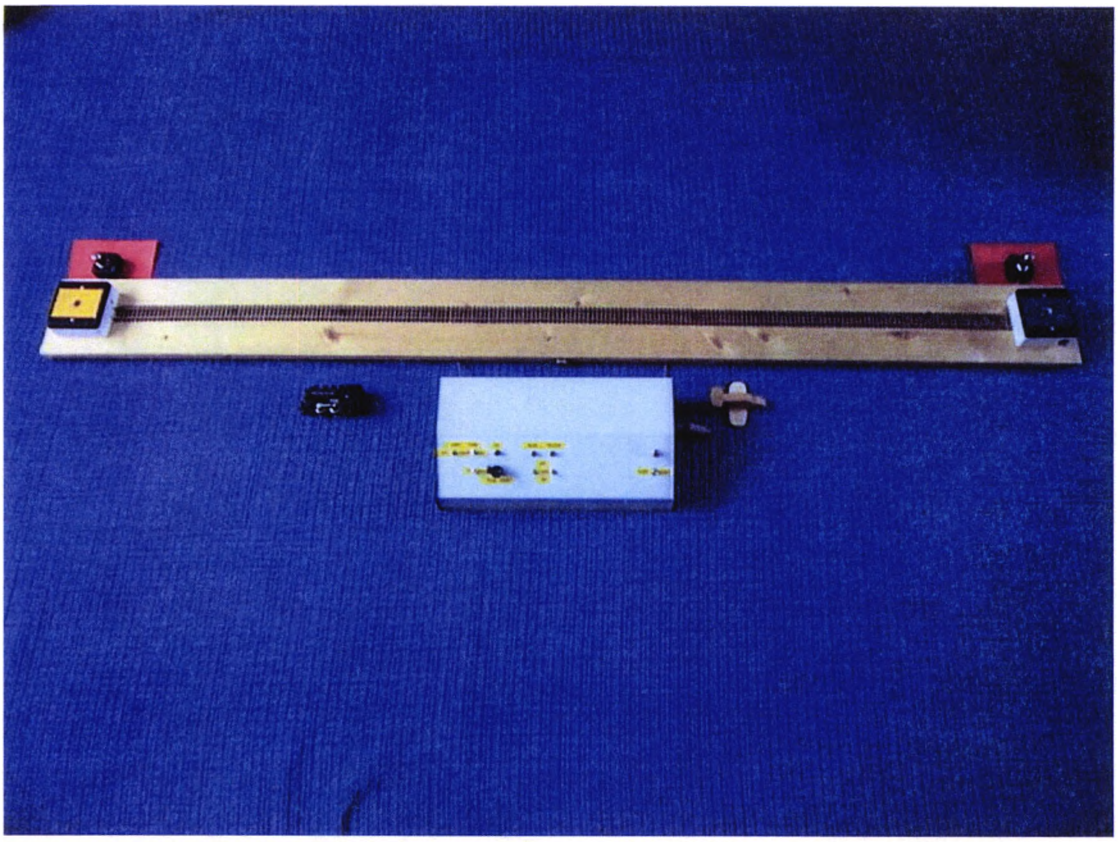

Figure 4.3. Landing pad light condition[27].

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[27] For both the LPLC and the CLC the red cards visible in Figures 4.2 and 4.3 were not present. They are provided here simply to highlight the locations of the light signals.

In the third condition, the Sound condition (SC), shown in Figure 4.4, lights were not utilised. A sound indicated the direction the train should go. A high-pitched sound signalled that the train would go to the yellow landing pad while a low-pitched tone indicated that the train would travel to the blue landing pad.

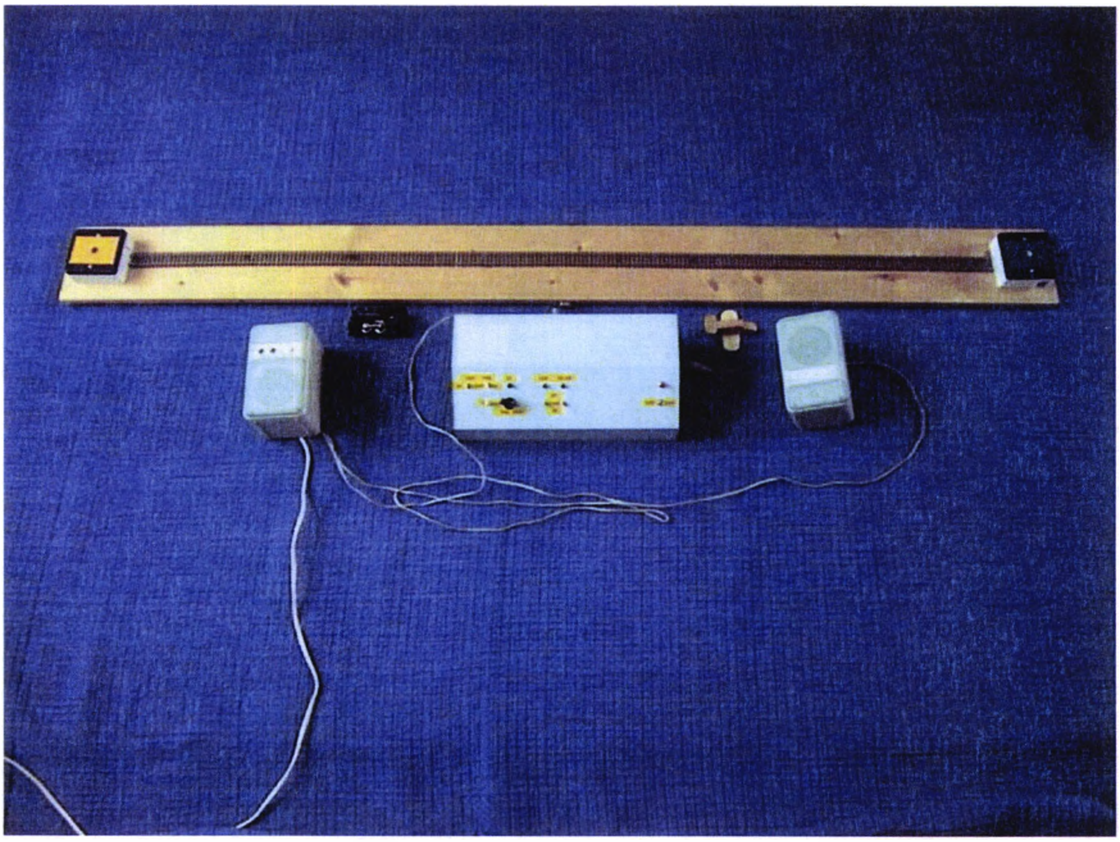

Figure 4.4. Sound condition.[28]

[28] Although this photograph depicts the speakers and control panel in view this was not the case whilst the study was being conducted. Participants could not see either the speakers or the control panel. Additionally the speakers were placed in the middle of the train track underneath the table to avoid any possible inadvertent cues being provided to the participants.

In each condition children were initially tested to ensure that they understood the cues associated with each scenario. It was explained verbally to the children prior to commencement of each signal light condition, that if the plane landed on the yellow/blue landing pad and the yellow/blue light came on, that the train would then go to the yellow/blue landing pad. It was also explained to the children that in the sound condition, if the plane landed on the yellow/blue landing pad that a high/low-pitched sound would be heard which would signal to the train to go to the yellow/blue landing pad. It was emphasised to the children that the train was completely automatic and that it relied exclusively on the lights or the sound as to what direction it should take. Regardless of where the plane landed the signal light or the signal sound would direct the train. Full experimental scripts are available in Appendix 3.

For the initial testing just discussed, the participants undertook six trials and were required to achieve a minimum of five correct predictions in order to continue to the experimental condition.[29] Once this prerequisite was met, the experimenter (without the child's knowledge)[30] altered the mechanism relating to the light and sound signals. In this altered situation, if the plane landed on the yellow landing pad the blue signal light would come on and vice versa. Additionally if the plane landed on the yellow landing pad the low-pitched signal would sound and vice versa. Accompanying this alteration was the experimenter's outward expression of surprise. The experimenter also highlighted this alteration verbally, contrasting the colour of the location of the plane and the state of the signal (colour for the light signal and tone

[29] Bowler, Briskman, Gurvidi & Fornells-Ambrojo (in press) conducted a similar set of trials. Considering the problems individuals with autism can have with over-selectivity and issues regarding dislike of change, perhaps so many initial testing trials could have been counter-productive. While it was necessary to consolidate participants' understanding of the logistics of the train task, perhaps less repetition via fewer testing trials would have been more appropriate.

[30] This was achieved by having the control panel on the experimenter's knee underneath the table.

for the sound signal). At this point, the signals were switched off and the landing pads were covered with a lid of the same colour as the landing pad. Each participant was then asked to predict the direction that the train would take, given that the correct prediction had been altered since the initial testing trials. This was the belief question. If the children indicated that the train would go to the location as signalled by the light or sound, they passed the belief question. If however they incorrectly predicted the destination of the train by stating the identical location of the plane, they failed the belief question. Two trials were given for each condition, with the initial location of the landing of the plane being counterbalanced across children and changed on the second trial. In addition initial plane location was counterbalanced for each child between signal conditions (CLC/LPLC/ SC).

After the belief question was asked, memory and reality questions were given in a counterbalanced order. The memory question for the light signal conditions was "What colour was the light?" and for the sound signal condition "What sound did you hear – high or low?" The reality question, "Where is the plane?" was identical for all three conditions. Reality and memory questions were asked to ensure that each participant had both knowledge of the actual current location of the plane and an accurate memory of the associated signal (Baron-Cohen, Leslie and Frith, 1985). The initial memory/reality question was also counterbalanced across children.

Sally-Anne task. The SA experimental procedure is illustrated in Figure 4.5. This figurative description reflects the protocol developed by Baron-Cohen et al. (1985). The SA experimental procedure used in the current study replicates that of Baron-Cohen et al. (1985) with the exception that a cup is used instead of a basket. In addition the distance between the box and cup in the current study is consistently 45cm. The apparatus used within the SA task is illustrated in Figure 4.6.

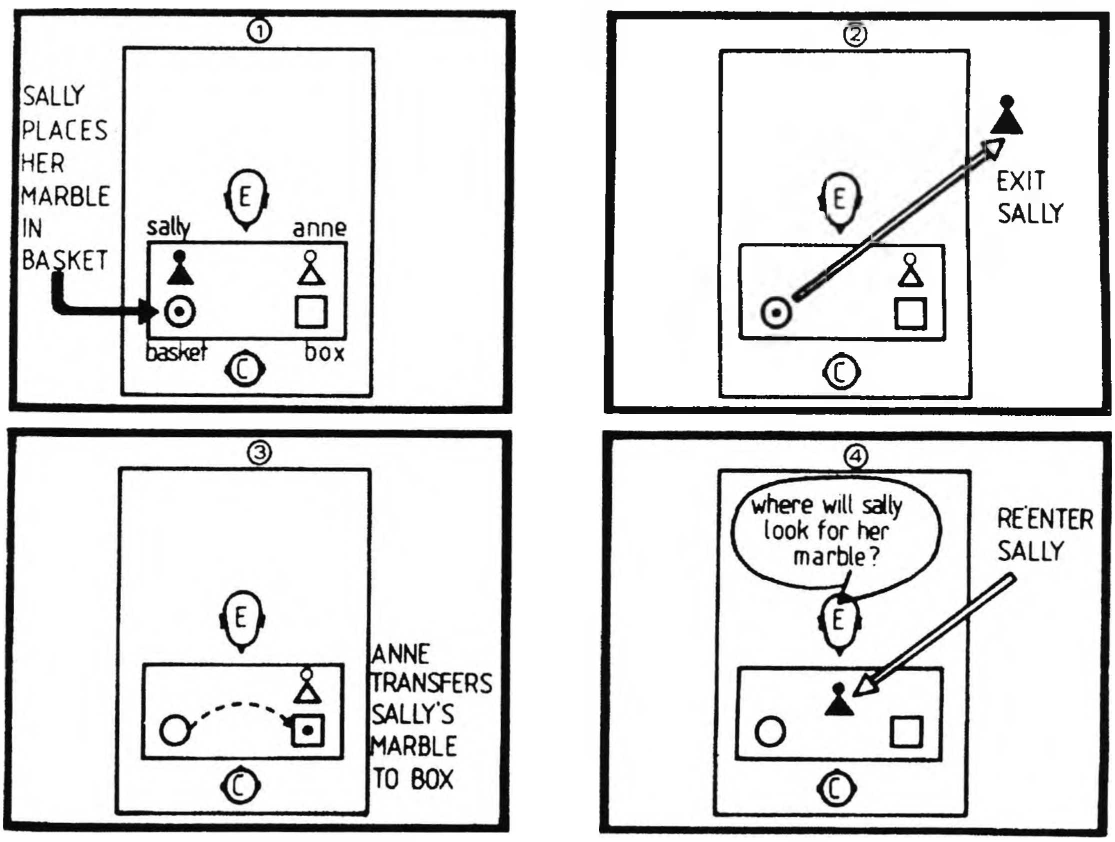

Figure 4.5. Sally-Anne task experimental scenario (taken from Baron-Cohen et al. (1985)).

Figure 4.6. Sally-Anne task apparatus.

Prior to the introduction of the experimental dialogue, each child was introduced to the two dolls. They were then asked to identify each one. Baron-Cohen et al. (1985) label this the naming question. Baron-Cohen et al. (1985) included the naming question in order to ensure that the children knew which doll was which – an important consideration bearing in mind that the participants would be answering questions specific to the two dolls. Once this was confirmed the experimental scenario was begun.

The delivery of the SA task followed a similar route to that of the train task with some clear differences. Firstly Sally placed her marble in either the cup or the box. Sally then left the room. At this point Anne moved the marble from one location to the other. Sally then returned to the room to look for her marble. It was emphasised to the children that Sally was not in the room when Anne moved her marble. The belief question was then asked.

Two trials of the SA task were presented to each child with the initial location of the marble being counterbalanced across children. The location of the marble was changed on the second trial. As in the train task, if the child passed the belief question "Where will Sally look for her marble?" they were then presented with counterbalanced memory ("Where did Sally leave her marble?") and reality ("Where is the marble?") questions. Presentation of these questions was also counterbalanced across children.

4.3 Results

For all four conditions (SA, CLC, LPLC, SC), children were included only if they correctly answered the reality and memory questions. All children tested answered both questions correctly. Table 4.2 provides a summary of the numbers of children who were successful on the false belief questions and those who failed, for all four conditions. Recall that a correct false belief response for the SA task was the location in which Sally left her marble, not where Anne moved the marble to. A correct false belief response for the train scenario was the location indicated by either the light or the sound, not the final destination of the plane. Chi-squared statistics indicate the degree of association between the two measures in each contingency table. Inspection of these data show that only the between-group difference on the LPLC was statistically significant. Although there was no significant difference between the two groups regarding the difficulty of the LPLC, cross-tabulation indicates that more than twice as many typically developing children (n=17) passed this task than did children with autism (n=8). The proportion of children with autism who passed the SA task (33%)[31] is identical to the proportion that passed the LPLC.

[31] The percentage of false belief passers with autism in the current study is in line with previously published studies by other authors (details provided in Chapter three) in which the percentage of false belief passers ranges from 20-40%.

Table 4.2

Performance of Participants in each Condition of Experiment One

	SA		LPLC		CLC		SC	
Group	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail
Typically Developing	13	11	17	7	13	11	7	17
With Autism	8	16	8	16	15	9	2	22
Pearson Chi-Square	$\chi^2 = 2.12$		$\chi^2 = 6.76$**		$\chi^2 = .34$		$\chi^2 = 3.42$	

* p<.05 ** p<.01 *** p<.005 **** p<.001

Table 4.3 illustrates within-group cross tabulations of the SA and three separate train task conditions. Phi statistics indicate the degree of association between the two measures in each contingency table; McNemar tests indicate the significance of the difference in difficulty between the two conditions. Upon inspection of these data it can be seen that all three train task conditions are correlated with the SA task for both groups of children, with one exception. For typically developing children, the SA task was not correlated with the SC. Closer inspection however gives some explanation for this. For typically developing children there was approximately a 50% chance of failing the SC regardless of performance on the SA task, whereas failure of the SA task almost certainly meant that failure would also occur on the SC.

McNemar tests indicate that for the typically developing children, all train tasks did not differ in difficulty when compared to the SA task. For the children with autism however, only the LPLC was statistically shown to be of equal difficulty to the SA task. Inspection of these data indicates that for the children with autism, the LPLC and the SA task are not significantly different in difficulty. For the children with autism, the CLC was significantly easier than the SA task, while the SC was significantly more difficult than the SA task.

These results replicate those of Bowler et al. (in press) in that the LPLC of the train task [similar to the train task in the Bowler et al. (in press) study] is a good analogue of the SA false belief task. The LPLC was most strongly correlated to the SA task for both groups. Additionally both tasks were of equal difficulty for both the typically developing children and the children with autism.

Table 4.3

Relationship Between Performance on the Sally-Anne and Train Tasks of Experiment One

Train Condition		SA					
		Typically Developing			With Autism		
		Pass	Fail	*Total*	Pass	Fail	*Total*
LPLC	Pass	12	5	***17***	6	2	***8***
	Fail	1	6	***7***	2	14	***16***
	Total	***13***	***11***	***24***	***8***	***16***	***24***
CLC	Pass	10	3	***13***	8	7	***15***
	Fail	3	8	***11***	0	9	***9***
	Total	***13***	***11***	***24***	***8***	***16***	***24***
SC	Pass	5	2	***7***	2	0	***2***
	Fail	8	9	***17***	6	16	***22***
	Total	***13***	***11***	***24***	***8***	***16***	***24***

Table 4.3 cont.

Relationship Between Performance on the Sally-Anne and Train Tasks of Experiment One

	Typically Developing	With Autism
SA vs. LPLC	Φ = .51*	Φ = .63***
	McNemar	McNemar
SA vs. CLC	Φ = .50*	Φ = .55**
	McNemar	McNemar*
SA vs. SC	Φ = .22	Φ = .43*
	McNemar	McNemar*

* p<.05   ** p<.01   *** p<.005   **** p<.001

Key:

SA	Sally-Anne test of false belief
LPLC	Landing Pad Light Condition
CLC	Central Light Condition
SC	Sound Condition

Table 4.4

Relationship of Difficulty Between Train Task Conditions for Children with Autism and Typically Developing Children in Experiment One

	Typically Developing	With Autism
CLC vs. LPLC	McNemar	McNemar*
CLC vs. SC	McNemar*	McNemar****
LPLC vs. SC	McNemar*	McNemar*

* $p<.05$ ** $p<.01$ *** $p<.005$ **** $p<.001$

Inspection of Table 4.4 highlights that for the children with autism all train conditions were of differing difficulty. An interesting point however, is that for the typically developing participants there was no significant difference in difficulty between the CLC and the LPLC. It can be inferred from this that the difference in difficulty of these conditions as experienced by the children with autism is particular to that group[32]. For the typically developing participants the LPLC and CLC were of equal difficulty. For the children with autism though, the CLC was significantly easier than the LPLC. Considering that for both groups the LPLC was the most analogous to the standard false belief test, the altered scenario as witnessed by the CLC may

[32] For this to be further validated the same experiment could be replicated with a second comparison group, for example, children with moderate learning difficulties.

provide some answers as to why children with autism find such tests difficult to pass. For the typically developing participants the alterations made to the stimulus had no significant effect upon performance. Performance was only compromised for the children with autism.

Further inspection illustrates that the SC was more difficult than the LPLC and CLC for both the typically developing participants and the children with autism.

4.4 Discussion

This research successfully replicated that of Bowler et al. (in press) in that a non-mental state analogue of the standard false belief test was constructed, in which participants found the false belief task and the analogue task (LPLC) to be of equal difficulty. This replication was achieved despite a significant design change. Additionally, the tests were strongly correlated for both the children with autism and the typically developing participants. These findings add further weight to the argument that the difficulty encountered by children with autism on tests of false belief may not necessarily be due to a deficiency of mentalising ability, but due rather to some other variable or variables.

In addition to the construction of a non-mental state analogue of the classic unexpected transfer test of false belief, this research aimed to show that what children with autism may find difficult with such tests, are the arbitrary rules that must be adhered to and followed in order for the successful completion of the task (Russell et al., 1999). It was hypothesised prior to the experiment that the three versions of the mechanical analogue varied specifically according to degrees of arbitrariness. This hypothesis was extended whereby it was predicted that the LPLC would be the least arbitrary, followed next by the CLC and finally that the SC would be the most arbitrary.

Arbitrariness in this context is defined as "based on random choice or whim" or alternatively to be "unpredictable". When considering the three versions of the mechanical analogue task and this definition of arbitrariness, one would have to agree that the order of arbitrariness was assigned appropriately to each version. While there may be some debate as to whether the LPLC or the CLC is the least arbitrary, there is unlikely to be debate over the perceived high level of arbitrariness of the SC. Despite the possibility of debate regarding the degree of difference in arbitrariness between the LPLC and CLC, it is clear that the LPLC is the less arbitrary of the two conditions.

In terms of the concept of unpredictability, the LPLC appears to be the more predictable of the two conditions. Within this condition, the destination of the train is not only illustrated by the colour of the light but also by its location. This is in contrast to the CLC where the destination of the train is independently signalled by the colour of the light: a condition less predictable than that, which provides both light and position, cues.

Despite what one may have expected, it was shown that even though for the typically developing children there was no significant difference in difficulty between the LPLC and CLC, for the children with autism, the CLC was significantly easier than the LPLC. So unlike the hypothesis suggested, it would appear that for the typically developing children the difference between the two tasks (possibly the increased arbitrariness) had no significant effect upon performance, whereas for the children with autism this was not the case. This may be interpreted to suggest that the difference between the two conditions affected performance on the non-mentalising false belief analogue, in a manner that is likely to be autism-specific. Perhaps even more importantly, this difference may be crucial in determining what it is about the classic unexpected transfer test of false belief that children with autism find difficult.

Given the findings of Experiment One an obvious heuristic emerges: "What **is** the difference between the LPLC and the CLC?" When comparing the two tasks it can be seen that the primary differences between them fall into three different categories:

- Arbitrariness of signal-goal relationships.
- Attentional Scanning – the ability to visually scan, shift attention and retain information within short-term memory.
- Information presented most recently may be more meaningful and useful to the workings of memory, a phenomenon I will term 'cognitive resonance' for the purposes of the present discussion.

When considering the difference in arbitrariness between the LPLC and CLC some concern arises. The condition that was predicted to be more arbitrary and therefore more difficult for the children with autism was actually significantly easier for them to pass. It is conceivable that some may argue that it is arbitrariness that affects performance on such tests for children with autism, alternatively the findings may highlight the atypical nature of autism, in that what one would expect to be arbitrary for the cognitively typical individual may not necessarily be arbitrary when considering the cognitive processes of individuals with autism. Indeed, it may be that for individuals with autism the CLC is in fact, less arbitrary than the LPLC.

One factor that may contribute to the differential arbitrariness of the two light conditions stems from the demands they make upon the participants with autism. The most salient difference between the LPLC and CLC is in fact the location of the light signal. During the experimental scenario the plane lands at a landing pad – either yellow or blue. At this point the discrepancy between where the plane landed and the colour of the light is highlighted to the child. The distance between where the plane lands and then where the child's attention is directed (i.e. the light signal) clearly differs across the two conditions. A greater degree of attentional scanning is required within the LPLC than in the CLC as the distance in the former is greater. It is possible that this requirement to scan between the two locations makes the LPLC more difficult for children with autism. This possibility is explored further within Experiment Three.

Moreover not only is additional attentional scanning necessary in the LPLC, but also in the CLC after all discrepancies have been highlighted, the central light is last thing that the child observes. In the CLC the participants are directed to where the plane has landed and then re-directed to the centre of the track where the lights are located. While this is also the case in the LPLC, in the CLC this observation is free from any other stimuli. In the CLC the child only sees the light whereas in the LPLC, both the light and the empty landing pad are observed. This could well prove to be a more compromising distraction for children with autism and therefore have an impact upon attentional resources. As Burack (1994) highlights "the appearance of non-target stimuli interferes with performance by adding demands to available attentional resources, thereby diminishing the efficiency of attention and the subsequent processing of information" (p. 536). The empty landing pad may also act as a sort of 'negative memory cue' as where the train should travel. That is the empty landing pad may cue recall regarding where the plane actually is. As well as this, after the light signal discrepancy is highlighted in the LPLC, the child's attention is naturally re-directed via the delivery of the belief question, to the centre, as this is where the experimenter is sitting. This is in contrast to the CLC as the child's attention is not re-directed after the light is witnessed. Rather the belief question is asked without the necessity of the child's attention being re-directed towards the experimenter. This could mean that the information gathered by the child within the CLC is less likely to be disrupted by yet another shift of attention. It could be argued that resulting from this undisturbed information processing and lessened re-direction of attention that information gathered within the CLC is more cognitively resonant. Cognitive resonance is a term introduced by the author of the current collection of studies to describe information that is cognitively rich and therefore useful to processes that are cognitive in nature. Alternatively this may be interpreted in terms of memory cues whereby the auditory cue (...but the light is blue/yellow) within the CLC is free from any visual distraction (the empty landing pad). This interpretation and further research concerning false belief and memory retrieval is explored in Experiments Four and Five.

The results of the current study also offer interesting findings regarding the SC. For the typically developing participants there was no significant difference in difficulty between the SA test of false belief and the SC. The children with autism however found the SC significantly more difficult than the test of false belief. For both typically developing children and children with autism the SC proved significantly more difficult than both the LPLC and CLC. It is unlikely to be disputed that the SC requires a greater understanding of arbitrary procedures in order to pass the belief question. The arbitrariness in this case is clear in that both the low-pitched and high-pitched sounds are arbitrary links to the destination to which the train should travel. The other main difference between the SC and the two light conditions is that of visual cues. Within both the LPLC and CLC there is a visual cue as to where the train should travel, whereas in the SC there is only an auditory cue. Is it that children on the whole find auditory cues more arbitrary or rather that the level of auditory cueing was not sufficient to be of equal assistance when determining the final destination of the train? Furthermore what was it about the SC that made it more difficult than the test of false belief for the children with autism and additionally why wasn't a similar disparity in difficulty observed for the typically developing children? These possibilities are examined in Experiment Two.

Chapter Five

Experiment Two: Arbitrariness of Auditory Cues - Does Increasing the Arbitrariness of Auditory Signals Affect the Performance of Children with Autism on Tests of Mechanical False Belief?

5.1 Introduction

When considering the arbitrariness of certain tasks for children with autism it is important to not only ascertain whether or not increased arbitrariness affects performance but also to seek to provide an explanatory account. One possible explanation of why children with autism may find some tasks more arbitrary and therefore more difficult could be particular learning styles and in particular how children with autism tend to receive and process information.

A learning style can be described as the more or less consistent way in which a person perceives, conceptualises, organises and recalls information. Learning styles are influenced by genetics, previous learning experiences, culture and the societies in which we live (Ellis, 1985). Research and theories concerning learning styles is extensive, however there is general agreement that people on the whole learn through a combination of three basic modalities – visual (learning through seeing), auditory (learning through hearing) and kinaesthetic/tactile (learning through touching or manipulation of objects) (Edelson, 2000). While it is possible for individuals to have a modality preference, generally most people learn by utilising two to three different learning styles. Individuals who prefer a visual learning style tend to: look at other people's faces intently; like looking at wall displays, books etc.; often recognise words by sight; use lists to organise their thoughts; recall information by remembering how it was set out on a page. Those who prefer an auditory learning style: like people to provide them with verbal instructions; like dialogues, discussions and plays; solve problems by talking about them; use rhythm and sound as memory aids. Finally, people who prefer a kinaesthetic/tactile learning style: learn best when they are involved or active; find it difficult to sit still for long periods; use movement as a memory aid; use writing and drawing as memory aids; learn well in hands-on activities such as projects and demonstrations.

For individuals diagnosed with autism the visual modality is often regarded as being dominant. The visual strengths and abilities of individuals with autism is often cited, for example Shah and Frith (1983) highlight visuo-spatial skills as one area in which classically autistic children of all levels of ability seem to perform particularly well. Wing (2002) reiterates this point in her assertion that within psychological tests of a visuo-spatial nature that do not involve language (the comprehension of which is an auditory ability) children with autism perform better than on those tests that do require the use or understanding of language. Siegel (1996) also emphasises that children with autism tend to do much better on performance intelligence (PIQ) tasks. For young children such tasks are typically measured by how well and how fast they can complete pegboards, form boards, and puzzles; how well they can stack blocks; and how well they can recognise visual features of objects. Furthermore Siegel (1996) makes the point that PIQ skills that are normally learned within the first three years of life often develop on time or nearly on time for children diagnosed with autism. Ozonoff (1997) also reports that visuospatial, visual organisation and visual matching skills tend to be areas of cognitive strength for children with autism. On the other hand individuals with autism typically have problems processing auditory information. A reduced ability in the performance on auditorily based psychological tests is mentioned by Wing (2002). Courchesne (1987) has also found significant impairments in the auditory processing abilities of children with autism on the basis of abnormal P300 evoked potentials. Described by Edelson (2000), the P300 brain wave occurs 300 milliseconds after the presentation of a stimulus (the ‘P’ refers to the positive polarity of the potential). As highlighted by Donchin, Ritter & McCallum (1978) these findings have considerable impact due to the association of P300 brain activity with cognitive processing and long-term memory retrieval. Schopler & Mesibov (1995) relate impaired auditory processing difficulties to attention deficits that individuals with autism typically display. Schopler & Mesibov (1995) also suggest that such deficits and impairments may further inhibit executive functioning abilities, cognitive problem solving and verbal reasoning.

Experiment Two was conducted to investigate the possibility that within tasks involving the processing of auditorily presented information, that if presented more or less arbitrarily, such information will have differential effects upon participants with autism. The current study replicated the design of Experiment One with some modifications. Instead of having a combination of auditory and visual conditions the train tasks in the current study were all auditory - there were three auditory train conditions. The auditory signal condition from Experiment One was replicated and two other auditory conditions were utilised. The two newly created auditory conditions were designed to be less arbitrary and therefore more directly related to the final destination of the train. In the current study the train is directed by either a single low or high-pitched tone (as in Experiment One), multiple or continuous tones or by pre-recorded auditory output clearly providing the destination that the train should travel to. The recorded output consisted of either “blue landing pad” or “yellow landing pad”. In addition participants were presented with a classic unexpected transfer test of false belief.

Arguments, such as those proposed by Biro and Russell (2001) that claim that autism is associated with difficulties in following arbitrary procedures would suggest that as the arbitrariness of the auditorily presented signals is reduced, the performance of the children with autism will improve. As a result, the first hypothesis of the current experiment is within group and concerns the participants with autism only. Considering the widely accepted difficulties that this population has with auditory processing and the findings of Biro and Russell (2001), it is hypothesised that when comparing auditory tasks of varying degrees of arbitrariness that the tasks in which arbitrariness is reduced will result in a greater amount of task success for children with autism. The investigation to be outlined here builds upon Experiment One, where it was found that of three conditions, the one condition that involved auditory signals was shown to be most difficult for children with autism. Recall from Experiment One that the three conditions consisted of a landing pad light condition, a central light condition and a sound condition. In all three conditions participants were expected to predict the destination that a signal-dependent train would take. In the central light condition and the landing pad light condition either a blue or yellow light would indicate the destination of the train (either the blue or yellow landing pad), the difference between the two conditions being the placement of the light signals - at either end or in the middle of the train track. In the sound condition either a low-pitched or a high-pitched sound would indicate to the participants where the train would travel. For the participants with autism the sound condition was shown to be the most difficult, indeed more difficult than the Sally-Anne test of false belief. This investigation was necessary in order to determine if children with autism find the processing of auditory information more difficult than information provided via the visual modality. The question: “Could it be that children with autism find passing tests of false belief difficult due to the auditory nature of the instructions provided to them?" arose intuitively from Experiment One. Furthermore could altering the arbitrariness of such instructions have a positive effect upon the performance of children with autism on such tasks? The current experiment aims to explore these possibilities.

The second hypothesis concerns a comparison between typically developing children and children with autism. For the typically developing children the sound condition in Experiment One did not prove to be significantly different in difficulty to the test of false belief, however for the children with autism the sound condition was shown to be significantly more difficult than the test of false belief. If it was arbitrariness alone that resulted in the sound condition proving to be more difficult for the children with autism, then because the typically developing children found the two tasks to be equivalent in difficulty, it is hypothesised that a reduction in the level of arbitrariness between the tasks in the current study will only have positive effects for the participants with autism. If, however rendering the train tasks in the current study less arbitrary increases the performance for both the typically developing children and children with autism then alternative explanations will need to be sought.

5.2 Method

5.2.1 Participants. Seventeen children with a diagnosis of autism spectrum disorder (the diagnoses of which were included within statements of Special Educational Needs located within school records) and 20 typically developing children took part in the study. The 17 participants with autism (15 boys and 2 girls) attended a special needs school in London while the 20 typically developing participants (11 boys and 9 girls) attended a mainstream primary school in Essex. Written consent was obtained from a parent or guardian for all participants. Letters of consent, detailing both the nature and expected duration of the study were written by the author and distributed by the school. An example of a consent letter is provided in Appendix 1.

The 37 children included within this research were chosen as participants as a result of their performance on the Test for the Reception of Grammar (TROG) (Bishop, 1982). Forty-nine children were initially tested however due to either falling below the pre-determined minimum Verbal Mental Age (VMA) of 45 months, or exceeding the maximum allowed VMA of 84 months, 12 were not included. The mean VMA of the children with autism was 55.2 months (n = 17, SD = 10.3) and the mean VMA of the typically developing children was 53 months (n = 20, SD = 4.2). Details of the participants' VMA and Chronological Age (CA) are set out in Table 5.1. Analysis of these data using a Mann-Whitney test[33] revealed a significant difference for CA (U = 67.50, N1 = 20, N2 = 20, p <.005, two-tailed), but not for VMA (U = 168.50, N1 = 20, N2 = 20, p = .96, two-tailed).

[33] Mann-Whitney test was used instead of Independent Samples t-test due to unequal variances.

Table 5.1

Chronological and Verbal Mental Ages of Participants in Experiment Two

	With Autism (N=17)	Typically Developing (N=20)
Chronological Age*** (months)		
Mean	84.2	62.7
SD	19.1	6.6
Range	55-118	54-76
Verbal Mental Age (months)		
Mean	55.2	53.0
SD	10.3	4.2
Range	45-84	48-60

* p<.05   ** p<.01   *** p<.005   **** p<.001 (Mann-Whitney)

*5.2.2 **Materials.*** The equipment used in this experiment consisted of typical Sally-Anne test materials and an electrical train apparatus. The Sally-Anne (SA) test of false belief was administered using two small dolls and a box, cup and marble. The train task used the equipment illustrated in Figure 5.1. The train apparatus measured 168 cm by 14 cm and consisted of a straight piece of zero gauge train track attached to a piece of timber, a control panel, a wooden plane and a locomotive engine. Incorporated into the control panel was an auditory signalling device eliciting three different types of sound signals – high/low single tones, multiple/continuous tones and voice signals "blue landing pad"/"yellow landing pad". At either end of the track was a landing pad for the plane, which also acted as a possible destination for the train. One landing pad was yellow and the other blue.

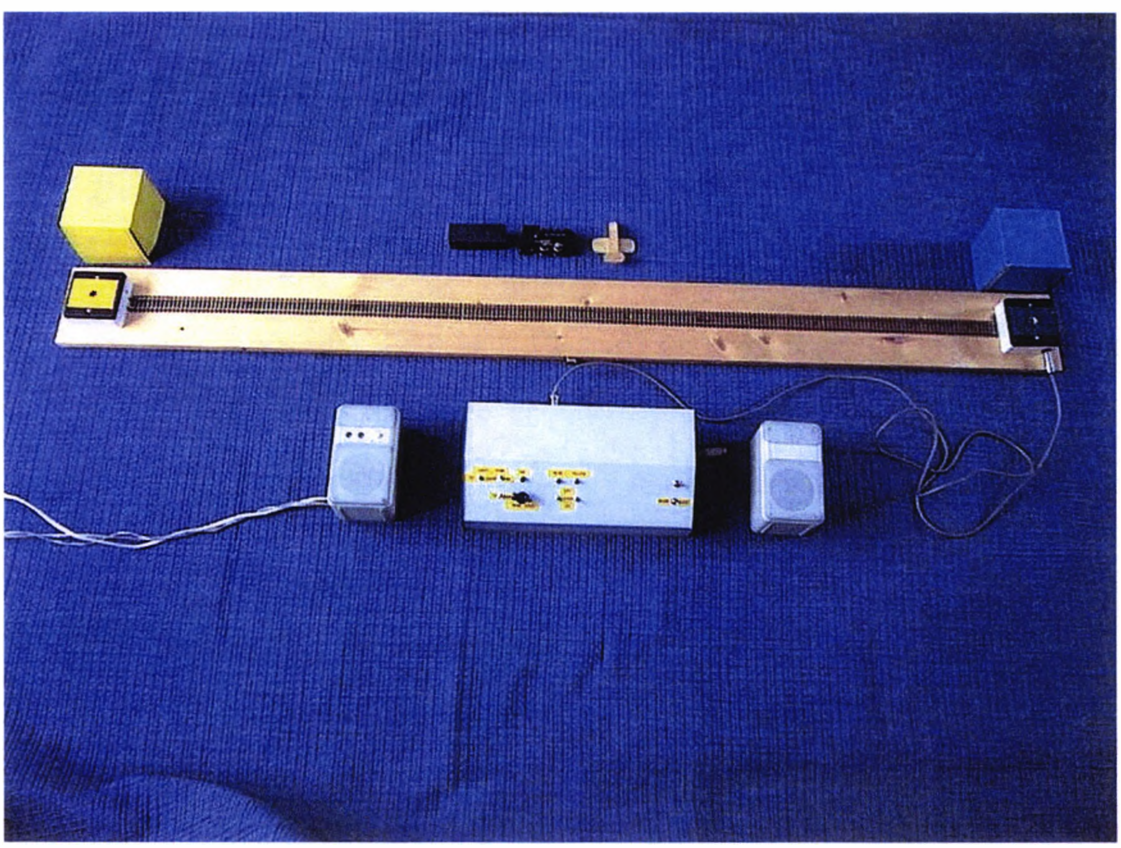

Figure 5.1. Train task experimental materials.

The purpose of this apparatus was that a fully automatic train would, when directed by the sound signals, travel to the appropriate landing pad so as to collect goods. Consistent with Experiment One, the train was positioned in the centre of the train track prior to the plane landing at a landing pad and was returned to this position after each trial. The train was covered so that no indication of direction was apparent to the participants apart from that provided by the respective sound signals. The experimenter manually orchestrated the landing of the plane in clear view of the participants. The experimenter also regulated the train movements and signals using the control panel. This was carried out discreetly underneath the table without the child's knowledge.

5.2.3 Design and procedure. All children undertook two trials of the SA task and two trials of three different train tasks. In total, each participant undertook eight experimental trials. The order of presentation was determined using Latin Squares (see Appendix 4). Children were also randomly allocated participant status. That is, whether a child was Participant 1 or 10 was not pre-determined. Rather children were chosen randomly according to the availability as determined by their timetable and lesson schedule.

Train task. The Train task consisted of three different sound signal conditions. In one condition, labelled the High/Low condition (HLC), either a low or a high-pitched single tone directed the participants as to where the train should go. A high-pitched sound signalled that the train would go to the yellow landing pad while a low-pitched tone indicated that the train would travel to the blue landing pad.

In the second sound condition, the Multiple/Continuous condition (MCC), either a multiple or a continuous tone directed the participants as to where the train should go. A multiple tone signalled that the train would go to the yellow landing pad while a continuous tone indicated that the train would travel to the blue landing pad.

In the third condition, the Voice signal condition (VSC), a pre-recorded voice would clearly indicate to which landing pad the train would travel. The voice would say, "blue landing pad" if the train was to travel to the blue landing pad and "yellow landing pad" if the train was to travel to the yellow landing pad.

In each condition children were initially tested to ensure that they understood the cues associated with each scenario. It was explained verbally to the children prior to commencement of each sound signal condition, that if the plane landed on the yellow landing pad that either a high pitched or multiple 'bleeping' sound, or a voice saying "yellow landing pad" would signal the train to go to the yellow landing pad. It was also explained that if the plane landed on the blue landing pad that either a low pitched or continuous sound, or a voice saying "blue landing pad" would signal the train to go to the blue landing pad. An example of each sound was given to each participant prior to the continuation of the experiment. It was emphasised to the children that the train was completely automatic and that it relied totally on the sounds as to what direction it should take. Regardless of where the plane landed the sound would direct the train. Full experimental scripts are available in Appendix 5.

For each condition, the initial testing just discussed involved six trials. In order to continue with the experiment each child was required to perform a minimum of five correct predictions as to the direction that the train would take.[34] Once this prerequisite was met, the experimenter (without the child's knowledge) altered the mechanism relating to the sound signals. In this altered situation, if the plane landed on the yellow landing pad the low-pitched or continuous sound, or voice saying "blue landing pad" signal would be heard and vice versa. Accompanying this alteration was an expression of surprise on behalf of the experimenter. The experimenter also highlighted this alteration verbally, contrasting the colour of the location of the plane and the state of the signal. At this point, the signals were switched off and the landing pads were covered with a lid of the same colour as the landing pad. Each participant

[34] Even though concern was raised over the number of initial testing trials in the previous experiment, the same number was utilised here so as to maintain consistency.

was then asked to predict the direction that the train would take, given that the correct prediction had been altered since the initial testing trials. This was the belief question. If the children indicated that the train would go to the location as signalled by the corresponding sound they passed the belief question. If however they incorrectly predicted the destination of the train by stating the identical location of the plane they failed the belief question. Two trials were given for each condition, with the initial location of the landing of the plane being counterbalanced across children and changed on the second trial. In addition initial plane location was counterbalanced for each child between signal conditions.

After the belief question was administered, memory and reality questions were given in a counterbalanced order. The memory question was either "What sound did you hear?" or "What did the voice say?" The reality question was consistently "Where is the plane?" Reality and memory questions were administered to ensure that each participant had both knowledge of the actual current location of the plane and an accurate memory of the associated signal (Baron-Cohen, Leslie and Frith, 1985). Memory and reality questions were also counterbalanced across children.

Sally-Anne task. The SA experimental materials are illustrated in Figure 5.2. The SA task utilised the same stimuli to that of Experiment One and was implemented in the same manner.

Figure 5.2. Sally-Anne task characters and apparatus.

5.3 Results

Participant responses were included in the final results only if (regardless of passing or failing the belief question) they consisted of accurate responses to both the memory and reality questions. In this study all children answered both questions accurately, therefore avoiding the need to include new participants. Table 5.2 provides a summary of the numbers of children who were successful on the false belief questions for all four conditions (SA, HLC, MCC, VSC) and those who failed. A correct false belief response for the SA test was where Sally had initially left her marble, not where Anne had unexpectedly transferred it to. Similarly a correct false belief response for the three train conditions was where the signal indicated, not where the plane had landed. Chi-squared statistics indicate the degree of association between the two measures in each contingency table. Inspection of the data in Table 5.2 show between-group differences for the three train conditions but not for the SA test. This suggests that the pattern of responding for the SA test was similar for both the typically developing children and the children with autism while the pattern of responding for the three separate train tasks was different for the two groups. While the percentage of SA passers with autism is somewhat lower than in other published papers, at 17 %, this was not deemed problematic due to the nature of the study. The purpose of this study was to investigate whether making auditory tasks less arbitrary would increase task success for children with autism. Therefore the children with autism having a low pass rate for the SA test of false belief was a positive rather than a negative outcome of this experiment. This was positive as it meant that increased success on tests where arbitrariness was reduced (in comparison to the SA test of false belief) would be more easily determined if a greater number of children failed the standard test of false belief.[35]

Inspection of the Chi-Square statistics in Table 5.2 reveals dissimilar patterns of responding on the three train conditions for the typically developing children when compared with the children with autism. From these results it can be seen that all 17 (100%) of the children with autism failed the HLC while only 7 of the 20 (35%) typically developing children failed. Similarly all of the children with autism, including the SA passers failed the MCC condition. More typically developing children (9 of the 20) failed the MCC condition than failed the HLC, however at 45 % this is still significantly less than the proportion of failers with autism. The percentage differences between the two groups of children however, are not as striking for the VSC. For the children with autism there is almost an equal chance of passing or failing the VSC, whereas for the typically developing children only 3 of the 20 (15%) failed.

[35] If for example 12 of the 17 children passed the Sally-Anne test then only five children would remain to test the experimental hypothesis. The fact that a large number of children with autism failed the Sally-Anne test is important here as what this study aimed to investigate was whether or not altering the level of arbitrariness of auditory information would increase the successful performance of children with autism. Essentially what this study aimed to do was to discover a way of making tests of false belief easier for children with autism, while at the same time providing possible explanations as to their initial failure.

Table 5.2

Performance of Participants in each Condition of Experiment Two

	SA		HLC		MCC		VSC	
Group	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail
Typically Developing	9	11	13	7	11	9	17	3
With Autism	3	14	0	17	0	17	9	8
Pearson Chi-Square	$\chi^2 = 3.14$		$\chi^2 = 17.01$**		$\chi^2 = 13.31$**		$\chi^2 = 4.52$*	

* p<.05 ** p<.01 *** p<.005 **** p<.001

Table 5.3 illustrates within-group cross-tabulations of the SA task and the three separate train conditions. Phi statistics indicate the degree of association between the two measures in each contingency table; McNemar tests indicate the significance of the difference in difficulty between the conditions. Upon inspection of these data it can be seen that for the typically developing SA failers there is almost an even chance of passing both the HLC and the MCC. For the typically developing participants the SA test did not correlate with any of the sound conditions, indicating differing patterns of performance when comparing the standard test of false belief and the sound conditions. McNemar statistics indicate that there was no significant difference in difficulty between the SA and the HLC or the SA and the MCC for the typically developing participants. This was not the case though for the VSC. The typically developing children found the VSC significantly easier than the SA test.

For the children with autism Phi statistics and McNemar tests could not be provided for the analyses between the SA and HLC and MCC. Eyeballing the cross-tabulations in Table 5.3 however reveals that all children with autism, regardless of whether they passed the SA test, failed both the HLC and MCC choosing that the train would travel to the plane's location rather than where the sound indicated. For the children with autism there was not a significant correlation between the SA test and the VSC indicating dissimilar patterns of performance between the two tasks for these participants. Close inspection of the contingencies for the children with autism show that all 3 passers and 6 of the 14 failers passed the VSC. There was a 35.29% increase in success from the SA test to the VSC. McNemar statistics indicate that the VSC was significantly easier than the SA test for the children with autism.

Table 5.3

Relationship Between Performance on the Sally-Anne and Train Tasks of Experiment Two

Train Condition		SA					
		Typically Developing			With Autism		
		Pass	Fail	*Total*	Pass	Fail	*Total*
HLC	Pass	7	6	***13***	0	0	***0***
	Fail	2	5	***7***	3	14	***17***
	Total	***9***	***11***	***20***	***3***	***14***	***17***
MCC	Pass	5	6	***11***	0	0	***0***
	Fail	4	5	***9***	3	14	***17***
	Total	***9***	***11***	***20***	***3***	***14***	***17***
VSC	Pass	8	9	***17***	3	6	***9***
	Fail	1	2	***3***	0	8	***8***
	Total	***9***	***11***	***20***	***3***	***14***	***17***

Table 5.3 cont.

Relationship Between Performance on the Sally-Anne and Train Tasks of Experiment Two

	Typically Developing	With Autism
SA vs. HLC	Φ = .24	N/A
	McNemar	N/A
SA vs. MCC	Φ = .01	N/A
	McNemar	N/A
SA vs. VSC	Φ = .10	Φ = .44
	McNemar*	McNemar*

* $p<.05$ ** $p<.01$ *** $p<.005$ **** $p<.001$

Key:

SA	Sally-Anne test of false belief
HLC	High/Low Condition
MCC	Multiple/Continuous Condition
VSC	Voice Signal Condition

For the typically developing children there was no significant difference in difficulty between the HLC and MCC or between the HLC and the VSC. These participants did however find the VSC significantly easier than the MCC. This is shown by McNemar statistics set out in Table 5.4. Unfortunately because all the children with autism failed the HLC and MCC, statistical comparisons using McNemar tests could not be made between these two conditions or between the HLC, MCC and the VSC. However as 9 of the 17 (52.94%) children with autism passed the VSC this may suggest that the children with autism found the VSC significantly easier than the other two train tasks.

Table 5.4

Relationship of Difficulty Between Train Task Conditions for Children with Autism and Typically Developing Children in Experiment Two

	Typically Developing	With Autism
HLC vs. MCC	$\Phi = .60$** McNemar	N/A
HLC vs. VSC	$\Phi = .57$* McNemar	N/A
MCC vs. VSC	$\Phi = .46$* McNemar*	N/A

* p<.05 ** p<.01 *** p<.005 **** p<.001

5.4 Discussion

The results of the current study support the first hypothesis - as arbitrariness was reduced the performance of the children with autism increased. This was clearly evident when comparing the performance of children with autism on the test of false belief and the sound condition that was included as the least arbitrary – the VSC. For the children with autism the VSC was significantly less difficult than the test of false belief. It might be argued that these findings need to be treated with some caution due to the inability to provide statistical analyses on the comparative performance of the participants with autism between the test of false belief and the other two sound conditions (HLC and MCC)[36]. However as noted considerably fewer children with autism passed the HLC and MCC when compared to the VSC. All children with autism failed the HLC and MCC while 9 of the 17 passed and 8 of the 17 failed the VSC. Also considering the results of Experiment One where only 2 of the 24 participants with autism passed the high/low condition[37], the findings of the identical condition for the sample of children with autism tested in the current study appears to replicate the findings of Experiment One, in as much as eye-balling the data reveals that the HLC was more difficult than the test of false belief for these children. That is all of the children with autism, including the three false belief passers failed the HLC. Another interesting finding concerning the children with autism was the observed lack of difference between the HLC and MCC. All of the children with autism failed both of these conditions. From this it can be inferred that for the children with autism, the assumed difference in arbitrariness between the two conditions had no effect upon performance. Is it that the two conditions were equally arbitrary and therefore difficult or that the two conditions differed according to arbitrariness but that the actual task

[36] This inability was due to all children with autism failing the HLC and MCC conditions.

[37] This condition was referred to as the sound condition (SC) in Experiment One.

was too difficult for the children with autism? Alternatively is some other explanation available for their equally poor performance on the two tasks. This possibility will be addressed later.

Of the three train tasks it was predicted that the condition utilising either high or low tones would be the most arbitrary, followed by the MCC, leaving the VSC as the least arbitrary of the three for both the typically developing children and the children with autism. For the typically developing children this however was not the case. The typically developing children's pattern of responding for all three train tasks when compared to the SA test of false belief was shown to be different. Additionally the degree of difficulty was not significantly different between either the HLC and the false belief test, or between the MCC and the false belief test. The degree of difficulty between the VSC and false belief test however, was shown to be significantly different for the typically developing participants, with the VSC being easier for them to pass.

For the children with autism statistical analyses could not be undertaken to compare patterns of responding between the HLC and the test of false belief or between the MCC and the test of false belief. As mentioned previously statistical analyses were not possible due to all participants with autism failing both of these sound conditions. The pattern of responding of the participants with autism on the VSC and the false belief test were shown to be unrelated. Similar to the typically developing children, the degree of difficulty between the VSC and the false belief test for the children with autism was shown to be statistically significant, with the VSC condition being easier for them to pass. These findings fail to provide support for the second hypothesis of the current study. Because both the typically developing children and children with autism found the VSC to be significantly easier than the test of false belief it is not possible to argue that it was arbitrariness alone that negatively affected the performance of children with autism on the sound condition in Experiment One. This is reinforced when considering that the performance of the typically developing children on the sound condition and test of false belief in Experiment One were shown to be non-significantly different, but that when the level of arbitrariness was reduced in the current experiment the performance of the typically developing participants improved. Arbitrariness alone cannot explain the statistical difference in performance of the children with autism on the sound condition and the test of false belief in Experiment One. Therefore an alternative explanation must be sought.

Although reducing the level of arbitrariness to its (possible) minimum within the train task of the current study resulted in improved performance for the children with autism, this was also the case for the typically developing participants. When considering this point and the findings from Experiment One that indicated that children with autism found the sound condition to be significantly more difficult than the test of false belief, while the typically developing children found the two tasks to be equivalent in difficulty; given that in the current study more children with autism failed the two voice-less conditions than failed the test of false belief, while for the typically developing participants there was no significant difference in difficulty between the voice-less conditions and the test of false belief, it seems likely that something other than arbitrariness had a diminishing effect upon the performance of the children with autism on the two voice-less conditions in the current study and the sound condition in Experiment One. Rather than re-investigating arbitrariness[38] with greater numbers of participants with autism who may pass both the test of false belief and arbitrary conditions, it may be more pressing to determine what it is about the voiceless conditions that make them significantly more difficult for children with autism to pass.

Two important questions need to be posed. What is it about the sound condition in Experiment One that children with autism found to be more difficult than the test of false belief in comparison to the typically developing children for whom there was no significant difference in difficulty? Why did fewer children with autism pass the voice-less conditions (and possibly find these more difficult) than the test of false belief in the current study? One possible explanation lay with memory and more specifically the encoding of information into memory. Perhaps the children with autism, when they encoded the high/low or multiple/continuous tone, they did so just as they were initially presented, that is as either a high/low or multiple/continuous tone and not as both a tone and a tone that was to be linked to an action that was to be taken (i.e. the destination to which a train would travel). This possibility is strengthened by the recognition that the children with autism were successful on the memory questions within both Experiment One and the current study – "What sound did you hear?" It may be however that this was **only** how the tones were encoded, as a sound and not as a sound (signal) that was to determine the action (destination) that an agent (train) would take. Memory abilities and more importantly the encoding and retrieval of information in terms of tests of false belief will be explored further in Experiments Four and Five.

[38] Further investigation could be undertaken whereby the voice-less conditions are altered so as to increase the performance of children with autism whilst retaining identical rates of performance for typically developing participants.

Prior to these investigations, as mentioned towards the end of the discussion of Experiment One, attentional requirements need to be explored with regards to tests of false belief. Recall from the preceding discussion that the distance between false belief stimuli may influence the performance of children with autism on false belief tests, whereby, as a result of added attentional requirements, false belief tests that utilise stimuli that require greater levels of visual scanning, may result in reduced performance by children with autism. The attentional requirements of tests of false belief and the effect that manipulations of such requirements have upon children with autism will now be investigated in Experiment Three.

Chapter Six

Experiment Three: The Effect of Added Attentional Requirements on the Ability of Children with Autism to pass Tests of False Belief

6.1 Introduction

Attention is the process of directing and focusing certain psychological resources, usually by voluntary control, to enhance perception, performance and mental experience (Bernstein, Clarke-Stewart, Roy, Srull & Wickens, 1994; Murray, Lesser & Lawson, in press). Mesulam (1981) takes the definition into a more operational realm by stating that "The effective execution of attention requires a flexible interplay among intense concentration, inhibition of distractibility, and the ability to shift the centre of awareness from one focus to another according to inner needs, past experience, and external reality" (pp.321-322). As Ruff and Rothbart (1996) highlight, this suggests that when considering attention there are three main areas that must be considered and understood – the selection of a target while inhibiting distraction, the engagement and disengagement of attention and the ability to selectively maintain and shift attention as and when necessary. Murray, Lesser and Lawson (in press) have recently added weight to the importance of this consideration advocating a focus on the quality of attention. In particular those authors suggest that what is critical is consideration of the difference between having few interests highly aroused (monotropic tendency) and the tendency of having many interests aroused (polytropic tendency).

Although in relation to tests of false belief little research exists concerning autism and the concept of attention, the field of attention in general and therefore in relation to typically developing individuals is considerable. Considering this, the three main areas just outlined will now be discussed in terms of typical development with reference to research findings within the area of autism.

Conscious human beings are constantly engaged in the process of attending. However, as attentional resources are limited and therefore people cannot attend to everything at once: attention is necessarily selective. Furthermore, attentional selectivity is a crucial component of attending if one is to manage the vast amount of information and stimulation that is presented at any given moment. When selectivity operates, the ability to perform and respond both accurately and appropriately to non-selected input becomes difficult. For example, if during a lecture a student selects to attend to the happenings outside and not to the information being presented then the likelihood of accurately answering a question posed by the lecturer is severely reduced.

The most common evidential indicator that someone is attending is the orientation of the individuals' eyes, which is often used as an investigative technique within infancy research (Ruff & Rothbart, 1996). That is not to say that there is a perfect and absolute link between eye direction and attention. It is often the case that individuals can be looking at one fixture but be attending to something completely extraneous to that fixture, or as Ruff and Rothbart (1996) state, "...we may mistake vacant staring for active visual attention to events" (p.16).

Considerable research has been conducted on participants with autism with regard to visuo-spatial skills (Lockyer & Rutter, 1970; Bartak, Rutter & Cox, 1975; Tymchuk, Simmons & Neafsey, 1977) with the general findings being of superior performance for the participants with autism compared to controls matched on overall IQ. Despite these findings, Shah and Frith (1983) found discrepancies between the performances of participants with autism on the Children's Embedded Figures Test

(CEFT, Witkin, Oltman, Raskin, & Karp, 1971), a test that involves spotting a hidden figure among a larger meaningful drawing, versus performance on a more general visuo-spatial task, the Block Design subtest of the Wechsler Intelligence Scale for Children (WISC, Wechsler, 1974, 1981) which requires the breaking up of line drawings into logical units, so that individual blocks can be used to reconstruct a design from its separate parts. The discrepancy was that participants with autism performed at a level expected for their chronological age for the embedded figures test but below their chronological age for the block design. The findings led Shah and Frith (1983) to hypothesise, that children with autism have good orientation ability but poor visualisation ability. It is possible to further hypothesise that children with autism have the ability to successfully orient to stimuli, but may be lacking in some other component necessary to perform a task after orientation has been achieved. That is even though children with autism may be efficient with regard to orienting to stimuli that is not to say that they are in fact attending appropriately to them. This further hypothesis is supported by the results of research conducted by Leekam, Lopez and Moore (2000) in which pre-school aged children with autism and controls were tested according to the ability to both orient and shift attention between stimuli. In their study participants were seated in-between two boxes and in front of another box. At the beginning of the experiment a toy train appeared out of the centrally placed box. Two conditions were used, an overlap condition in which a target train appeared in the periphery whilst the train in the centrally placed box remained partially in view, and a non-overlap condition in which the train in the centre disappeared into the box just before the peripheral target train appeared. It was predicted that if children with autism have an overall impairment in orientation that they would be slower to respond and/or make more errors in both conditions.

Additionally it was predicted that if the participants with autism were specifically impaired in disengagement or shifting attention when having competing stimuli present that they would perform worse only in the overlap condition. Leekam et al. (2000) found that the children with autism were not slower and in fact were faster than controls at shifting their attention toward the peripheral target in both conditions. Furthermore the children with autism were as fast and as accurate as controls in the overlap condition, that is where attention had to be shifted to a peripheral target whilst a central stimulus overlapped and competed for their attention. These findings suggest that pre-school aged children with autism across a range of IQ levels are not impaired in their ability to orient attention to stimuli even when such orientation requires a disengagement of attention from one object/event to another.

Although the findings reported by Shah and Frith (1983) and Leekam et al. (2000) tend to suggest that individuals with autism do not suffer from deficits with regard to visual orientation, such findings are not fully supported. In a paper by Wainwright and Bryson (1996) visual-spatial orienting abilities of high functioning adults with autism were investigated. In particular, lateral differences in spatial attention for this population were examined. Employing a traditional visual orienting task, participants were required to detect simple central or lateralized stimuli for which typically developing people normally respond more quickly to left-handed stimuli, suggesting that the right hemisphere is usually dominant for the processes of orienting to and detecting a stimulus in visual space. Within the research conducted by Wainwright and Bryson (1996) the participants with autism responded differently from typically developing controls in that they showed a right-hand advantage when detecting either left or right lateralized stimuli. Furthermore the responses of the participants with autism to central stimuli were faster than their responses to lateralized stimuli. Wainwright and Bryson (1996) relate the differential responses of the participants with autism to previously reported findings of autistic individuals' over focused attention and of difficulties that such individuals have with disengaging and/or shifting attention in space. The concept of over focused attention in individuals with autism has been metaphorically referred to as attentional spotlight. Rincover and Ducharme (1987) argue that for individuals with autism the beam of attention or the attentional spotlight is smaller and therefore more restricted than that of typically developing controls. Rincover and Ducharme (1987) refer to this attentional restriction as "tunnel vision" and argue that such restrictive vision has the effect of reducing the attentional field, therefore necessarily restricting what can be attended to. Rincover and Ducharme (1987) found that as the distance between particular stimulus features was increased, that the participants with autism would selectively respond to a smaller part of the stimulus array. Given these findings it is possible to hypothesise that children with autism will respond more favourably to stimuli when presented centrally and also when there is no attentional shift required to capture all of the stimulus features necessary to respond correctly.

As well as orienting to an object, what is also necessary in order to attend satisfactorily is the inhibition of distraction. As Ruff and Rothbart (1996) point out, there are always multiple objects and events to respond to at any point in time. Highly focused attention to one object or event necessarily requires some degree of blocking of responsiveness to others. As Ruff and Rothbart (1996) state, if this blocking does not take place, events that are not immediately relevant may interfere with effective action. Burack (1994) investigated selective attention deficits in persons with autism.

Within this research the ability to focus attention while minimizing distraction is regarded to as 'filtering'. As put by Burack (1994), "...filtering is the ability to ignore irrelevant and potentially distracting stimuli to effectively process other, more relevant information" (p.536). When considering group differences, Burack (1994) found that participants with autism suffered from a filtering deficit whereby reaction times to target stimuli improved considerably in the absence of distracters.

In order to engage stimuli it is first necessary to initiate attention. As Ruff and Rothbart (1996) point out, one of the major ways that attention is initiated is through an orienting response. Typically an orienting response occurs when a specific event or situation 'captures' our attention. However there is necessarily a distinction between orienting and engaging. Engaging seems to involve a somewhat greater degree of interest, whereby "interesting or important events are subject to more prolonged scrutiny and consideration" (Ruff & Rothbart, 1996, p.98). Other researchers have referred to prolonged scrutiny as 'sustained attention'. Burack, Enns, Stauder, Mottron and Randolph (1997) suggest that sustained attention involves the allocation of both sensory and cognitive resources to a particular event for extended periods of time as exclusively as possible. When considering engagement or sustained attention in this light, interesting associations can be made with autism and the common occurrence of perseverative behaviours observed in this population. As perseveration is characteristic of many individuals with autism it might be suggested that they have a heightened ability to sustain focus. However as Burack et al. (1997) highlight, such maintenance of focus may only be endured for tasks that involve self-selection rather than those tasks imposed by others. Orientation and attention may not necessarily be linked in any systematic way. So, while individuals with autism may possess the capacity to sustain focus, this does not necessarily mean that this capacity will be operationalised.

Recent research by Leekam, Lopez and Moore (2000) investigated the ability of children with autism to orient and engage attention both with and without the need for attentional disengagement. The authors discovered that children with autism appeared to have an intact ability to orient and engage attention to stimuli even when orientation and engagement required initial disengagement from a competing stimulus. Despite these findings other researchers have noted difficulty with the disengagement of attention for children with autism. Hughes and Russell (1993) found while researching a test for strategic deception that participants with autism failed such deception tests as a result of difficulty with mentally disengaging from a focal object. Additionally Hughes and Russell (1993) discovered that participants with autism had difficulty with disengaging attention from salient and desired objects. The latter finding adds weight to the assertion that children with autism may not have difficulty with engagement when motivation is high or indeed if the task was one of self-selection, but that the ability to truly attend in a general sense may be somewhat impeded.

Even though the concepts of engagement/disengagement and attentional shifting were separated within the account provided in the introduction, in real terms this is clearly artificial. Once we have oriented and engaged, in order to shift attention from one arena to another it is necessary to firstly disengage attention. Typically developing infants within the first two to three months of life often find it difficult to disengage attention from salient objects and events. However such disengagement seems to occur much more freely by four to five months (Ruff & Rothbart, 1996). Even though it may be difficult to separate the concepts of disengagement of attention and attentional shifting it is important to do so. Indicators that would inform us that an individual has disengaged from one point and re-engaged to another are unspecified. Once again the only physical detector we have is that of eye orientation. We can detect disengagement by observing what an individual is looking at however this does not necessarily indicate that attention has been shifted. It is possible for an individual to physically disengage themselves from stimuli but to still be focusing their attention on that stimulus. In a paper by Courchesne et al. (1994) which investigated impairment in the ability to shift attention in both patients with autism and cerebellar patients, it was found that while both groups of individuals performed similarly to the typically developing children in an attentional focusing task (which reinforces other research [Shah & Frith, 1983; Leekam & Moore, 2001]), they were significantly impaired in their ability to accurately and rapidly respond in an attentional shift task. It is the accuracy component that allows us to predict actual attentional shift. If an individual is attending to stimuli, the likelihood of responding accurately to new stimuli is severely retarded.

In Experiment One, participants were required to predict the destination of a train based on signal information provided to them. Two of the conditions within that experiment (from this point on to be referred to as the arbitrariness experiment) were identical with the exception of where the actual signals were placed. In one condition the light signals were placed in the middle of a train track (Central Light Condition) while in the other condition the light signals were placed at the respective ends of the track (Landing Pad Light Condition). The arbitrariness experiment involved a plane that would land at either a blue or a yellow landing pad, located at either end of a train track. A light would then signal where the train should travel to collect cargo. In order to ensure that this task was analogous to a false belief transfer this signal would indicate the opposite location to the one where the plane landed.

Statistical analysis confirmed that for the children with autism the condition in which the lights were placed in the middle of the track was easier than the other light signal condition and the Sally-Anne test of false belief. This finding was in direct contrast to the typically developing children, for whom there was no difference between performances on the two tasks. As highlighted in the discussion of Experiment One that the central light condition was significantly easier for the children with autism, therefore may inform us as to what the participants with autism found difficult with both the landing pad light condition and more importantly the Sally-Anne test of false belief. It was possible to extend the investigation detailed within the arbitrariness experiment to include the Sally-Anne test, as for the children with autism, the Sally-Anne test and the landing pad light condition were positively correlated and of equal difficulty. The most observable difference between the two light signal conditions within the arbitrariness experiment was that of the distance between the two sets of signals from the other experimental stimuli (the plane). For this reason the current experiment aims to investigate false belief performance when the distance between target stimuli are altered.

When considering attention and what psychological resources are actually required in order to attend, the distance between attentional stimuli becomes a real and possibly influential variable. In order to attend successfully it is necessary to select and orient to stimuli while inhibiting distraction, to engage and disengage from stimuli and finally, successfully and voluntarily to shift attention from one attentional locus to another.

On the basis of the findings of the arbitrariness experiment it was hypothesised that the altered distance between the signal stimuli and the plane for the two train conditions affected the performance of the children with autism. Moreover it was further hypothesised that when the distance between the signal and the plane was greater, poorer performance would result. When considering the necessary components of attention these hypotheses become increasingly valid. In the central light condition there is less of an attentional shift required by the participants in comparison to the landing pad light condition whereby a shift from one end of the train track to the other was necessary. Another observation from the arbitrariness experiment concerned distracting stimuli. Within the central light condition the only other stimulus present was the train track, whereas in the landing pad light condition the participants could also clearly see, and therefore have to filter out, an empty plane landing pad as well as the train track. Also given that the stimulus requirement of the central light condition was centrally located this could have had a positive impact upon the performance of the children with autism. This suggestion is in line with the research findings reported by Wainwright and Bryson (1996) whereby centrally located stimuli were attended to more successfully than stimuli presented in the lateral fields. Also within the arbitrariness experiment, after each participant had witnessed the signal, attention was necessarily redirected to a central point (that is where the experimenter was sitting) to enable the experimental questions to be delivered. This raises the possibility that the added attentional shift required in the landing pad signal condition adversely affected false belief performance. That is to say that within the central light condition an attentional shift from the central signal to the delivery of the experimental questions was not necessary as the participants were already attending to a centrally fixated point.

The current experiment utilises three differing types of Sally-Anne scenarios so as to enable distance, stimulus location and distraction to be examined more closely. It is hypothesised that false belief performance will improve as a result of the stimuli being at closer intervals and furthermore as a result of the experimental stimuli being centrally located. It is additionally hypothesised that as distance increases and therefore as stimuli become more laterally placed that the false belief performance of the children with autism but not the typical children will deteriorate.

6.2 Method

6.2.1 Participants. Fourteen children with autism (13 boys and 1 girl) and 14 typically developing children (7 boys and 7 girls) participated in the study. The children with autism all had a defining diagnosis of autism spectrum disorder as reported by Statements of Special Educational Needs within school records. All diagnoses were validated by observation conducted by the author. The children with autism were recruited from Special Needs schools within London and the surrounding areas. The typically developing children attended a mainstream Primary School in Essex. For all participants written consent was obtained from a parent or guardian. Letters of consent, detailing both the nature and expected duration of the study were written by the author and distributed by the school. An example of a consent letter is provided in Appendix 1.

All participants were assessed for inclusion using the Test for the Reception Of Grammar - TROG (Bishop, 1982). Only those children with a minimum Verbal Mental Age (VMA) of 48 months were included in the study. The mean VMA of the children with autism was 67.7 months (n=14, SD=19.1). The mean VMA of the typically developing participants was 57.0 months (n=14, SD=8.5). Details of all of the participants' VMA and Chronological Age (CA) are outlined in Table 6.1. Analysis of these data using an Independent t-test revealed a significant difference for CA[39] ($t = 8.33$, $df = 26$, $p<.001$), but not for VMA ($t = 1.92$, $df = 26$, $p = .07$).

[39] Equality of Variance was not met.

Table 6.1

Chronological and Verbal Mental Ages of Participants in Experiment Three

	With Autism (N=14)	Typically Developing (N=14)
Chronological Age**** (months)		
Mean	130.8	63.2
SD	30.1	3.9
Range	82-173	58-69
Verbal Mental Age (months)		
Mean	67.7	57.0
SD	19.1	8.5
Range	51-120	51-84

* p<.05 ** p<.01 *** p<.005 **** p<.001 (Independent t-test)

6.2.2 Materials. The stimuli utilised within this experiment consisted of three different types of Sally-Anne like materials. The three different versions can be categorised according to the characters portrayed within them. In Set 1, 'Sally-Anne' (SA), there were two small dolls, Sally and Anne, a box, a cup and a marble. In Set 2, 'Winnie-Tigger' (WT), there were two well-known figurine-type dolls, Winnie the Pooh and Tigger, a plastic pencil case, a metal case and a pencil sharpener. Set 3, 'Blackbeard-Redbeard' (BR), composed of two small plastic figurines of wizards, named by the author Blackbeard and Redbeard, a pouch, a cylinder and a plastic wand. The three different groups of characters were chosen to provide for variation of preferences. The three character groups and associated stimuli are illustrated in Figures 6.1-6.3.

Figure 6.1. Sally-Anne task materials.

Figure 6.2. Winnie-Tigger task materials.

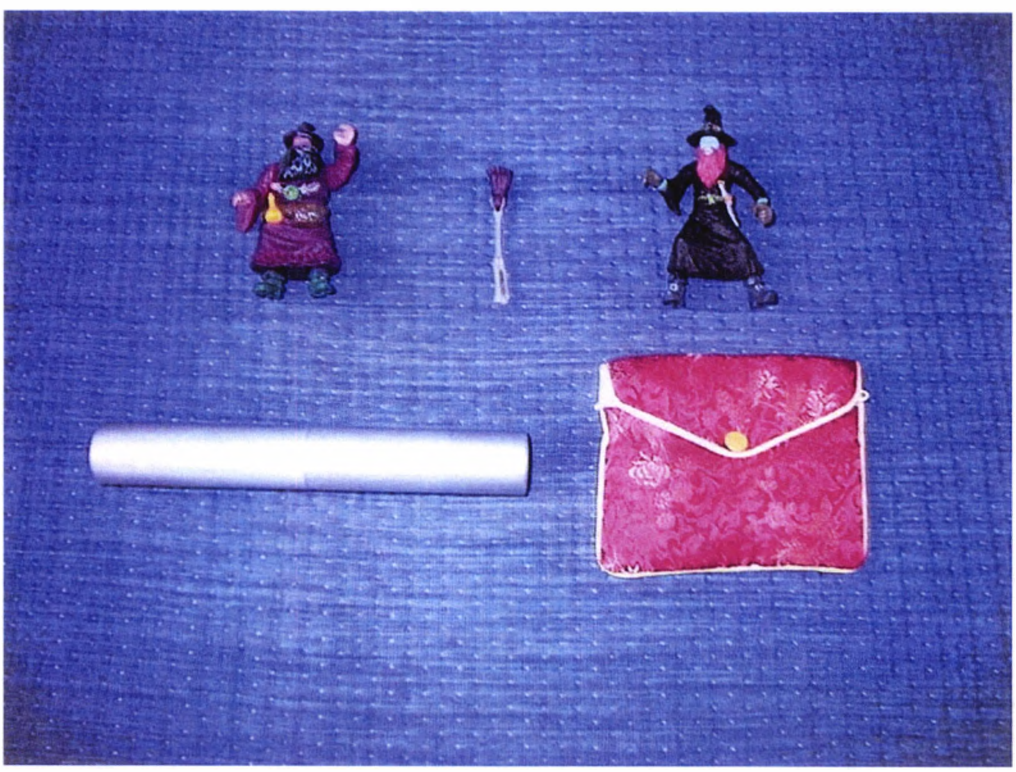

Figure 6.3. Blackbeard-Redbeard task materials.

6.2.3 Design and procedure. Each child from both groups undertook two trials of the SA task. Each participant also undertook two trials for each of three separate conditions for both the WT scenario and the BR scenario. In total each participant participated in 14 experimental trials. Participants were randomly allocated to participant status and the order of presentation was determined using Latin Squares (see Appendix 6).

Sally-Anne task. The SA experimental procedure used was consistent with the protocol developed by Baron-Cohen, Leslie and Frith (1985). The implementation was identical the apparatus was varied. Instead of using a basket this procedure utilised a cup. The distance between the box and cup remained at 45cm, consistent with the arbitrariness experiment discussed in Chapter Four.

As in the arbitrariness experiment each child was initially introduced to, and subsequently asked to identify by name the two characters – Sally and Anne. This naming question enabled correct character identification by the participants. After a correct identification was made the experimental scenario was delivered. The delivery of the SA scenario was consistent with the arbitrariness experiment. The instructions are outlined in Figure 6.4.

As mentioned previously each child undertook two trials of the SA task. Two trials were delivered so that the initial location of the marble could be counterbalanced, therefore ruling out individual preferences for one location over another. After the scenario was acted out the belief question, “Where will Sally look for her marble?” was administered. The reality question, “Where is the marble?” and the memory question, “Where did Sally leave her marble?” were then asked in counterbalanced order for each child. Whether or not the reality or the memory question was asked first was determined by counterbalancing across children.

This is Sally with the red hair. This is Anne with the hat on.

[At this point the naming question was asked.]

Sally has a marble. Sally puts her marble in the box/cup and leaves the room.

[Experimenter removes Sally and keeps her out of view.]

Anne moves the marble from the box/cup to the cup/box.

Sally comes back into the room and wants to play with her marble. Sally wasn’t there when Anne moved her marble.

[The belief question was asked now, followed by the reality and memory questions in counterbalanced order.]

Figure 6.4. Sally-Anne scenario instructions.

Winnie-Tigger and Blackbeard-Redbeard tasks. Both the WT task and the BR task were divided into three separate conditions. These conditions were labelled Near, Middle and Far. All conditions were identical with respect to the scenario information provided to the children. The scenario information was the same as that provided within the SA scenario with the only differences obviously being different characters and altered initial and final locations of the object in question. The characters within the WT scenario were Winnie the Pooh and Tigger. The object to take the place of the marble was a sharpener, while the initial and final locations of the sharpener were either a plastic or a metal pencil case. The WT scenario information is provided in Figure 6.5. Similarly the characters within the BR scenario were two plastic wizard figurines – Blackbeard and Redbeard. In this scenario the object to replace the marble was a wand, while the respective locations were either a small metal cylinder or a material pouch. The BR scenario description is detailed in Figure 6.6.

The distance between the initial and final location of the sharpener or the wand varied across the three conditions. In the near condition the plastic and metal pencil cases and the cylinder and pouch were placed directly next to each other. These objects in the middle condition were placed 45 cm apart, equal to the distance between the box and the cup in the SA task. The distance between the objects within the far condition was 120 cm.

Each child undertook two trials of each of the conditions for both the WT and BR scenarios. Each child participated in six trials of the WT scenario (two near, two middle and two far) and six trials of the BR scenario (two near, two middle and two far). Each child undertook two trials of each condition so that the initial location (either the plastic or metal pencil case and either the cylinder or the pouch) of the object in question (either the sharpener or the wand) could be counterbalanced. After the scenario was acted out the belief question, “Where will x look for his y?” was administered. At this point the reality question, “Where is the y?” and the memory question, “Where did x leave his y?” were delivered in counterbalanced order. These questions were also counterbalanced across children.

This is Winnie the Pooh. This is Tigger.

[At this point the naming question was asked.]

Winnie the Pooh has a sharpener. Winnie the Pooh puts his sharpener in the plastic/metal pencil case and leaves the room.

[Experimenter removes Winnie the Pooh and keeps him out of view.]

Tigger moves the sharpener from the plastic/metal pencil case to the metal/plastic pencil case.

Winnie the Pooh comes back into the room and wants his sharpener. Winnie the Pooh wasn't there when Tigger moved his sharpener.

[The belief question was asked now, followed by the reality and memory questions in counterbalanced order.]

Figure 6.5. Winnie-Tigger scenario instructions.

This is Blackbeard and this is Redbeard.

[At this point the naming question was asked.]

Blackbeard has a wand. He puts his wand in the pouch/cylinder and leaves the room.

[Experimenter removes Blackbeard and keeps him out of view.]

Redbeard moves the wand from the pouch/cylinder to the cylinder/pouch.

Blackbeard comes back into the room and needs his wand. Blackbeard was not there when Redbeard moved the wand.

[The belief question was asked now, followed by the reality and memory questions in counterbalanced order.]

Figure 6.6. Blackbeard-Redbeard scenario instructions.

6.3 Results

For all conditions, participants were included only if they successfully answered both the reality and memory questions. Within this experiment all participants tested correctly answered both of these questions. Table 6.2 summarises the numbers of typically developing children and children with autism who both passed and failed the false belief questions for all conditions. Chi-squared statistics indicate the degree of association between the two measures in each contingency table. Inspection of the between-group comparisons show similar patterns of responding for both groups of children across all tasks, where $\chi^2 = 2.29$, d.f. = 1, $p>.05$. Interestingly the proportion of typically developing passers for all conditions was equal to the proportion of children with autism who failed each condition and vice versa. Of the typically developing children, 64.3% passed all conditions while 35.7% failed all conditions. Of the participants with autism 35.7% passed all conditions, while 64.3% failed. The proportion of SA passers with autism in this study (35.7%) is similar to the proportion of passers with autism in Experiment One (33%).

Table 6.2

Performance of Participants in each Condition of Experiment Three

Group	SA		W-T Near		W-T Middle		W-T Far		B-R Near		B-R Middle		B-R Far	
	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail
Typically Developing	9	5	9	5	9	5	9	5	9	5	9	5	9	5
With Autism	5	9	5	9	5	9	5	9	5	9	5	9	5	9
Pearson Chi-Square	χ^2=2.29		χ^2=2.29		χ^2=2.29		χ^2=2.29		χ^2=2.29		χ^2=2.29		χ^2=2.29	

* $p<.05$ ** $p<.01$ *** $p<.005$ **** $p<.001$

Another interesting finding was that related to within-group comparisons. For both the typically developing children and the children with autism performance on each test was identical. This is validated and confirmed in Tables 6.3 and 6.4. Phi statistics indicate the degree of association between the two measures in each contingency table; McNemar statistics indicate the significance of the difference in difficulty between the conditions. Upon inspection of these tables it can be seen that all six-distance conditions are perfectly correlated with the SA task for both groups of children indicating identical patterns of performance between the conditions for both groups of participants. Nine of the 14 typically developing participants passed all conditions, while 5 failed. Conversely 5 of the participants with autism passed all conditions, while 9 failed. McNemar tests indicate that for both groups of participants each distance condition was of equal difficulty to the Sally-Anne test of false belief.

Statistical analysis was not necessary to examine the relationship between individual distance conditions for the typically developing participants and children with autism, as differences were so slight it would be meaningless. For the typically developing children, all seven false belief conditions, including the SA task, were of equal difficulty and in addition were perfectly correlated with each other. This was also the case for the children with autism. If a participant with autism passed one task they passed all seven tasks, if they failed one task they failed all seven tasks. To further clarify the results, of the 14 participants with autism, 5 passed each condition and 9 failed. Of the 14 typically developing participants, 9 passed each condition and 5 failed. Clearly distance had no effect upon the false belief performance of either the participants with autism or the typically developing participants. Additionally the stimuli had no bearing on the results.

Table 6.3

Relationship Between Performance on Sally-Anne and Distance Conditions of Experiment Three

Group	SA	W-T Near		W-T Middle		W-T Far		B-R Near		B-R Middle		B-R Far	
		Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail
Typically Developing	Pass	9	0	9	0	9	0	9	0	9	0	9	0
	Fail	0	5	0	5	0	5	0	5	0	5	0	5
With Autism	Pass	5	0	5	0	5	0	5	0	5	0	5	0
	Fail	0	9	0	9	0	9	0	9	0	9	0	9

Table 6.4

Phi and McNemar statistics for Table 6.3

	Typically Developing	With Autism
SA vs. W-T Near	Φ = 1.00**** McNemar	Φ = 1.00**** McNemar
SA vs. W-T Middle	Φ = 1.00**** McNemar	Φ = 1.00**** McNemar
SA vs. W-T Far	Φ = 1.00**** McNemar	Φ = 1.00**** McNemar
SA vs. B-R Near	Φ = 1.00**** McNemar	Φ = 1.00**** McNemar
SA vs. B-R Middle	Φ = 1.00**** McNemar	Φ = 1.00**** McNemar
SA vs. B-R Far	Φ = 1.00**** McNemar	Φ = 1.00**** McNemar

* p<.05 ** p<.01 *** p<.005 **** p<.001

6.4 Discussion

This experiment was designed in order to examine the effect that distance and visual-spatial orienting between centrally and laterally located stimuli has upon the performance of children with autism on tests of false belief. This study was inspired by results obtained in Experiment One whereby conditions that involved more centrally located stimuli were significantly easier for children with autism to pass.

Participants were given a standard SA false belief test and two analogous false belief tests, each comprising three separate conditions. The analogous false belief tests were divided into three conditions with distance and stimulus location being altered. In one condition labelled the near condition, stimuli were presented immediately next to each other in a centrally fixed position. In another condition, the middle condition, experimental stimuli were presented at an identical distance and location to the standard SA stimuli, 45 cm apart with no stimuli being centrally located. In the final condition, the far condition, the experimental stimuli were presented in lateral positions 120 cm apart.

Despite previous findings that report superior performance by individuals with autism when experimental stimuli is presented centrally (Wainwright & Bryson, 1996); findings that report that children with autism have difficulty disengaging and shifting attention (Hughes & Russell, 1993; Courchesne et al., 1994) as well as inhibiting distractors (Burack, 1994); and that when the distance between experimental stimuli is increased the performance of participants with autism suffers (Rincover & Ducharme, 1987), the research reported here failed to show any differences in performance by children with autism when these variables were manipulated in a series of false belief tests.

In the near conditions of the current experiment, stimuli were presented centrally and immediately next to each other. One would expect that if individuals with autism respond favourably when stimuli are presented centrally, that this condition would have shown improved performance in children with autism. However this was not the case. Similarly within the far conditions, given the added need to disengage and shift attention as well as the fact that the stimuli were presented in lateral positions 120 cm apart from each other, it was conceivable that poorer performance would have resulted for the children with autism. However this was not the case. Rather what was discovered was that performance was not affected by the alterations made to the stimuli distance and location, and that within-group performance was identical for both the typically developing children and the children with autism across all conditions.

One possible explanation that may account for why the near condition did not result in improved performance for the children with autism is a possible counter effect of the stimulus being presented simultaneously in a central position. That is, perhaps the possible improvement by the stimuli being centrally located was overruled by the added need to selectively engage the appropriate stimuli and inhibit that stimulus that was distracting. However this raises the question: "What could explain the identical performance of the two nearer conditions to the far condition?" Within the far condition not only was the experimental stimulus laterally placed but a greater degree of attentional disengaging and shifting was required. Also once the experimental scenario had been enacted, attention was once again re-directed from a lateral location to a central location so as to enable the delivery of the experimental questions. There are no immediate explanations to account for this particular finding. However what becomes increasingly interesting is the possibility that it was something other than distance variables or visual-spatial orienting difficulties affecting the performance of the children with autism in Experiment One.

The final possibility discussed within Experiment One for this differential performance was described briefly in terms of 'cognitive resonance'. This notion centred on the usefulness of the information that is presented to children with autism in solving false belief dilemmas. More specifically what is suggested is that information presented most recently may be more useful in terms of the workings of memory in understanding false belief. Experiments Four and Five further investigate this possibility. Experiments Four and Five explore the possible effects that cueing has upon the performance of children with autism on tests of false belief. In Experiment One the central condition was easier to pass for children with autism than the standard false belief test. In the central condition the last thing that the children were exposed to was the signal indicating the location to which a train should travel. In addition to this visual signal, the experimenter provided auditory input that even though the plane landed at 'x', the signal showed 'y'. This visual and/or auditory information may have successfully cued the children with autism to respond correctly, indicating that the train would travel to 'y'. Even though the landing pad condition in Experiment One also provided identical information, what was different was the last thing that the participants witnessed was an empty landing pad. This could have possibly resulted in confusion, as it is reasonable to assume that the train would travel to where the plane had landed, as it did in all of the initial testing trials?

Chapter Seven

The Effect of Memory Cues on False Belief Performance of Children with Autism

7.1 General Introduction

Despite the vast amount of false belief research conducted with children with autism, very little of this research has adequately explored the workings of memory in relation to these tasks. Since the seminal theory of mind experiment was conducted by Baron Cohen, Leslie and Frith (1985), memory questions have consistently been included, however such questions were posed solely to ensure that the participants were aware of the location of the object (in Baron-Cohen et al.'s (1985) research this object was a marble) prior to it being relocated and also to the whereabouts of the object once it had been moved. These questions were labelled the memory and reality questions respectively. In order for the participants to be included within the research both questions had to be answered correctly. This was and continued to be the case both for participants with autism and typically developing participants.

That all children who have been included within false belief research have necessarily answered both the reality and memory questions correctly is interesting. This essentially means that all children included within this research have possessed the required information so as to enable them to answer the false belief question successfully, yet many children with autism of varying ages and typically developing children aged four or younger still fail. This brings us back to the recurring question of this thesis - whether or not false belief failure is due to a lack of theory of mind as suggested by Baron-Cohen et al. (1985) or in fact due to some other unspecified factor. Additionally it needs to be added that it is possible that the reason why children with autism fail the false belief question may be different to that leading to failure in typically developing children (and children with other psychopathologies). The current research is conducted so as to explore possible factors leading to failure.

Moreover the current research hypothesises that the typically developing children who fail the false belief task do lack a theory of mind and as a result, despite possessing the required information so as to pass the false belief test continue to fail. It is additionally hypothesised that the failure of children with autism is in fact due to an incomplete operation within memory and more specifically due to a particular storage and retrieval deficiency. It is further hypothesised that if this is the case that when given cues to facilitate recall that the participants with autism will show an improvement in false belief performance while the typically developing children will not.

Prior to continuing with any discussion concerning individuals with autism and their memory abilities and/or deficits it is first necessary to provide an overview of the history and concepts of memory. While even the earliest societies placed considerable value upon memory ability and ways of improving memory performance the first experimental study of memory was not published until 1885 when Hermann Ebbinghaus published *Memory: A Contribution to Experimental Psychology*. This paper while also being the first of its kind shifted the interest of memory from a practical and often philosophical nature to a more experimental approach (Searleman & Herrmann, 1994). In this sense Ebbinghaus may well be considered the father of modern memory research.

Baddeley (1990) provides a succinct definition of memory when he states:

> Human memory is a system for storing and retrieving information, information that is, of course, acquired through our senses. Whether we see something, hear it

> or smell it will obviously influence what we recall, since in one sense our memories are records of percepts (p.13).

This definition while being succinct is limited and fails to include reference to the encoding of information[40]. Baddeley (1990) highlights two of the three generally understood processes of memory, storage and retrieval, however omits reference to the encoding process. When including encoding within this definition one is introduced to the three basic processes of memory – encoding, storage and retrieval[41]. Encoding involves introducing information into memory, transforming information into a form that individuals can retain for possible future retrieval. Even though storage has been at the centre of much debate it is reasonably straightforward to define. Storage refers to how we hold information so that it can be accessed in the future to aid our learning and everyday functioning in a world that requires almost constant use of skills and information that is stored within our memory. Retrieval is the process of 'getting back' information that we need at any one time in order to think, act and respond in our everyday lives. Baddeley (1990) cleverly adopts an analogy of a library when describing the three processes of memory:

> One way in which memory and a library are closely similar is in the extent to which both will only work efficiently if information is stored in a structured systematic way, with retrieval of information depending on this initial "cataloguing" or encoding (p.263).

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[40] This is not to suggest that Baddeley (1990) disputes the existence of encoding nor does it suggest that he does not cover the concept of encoding later in this text. Rather the concept of encoding is not included within this particular definition of memory provided by the author.

[41] These terms are sometimes referred to as registration, retention and remembering respectively (Searleman & Herrmann, 1994).

Memory, due to its very nature and the fact that this is how we encode, store and retrieve all information, is often regarded as one of the most important concepts in learning, as if information is not remembered learning cannot take place. Perhaps as a result of the importance of memory and its significant role within learning and consequently psychology, many theories have been postulated with regard to not only how it works but also how we understand it. Along with this abundance of theorising has been considerable debate over whether there is a unitary memory system or rather, multiple memory systems.

Prior to the late 1950s memory was largely considered to be composed of a single system, however from this time onwards some researchers began considering the possibility that memory was in fact made up of multiple systems or stages. Despite these differences in theoretical approach, three of the most common models of memory to date are: the Atkinson-Shiffrin (1968) model of memory; the levels of processing approach put forward by Craik and Lockhart (1972); and the working memory model as proposed by Baddeley and Hitch (1974). Perhaps the most influential of these, the Atkinson & Shiffrin (1968) model (often referred to as the modal model), proposes three kinds of memory store: sensory registers, short-term store and long-term store[42]. In terms of this model it is assumed that the sensory registers initially receive information in a modality-specific manner (i.e. depending on whether the information is visual or auditory). These stores in turn hold pieces of information exactly as they are received for very short (1-2 seconds) periods of time. From here some information is attended to and selected for further processing by the short-term store. Once in the short-term store information is again actively processed

[42] The terms sensory store, short-term store and long-term store are used synonymously with sensory memory, short-term memory (STM) and long-term memory (LTM) respectively.

and possibly transferred into the long-term store (Cohen, Eysenck & Le Voi, 1986). This model assumed that the short-term store had multiple functions – to hold information for short durations but also as pointed out by Searleman & Herrmann (1994) to act as a workplace for processing information, controlling its flow and making decisions.

Baddeley & Hitch (1974) challenged the idea that the short-term store was a single system. Rather these authors while accepting that the short-term store was a place where considerable processing took place, proposed that the short-term store was composed of multiple and separate components. Known as the working memory model, this new theory proposed that STM was composed of three separate components – the central executive, the visuo-spatial sketchpad and the phonological loop. According to Baddeley (1990) the central executive serves the role as a controlling attentional system that supervises and co-ordinates two main subsidiary slave systems, that of the visuo-spatial sketchpad and the phonological loop. These slave systems in turn are reported as being responsible for setting up and manipulating visual images and the manipulation of speech-based information respectively.

Craik and Lockhart (1972) put forward their levels of processing approach to memory in a reaction against what they felt was an over-emphasis by theoreticians on the structure of memory. It could be said that Craik and Lockhart (1972) were more interested in how information was processed within memory rather than where it was processed. The levels of processing approach suggests that the most important determinant of memory is not where the information is processed but rather how extensively information is encoded when it is first encountered (Bernstein, Clarke-

Stewart, Roy, Srull & Wickens, 1994). The levels of processing approach does not argue against the existence of different types of memory systems (such as short-term and long-term memory), but does, unlike the modal model, assume that there is a single memory store (Searleman & Herrmann, 1984).

It becomes apparent from the definition of memory provided at the outset of this chapter and the brief introduction to three dominant theories of memory that what theories or models of memory have in common is an understanding that in order to be utilised within memory, information must be encoded, stored and retrieved. Accordingly, rather than viewing memory as comprising separate areas or components, this discussion will now treat memory as a unitary system, a system that in order to be effective must successfully encode, store and retrieve information. Furthermore, like Craik and Lockhart (1972), instead of postulating any particular set of structural components of memory, it is considered for the purpose of this discussion more important to focus more on the 'how' of memory, rather than the 'where' and perhaps even more important to concentrate on the different types of information that individuals are presented with for processing.

Highlighted by Bernstein et al. (1994) there is no absolute consensus on how many types of memory there might be, however there appears to be some agreement that there are three basic types – episodic, semantic and procedural. These three types of memory are named according to the type of information that they represent. Tulving (1985, 1987) was the first to distinguish between episodic memory, semantic memory and procedural memory and the associated types of information. Episodic memory is thought to be that memory that is involved in remembering past events and perhaps more importantly autobiographical events. Semantic memory on the other hand refers to generic information about the world in which we live. Considering that episodic memory is defined as remembering past events, semantic memory is therefore not tied to specific experiences. Rather, as noted by Searleman & Herrmann (1984), semantic memory is extracted from experience by noting the commonalities of many different experiences, or perhaps generalised experience. Procedural memory is considered to be the memory of procedures and skills and typically involves learning how to perform a task or acquire a new skill. Later in his career Tulving further developed his theory of memory. Maintaining that there are in fact three types of memory, Tulving (1985, 1995) associated each form of memory (episodic, semantic and procedural) with different states of conscious experience. Parkin (1997) observed that because Tulving considered procedural memory to be divorced from any conscious accompaniment he termed procedural memory as anoetic. Tulving (1985, 1995) described semantic memory as noetic so as to reflect a basic feeling of assuredness and episodic memory as autonoetic or in more simple terms as self-knowing.

When reviewing the definitions of episodic and semantic memory it becomes evident that both forms of memory involve the knowledge of facts. As a result some researchers (Cohen & Squire, 1980; Squire, 1987) prefer to consider episodic and semantic memory together as one form of memory – declarative memory. Declarative memory is broadly defined by Parkin (1997) as consisting of all consciously accessible knowledge. Similarly due to the restrictive nature of the term procedural memory, the term nondeclarative has often been substituted. So from this discussion it would now appear that some theorists think of memory as comprising two systems.

What these types of memory are called often changes but ostensibly refers to the same thing. For example Schacter (1987) refers to explicit and implicit memory, Cohen & Squire (1980) to declarative and procedural memory, Zola-Morgan & Squire (1990) to declarative and nondeclarative memory and Hill and Kodituwakku (2002) to representational and habit memory. The relationship between these components of memory can be seen in diagrammatical form in Figure 7.1. At its grossest memory can be divided into two categories – declarative and procedural, which can be respectively characterised as accessible or not accessible to consciousness (Parkin, 1997).

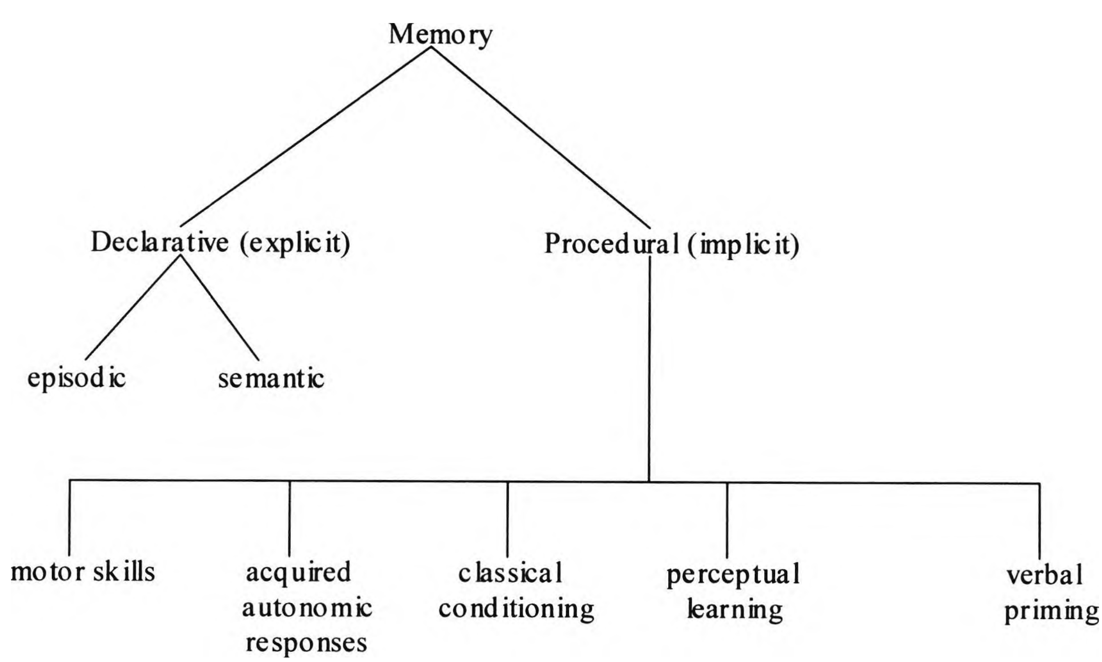

Figure 7.1. A proposed taxonomy of the memory system (adapted from Parkin, 1997).

Returning to the encoding, storage and retrieval of information, it is necessary to relate these practices to false belief tasks: the concern of this collection of studies. In general, in order to carry out a mental task or indeed for the solving of a problem, information concerning the problem must have been effectively stored within memory. Additionally the stored information must be able to be retrieved from memory when necessary and used so as to solve the problem. These two skills are quite different. It is possible for instance to have information available to us but not necessarily be able to utilise this information in order to adequately solve problems. Considering false belief tasks in particular, it is widely accepted that all participants within false belief research must successfully answer both memory and reality questions in order to be included. Because of this it can be assumed that these children are clearly storing the appropriate information provided within the false belief scenarios. However there are several possible explanations that account for why these same participants do not then utilise this information in order to solve the false belief dilemma. Obviously one possible explanation is that the participants do not possess a theory of mind. Another possible explanation though is that due to an unspecified factor the stored information is not being retrieved and used in a way that leads to the solving of the problem. This may even be more relevant for the participants with autism for as Wing (1976) points out, children diagnosed with classic autism are typically able to store items within memory for prolonged periods of time but only in the exact form in which they were first experienced. Moreover Wing (1976) continues by stating that unlike typically developing children and indeed adults, the items selected for storage by children with autism are stored without being interpreted or changed. This latter point would explain why children with autism successfully pass the memory and reality questions of false belief tests but still fail the false belief question. It is possible that although participants with autism are aware of where the marble was before being moved and also of where the marble was moved to, that this information, because it was stored solely in this manner and not in terms of where an individual may look for the marble in the future, is not being used in order to solve the false belief question. It could be that there is a failure within the memory system and in particular a specific failure with the retrieval of information.

Related to the proposal of a retrieval difficulty and given that children with autism tend to store information without interpreting or changing it in any way is the concept known as encoding specificity (Thomson and Tulving, 1970; Tulving and Osler, 1968; Tulving and Pearlstone, 1966). This is an important point especially when considering the previous statement, for if when information is stored by children with autism it is only stored in a particular manner it is unlikely to be utilised appropriately unless it is retrieved in a similar fashion to the way in which it was initially encoded. Considering that the false belief question by its very nature is distinct from both the reality and memory questions it may not be tapping the appropriate information for the participants with autism, but rather accessing information in the manner in which it was stored, that is as either where a object was prior to being relocated or of the new location of an object once being moved.

Another possible explanation for the failure of children with autism on false belief tasks stems from neurobiological research. Declarative or Representational memory is thought to be related to intact limbic system, an area noted to be abnormal in children with autism while it is thought that Procedural or Habit memory is mediated by the striatum and neocortex, areas thought to be unaffected in children with autism (Hill and Kodituwakku, 2002). Procedural (or Habit) memory has also been referred to as rote memory, an ability widely accepted as being relatively normal in the autistic population (Frith, 2000; Siegel, 1996; Mesibov, Adams & Klinger, 1997). In further consideration of individuals with autism, Hill and Kodituwakku (2002) point out that the difficulties in understanding and controlling emotions, learning from experience and storing, processing and retrieving information observed in children with autism may be related to early damage to the limbic system. The fact that false belief tests require participants to not only retrieve information but also then use this information via the experience of witnessing it to solve a problem makes the argument put forward by Hill and Kodituwakku (2002) a possible one in understanding autistic failure on tests of false belief. Furthermore the fact that the area of the brain involved in retrieving information and then utilising this information in a declarative rather than procedural manner is affected in children with autism gives further strength to the argument that false belief failure may well be as a result of inappropriate retrieval of information from declarative memory or in fact as a result of inadequate cueing strategies.

Let us firstly consider the failure of false belief tests by children with autism from the perspective of inadequate retrieval from declarative memory. Recall that while Tulving (1985) separates semantic and episodic memory, others (Cohen & Squire, 1980; Squire, 1987) consider both to be declarative memory as both involve the knowledge of facts. However, considering that Tulving (1995) associates semantic and episodic memory to different levels of conscious experience, noetic and autonoetic respectively, it is perhaps more appropriate for this discussion to again treat them separately. While inadequate retrieval from declarative memory can be explained as a result of an impaired limbic system there are other possible explanations, that can be either considered alongside the neurobiological explanations or indeed separate from them.

Within his paper investigating remembering and knowing and free versus cued recall, Tulving (1985) argues that individuals can access two types of information in order to retrieve items from memory – semantic cue information and episodic trace information. When considering cued recall and free recall the mere labels provide insight as to what types of information are available to individuals retrieving information within these conditions. Under cued recall individuals clearly have semantic cue information, while in free recall such information is not available or is relatively poor, therefore under free recall it becomes obvious that one must rely more heavily upon episodic trace information, which in turn depends upon levels of autonoetic awareness. That is if one is not cued to remember one must have information available of the experience so as to remember it. Hence the distinction Tulving (1985) makes between remembering and knowing. The adult participants within Tulving's research judged correct free recall as remembered and correct cued recall as known. The participants made this distinction based on their belief that in order to justify a judgement of remembered they necessarily had to recollect the experience rather than being given cues.

Considering the free recall versus cued recall argument and given that free recall requires a greater amount of episodic awareness it necessarily holds that children with autism and indeed young typically developing children who fail tests of false belief should do worse on free recall tests than children who pass false belief tests. This point, in terms of typically developing children, was made by Perner and Ruffman (1995) in their investigation into the relationship between typically developing children's understanding that seeing leads to knowing and episodic memory. Perner and Ruffman (1995) made the link between free recall and episodic memory so that they could test young typically developing children[43]. They hypothesised that typically developing children who fail tests that require an understanding that seeing leads to knowing should perform more poorly on free recall tests than children who pass see-know tests. This was hypothesised, as children that fail see-know tests should lack the episodic or autonoetic awareness that they know something because they experienced it. Perner and Ruffman (1995) compared typically developing children on free recall tasks, cued recall tasks and see-know tests, showing that there was "a specific relationship between different measures of experiential awareness and free recall" (p.538). Perner and Ruffman (1995) explain their findings in terms of autonoetic consciousness in that without experiential awareness typically developing children find free recall and therefore see-know tests difficult.

From the findings of Perner and Ruffman (1995) it is possible to suggest that children with autism who fail tests of false belief may do so as a consequence of not accessing experiential awareness, subsequently resulting in difficulties in free recall, hence manifest impairments in episodic memory development. Providing support for these suggestions research has been conducted: testing the abilities of children with autism with regard to free recall versus cued recall (Boucher & Lewis, 1989; Tager-

[43] Recall that Tulving (1985) had his adult participants judge whether they remembered something or whether they simply knew something. This however would be an unreliable and inappropriate measure for young children, so Perner and Ruffman (1995) decided to use free recall as a measure of remembering and cued recall as a measure of knowing.

Flusberg, 1991); and testing adults with Asperger's syndrome on remember versus know recognition memory (Bowler, Gardiner & Grice, 2000). In one of a series of experiments conducted by Boucher and Lewis (1989) children with autism and matched controls were tested on the ability to answer questions about past experiences. In two conditions participants were expected to answer questions about past experiences, one condition provided participants with cues while the other did not – a free recall condition. It was found that the children with autism performed poorer in the free recall condition when compared to the matched controls, while there was no significant difference between the two groups for the cued recall condition. The results provided by Boucher and Lewis (1989) suggests that in autism, episodic memory may be affected, while semantic memory appears to be intact.

Tager-Flusberg (1991) presented the findings of two studies of children with autism, mentally retarded children and typically developing children. One study investigated free recall, the other cued recall. In the free recall study participants were tested on their free recall of semantically related and unrelated words in order to investigate whether children with autism utilise semantic relatedness to aid free recall. The results of the free recall experiment provided evidence that children with autism perform poorer than controls when using semantic relatedness as a cue for free recall. For the control participants there was a significant improvement in free recall from the unrelated to the related word lists, with the related word list proving easier. This was not the case for the children with autism. For the children with autism there was no significant difference between their performances on the two word lists. Tager-Flusberg (1991) suggests that this is due to children with autism being impaired in free recall and more specifically impaired in the utilisation of semantic relatedness so as to facilitate free recall. Tager-Flusberg (1991) conducted the cued recall experiment to investigate whether children with autism encode the meaning of words presented to them for recall similarly to controls. One word list used rhyming cues (e.g. fox-box) the other semantic cues (e.g. cherry-fruit). The results showed that children with autism use semantic (and rhyming) cues equally well as controls. Overall the results provided by Tager-Flusberg (1991) support previous research that children with autism are impaired in relation to free recall which relies more heavily upon remembering personally experienced events, but unimpaired on cued recall that relies largely upon an intact semantic memory. This may be extended in that the findings of Tager-Flusberg (1991) could be used to suggest that children with autism have impairments in episodic memory, as this is the memory that involves remembering personally experienced events.

Bowler, Gardiner and Grice (2000) compared adults with Asperger's syndrome and an IQ-matched control group on remember versus know recognition memory, or from Tulving's (1985) perspective, episodic or autonoetic awareness and semantic or noetic awareness respectively. Participants were asked to memorise a list of words (study phase) on which they were told they would be tested at a later stage (test phase). Participants were informed that when tested, words would be presented to them some of which they were given to memorise and others that they had not been given. If they recognised the word as one they had been shown in the study phase participants were instructed to say "yes". If they were words they had not been shown in the study phase participants were instructed to say "no". If unsure, participants were also instructed to say "no". For the "yes" words participants were asked to make a choice as to how they remembered the word either as a word they remembered seeing in the study phase as well as remembering it by some other means (e.g. the placement of the word in the list, what they thought when they saw the word) or by just remembering that they had seen the word, that they simply knew that the word was on the list. The results of the study just described provided evidence that adults with Asperger's syndrome do not differ in overall word recognition when compared to controls but that their associated states of awareness to remembered words do differ from that of controls. For the adults with Asperger's syndrome memory was more associated with knowing and less associated with remembering. Bowler et al. (2000) relate this to individuals with Asperger's syndrome relying more on noetic awareness and less on autonoetic awareness with recognition memory tasks. It is possible to suggest from this, as do Bowler et al. (2000), that individuals with Asperger's syndrome or high-functioning autism could possibly be impaired in the retrieval of information from episodic memory. In their conclusion, Bowler et al. (2000) state that high-functioning individuals with autism have deficits in certain episodic memory tasks and particularly on those episodic memory tasks that place greater demands on executive function.

In their examination of memory functions in individuals with autism, Bennetto, Pennington and Rogers (1996) compared high-functioning children with autism and children without autism but with learning disorders on a series of memory and executive function measures. The memory measures used were: an adaptation of the Corsi Memory Task (Milner, Corsi & Leonard, 1991) that allowed a within-subject comparison of memory for temporal order and recognition memory; the California Verbal Learning Test (CVLT; Delis, Kramer, Kaplan & Ober, 1986) that measures the learning and retention of verbal information and provides information on free recall, cued recall, recognition memory and source memory; the Stanford-Binet Intelligence Scale, Fourth Edition – Memory for Digits Test (Thorndike, Hagen, & Slatter, 1986) that tests the short-term auditory memory for digits; the Working Memory – Sentence Span task (adapted for use with children by Siegal & Ryan, 1989 but initially developed by Daneman & Carpenter, 1980) in which participants have to process and store verbal information for later recall; and the Working Memory – Counting Span task (Case, Kurland, & Goldberg, 1982). Bennetto et al. (1996) also used two executive function tasks: the Wisconsin Card Sorting Test (WSCT; originally developed by Grant & Berg, 1948 but updated and expanded by Heaton, Chelume, Talley, Kay & Curtiss, 1993) that measures both rule-based categorisation and set-shifting abilities; and the Tower of Hanoi task that tests planning and problem-solving abilities. Bennetto et al. (1996) hypothesised that "if individuals with autism mainly have executive function impairments, then their profile of memory performance ought to be similar to that exhibited by patients with frontal lesions" (p.1819). More specifically, Bennetto et al. (1996) hypothesised that the participants with autism would perform less well than comparison participants on the temporal order, source and working memory tasks as well as the executive function tasks, but equally as well as comparison participants on tasks involving cued recall, short-term recognition and long-term recognition. Their hypotheses were supported by their findings. The participants with autism performed significantly worse than comparison participants on the temporal order memory, source memory, free recall, working memory and executive function tasks. As well as supporting the aforementioned hypothesis the results of the study conducted by Bennetto et al. (1996) reinforce the claim made by Bowler et al. (2000) that high-functioning individuals with autism have deficits in certain episodic memory tasks and particularly on those episodic memory tasks that place greater demands on executive function.

The other possible explanation for false belief failure in autism concerned inadequate cueing strategies. As discussed previously, children with autism that are included within false belief research, always answer the reality and memory questions correctly (otherwise they would be omitted from the research) but tend to fail the false belief question. In this sense the reality and memory questions may well be considered as rote in nature as the information is not being used or altered so as to solve problems, but rather is simply drawn out from memory in an identical fashion to which it was initially stored. So what of the false belief question? The false belief question requires information to not only be retrieved but also retrieved in a manner that will allow for a problem to be solved. The information needs to be used and altered so as to solve the false belief dilemma. However if the information related to the solving of the false belief question was not stored in the exact manner required in order to answer the false belief question, that is as where Sally will look for her marble, perhaps for children with autism the false belief question is not an appropriate cue for the retrieval of this information.

The *encoding specificity principle* originated from research conducted by Tulving and Pearlstone (1966) and Tulving and Osler (1968), in which the effectiveness of retrieval cues on to be remembered items was being explored. In the second of these papers it was documented via empirical evidence that a retrieval cue is effective if, and only if, the information about its relation to the to-be-remembered-item is stored at the same time as the to be remembered item itself. Thomson and Tulving (1970) describe the encoding specificity hypothesis in the following terms:

> The encoding specificity hypothesis, among other things, clearly implies that no cue, however strongly associated with the to be remembered item or otherwise related to it, can be effective unless the to be remembered item is specifically encoded with respect to that cue at the time of its storage (p.255).

At this point in time it must be pointed out that a question posed to an individual, whereby a particular response is expected if that response is to be considered correct, is necessarily a cue for that particular response. In terms of Applied Behaviour Analysis this means that unless the appropriate discriminative stimulus is issued to an individual a correct response will not be given. Considering tests of false belief and indeed how information is encoded and then expected to be retrieved the salience of this becomes increasingly interesting. At the time of encoding, the information given to participants of false belief tests is done so in terms of where an item currently is and then of where it is moved to. No mention is given at the point of encoding that the initial location may also be related to where an individual may look for it in the future. This may initially appear trivial however when considering the widely reported problems that children with autism have with generalisation (Jordan, 2002; Frith, 2000; Siegel, 1996; Taylor, 1997; Maddock, 1997) such matters of triviality quickly dissipate. Anyone working with individuals with autism, as has the author, will often report that children with autism will only answer questions correctly if such questions are asked in the identical manner to which the information was initially taught. For example if a child with autism is taught to answer his/her name when asked the question "What is your name?" it is more often than not the case that if asked, "What are you called?" that the child will frequently not answer or indeed give a response that is not appropriate for that particular question. In this particular example because "What are you called?" or even the word 'called' was not encoded (or in behavioural terminology – paired) at the same time as the correct response, that question will not act as an appropriate retrieval cue for that particular response. Taylor (1997) reinforces this argument when he points out that:

> It is very clear that children with autism learn to carry out certain skills in specific contexts but when presented with what may seem to an outside observer as a very similar context, are seemingly unable to carry out the task (p.119).

Jordan (1999) also highlights the specific cue-dependent responding of individuals with autism. Referring to investigations by Rincover and Koegel (1975), Jordan (1999) states, "their learning was significantly hampered because they would produce that response only in the presence of that cue" (p.122).

The findings of Experiment One reported that for the children with autism the central light condition proved to be easier to pass. One explanation for such differential responding on behalf of the children with autism can be given in terms of memory and more specifically in terms of retrieval cues. Within this condition the last thing that the participants' saw was the light (in the absence of an empty landing pad in comparison to the Landing pad light condition where the participants were witness to both the light and the empty landing pad) indicating the location to which the train would travel. In addition to this visual input the last piece of auditory information that the participants received ("the plane landed on the x landing pad **but the light is y**") also indicated the location to which the train would travel, again in the absence of any possible confusion caused by observing an empty landing pad. Perhaps it was the uninterrupted provision of the visual information, the auditory information or a combination of the two pieces of information that resulted in enhanced performance of the central light condition when compared to the Sally-Anne test for the children with autism. This raises the question of whether cues can facilitate successful performance on tests of false belief for children with autism.

Bowler and Briskman (2000) investigated the effect of cues in relation to the false belief performance of children with autism, typically developing children and children with retardation. For one of the studies in that investigation, participants were tested on a standard unexpected transfer test of false belief and a false belief test that utilised photographic cues. In the cued condition, after she had left her ball in a basket, but prior to covering the basket, Sally took a photograph of where the ball was. It was explained to the participants that Sally did this so that she could remember where she had left her ball. Once the photograph had developed the participants were asked if the picture was one of where Sally had left her ball. All participants responded correctly to this question. Sally was then removed from the scene with her photograph. The second protagonist in the scenario, Andy, then moved the ball from the basket and put it in the other provided location, a box. Sally then returned to the scene with her photograph at which point it was highlighted to the participants that Sally was looking at the picture of her ball in the basket and that she wanted to play with her ball. Participants were then asked where Sally would look for her ball.

Despite the provision of the photographic cue, the false belief performance of the participants, including those participants with autism, did not significantly improve from the baseline, standard test. The cue did not improve false belief performance. Mindful of the encoding specificity principle it might conceivably be assumed that if any cues were to facilitate appropriate retrieval of false belief information that the cues provided by Bowler and Briskman (2000) would do so. This was not the case. On face value these findings could be used to support the false belief deficit hypothesis in autism, for if the information was available the cues should have successfully aided retrieval, as the cues were identical to the information that was encoded by the participants. This reasoning is not uncontentious. Participants being told that Sally was looking at the photograph of her ball in the basket clearly provided the auditory cue of where the ball was left but unless the participants also viewed the photograph, the visual cue would not have been encoded. Bowler and Briskman's (2000) account is not clear as to whether participants viewed the photograph. To be assured that the participants accessed both the auditory and visual cue it would have been necessary to show the photograph to the participants whilst at the same time providing the auditory information. According to the encoding specificity principle, for the cues to be effective in aiding retrieval simultaneous exposure would be required. If only one of the two cues that were encoded at the time of storage was presented at the time of retrieval, successful retrieval would not have occurred. This may be a plausible explanation that accounts for the findings presented by Bowler and Briskman (2000).

Given the findings of Experiment One and the possible explanation of improved performance being in terms of cue effects, as well as the potential procedural problems with the photographic cueing study conducted by Bowler and Briskman (2000), two further experiments, Experiment Four and Experiment Five, were designed to assess the possibility that (i) the auditory cue was responsible for the improvement in false belief performance in Experiment One, or (ii) that improved performance was due to the visual cue. Experiment Five was designed to additionally assess the possibility that improved performance may have resulted from a combination of both the visual and auditory cues provided to the participants.

7.2 Experiment Four: The Effect of Auditory Cues on the Performance of Children with Autism on Tests of False Belief

7.2.1 Introduction

Experiment Four was conducted to investigate the effect of auditory cueing on the performance of typically developing children and children with autism on tests of false belief. In Experiment One it was found that children with autism responded favourably to a train condition where verbal information was given to the participants in the absence of visual distraction. This condition, referred to as the central light condition, also provided the participants with a light signal indicating the location to which a train would travel, despite the fact that the plane to which the train typically travelled to so as to unload it, was at a different location – hence the previously stated analogy to the Sally-Anne false belief test. This condition unlike the landing pad light condition did not have an empty landing pad to visually distract and possibly confuse the participants. The current experiment aims to replicate the conditions of the central light condition of the mechanical analogue and render the scenario and overall test conditions more similar to the standard Sally-Anne test of false belief. Unlike the protocol false belief test though, the doll protagonists in the scenario outlined in the current experiment speak to themselves, remembering where they had left their item on their return to the room. It is hypothesised that like the central light condition in Experiment One that children with autism will find this easier, therefore supporting an argument that providing children with autism with auditory cues can potentially increase their correct performance on tests of false belief. It is also hypothesised that unlike the children with autism, typically developing false belief failers will not improve their performance given the added auditory input and will consequently fail at the same rate.

7.2.2 Method

7.2.2.1 Participants. Participants included 24 typically developing children and 24 children diagnosed with autism spectrum. The typically developing children attended a mainstream primary school in Essex. The children with autism attended a special needs school in London. The diagnosis of autism for these children was determined from Statements of Special Educational Needs held within school records. For each participant, written consent to be included within this study was obtained from a parent or guardian. Letters of consent, detailing both the nature and expected duration of the study were written by the author and distributed by the school. An example of a consent letter is provided in Appendix 1. Chronological Ages (CA) and Verbal Mental Ages (VMA) for both groups of children are set out in Table 7.1. Analysis of these data using a Mann-Whitney test[44] revealed a significant difference for CA ($U = 0$, $N1 = 24$, $N2 = 24$, $p < .001$, two-tailed), and for VMA ($U = 175.0$, $N1 = 24$, $N2 = 24$, $p < .05$, two-tailed)[45].

[44] Mann-Whitney test was used instead of Independent Samples t-test due to unequal variances.

[45] Significant differences in CA and VMA were found as a result of desiring a greater number of Sally-Anne passers with autism. This is discussed further within the chapter entitled Methodological Issues.

Table 7.1

Chronological and Verbal Mental Ages of Participants in Experiment Four

	With Autism (N=24)	Typically Developing (N=24)
Chronological Age**** (months)		
Mean	136.3	64.9
SD	33.4	5.8
Range	82-210	58-78
Verbal Mental Age* (months)		
Mean	73.1	58.4
SD	22.6	6.0
Range	51-120	51-69

* p<.05 ** p<.01 *** p<.005 **** p<.001 (Mann-Whitney)

7.2.2.2 Materials. This experiment utilised three different false belief scenarios: Sally-Anne (SA), Winnie-Tigger (WT) and Blackbeard- Redbeard (BR). The scenarios named after the characters portrayed within them, were identical in that they all involved unexpected transfer, yet the characters and props were different in all three. The SA scenario involved the use of two dolls named Sally and Anne by the author so as to replicate Baron-Cohen et al. (1985), a box, a cup and a marble. The WT scenario was acted out using two small soft toys of the well-known cartoon characters, Winnie the Pooh and Tigger, a plastic pencil case, a tin case and a pencil sharpener. In the third scenario two plastic figurines depicting wizards were used. The figurines were named Blackbeard and Redbeard as one had a black beard and the other a red beard. In addition to the figurines this scenario adopted the use of a small plastic wand, a red pouch and a silver cylinder. The characters and apparatus for the SA, WT and BR scenarios can be seen in Figures 7.2, 7.3 and 7.4 respectively.

Figure 7.2. Sally-Anne characters and apparatus.

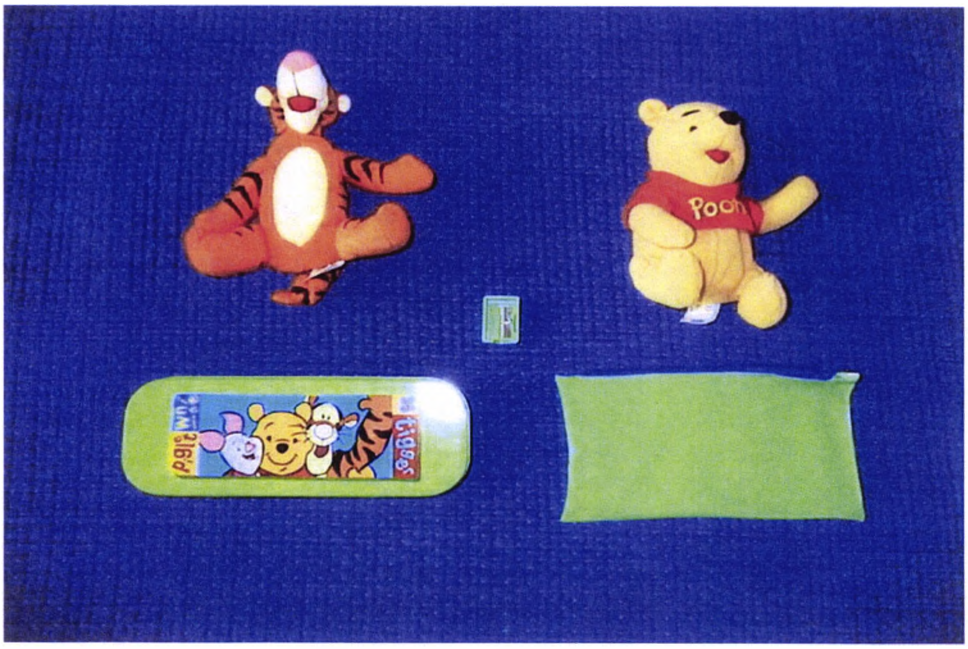

Figure 7.3. Winnie-Tigger characters and apparatus.

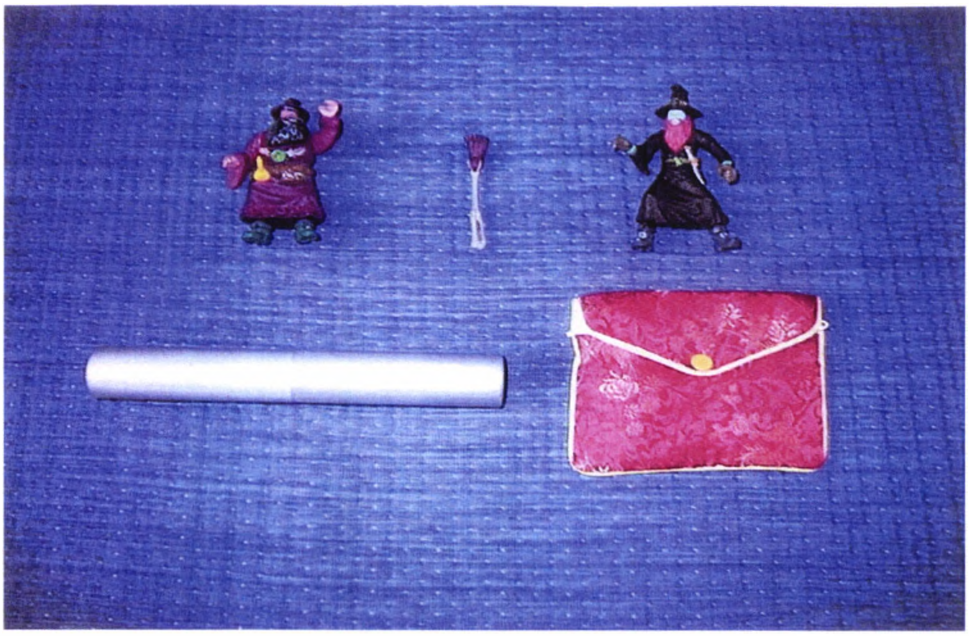

Figure 7.4. Blackbeard- Redbeard characters and apparatus.

7.2.2.3 ***Design and Procedure.*** Apparent from the description of the scenarios, within each condition, there were two possible protagonists and two possible locations resulting in four protagonist/location pairings for each scenario (See Table 7.2). Each pairing from all three scenarios was then randomly grouped to form four possible pairing combinations (See Table 7.3). Each grouping was then ordered using Latin Squares and participants were randomly allocated accordingly. Six typically developing participants and six participants with autism were allocated to each grouping, enabling each possible ordering being delivered to two participants from each group of children (See Table 7.4). This protocol differs considerably from the research conducted by Baron-Cohen et al. (1985) in that characters and locations were altered so as to account for possible character or location preferences of the participants.

For all conditions the belief question, "Where will 'x' look for their 'y'?" was administered first. Reality, "Where is the 'y'?" and memory, "Where did 'x' leave their 'y'?" questions were then delivered in counterbalanced order. In total all participants were asked nine experimental questions, three belief questions, three reality questions and three memory questions. Unlike prior studies conducted by the author and indeed others, only one trial of each condition was administered for the participants.[46] That is each scenario was enacted once to each participant rather than twice.

[46] One trial was chosen in preference to the norm of two, due to anecdotal observations made by the author of satiation and related shifting of attention by all participants, particularly those participants with autism.

Table 7.2

Possible Protagonist/Location Pairings for Experiment Four

Protagonist	Location
Sally	Cup
Sally	Box
Anne	Cup
Anne	Box
Winnie	Plastic Case
Winnie	Tin Case
Tigger	Plastic Case
Tigger	Tin Case
Blackbeard	Pouch
Blackbeard	Cylinder
Redbeard	Pouch
Redbeard	Cylinder

Table 7.3

Protagonist/Location Pairing Combinations for Experiment Four

Group	Protagonist/Location triads		
1	Sally/Cup (SC)	Winnie/Plastic Case (WP)	Blackbeard/Pouch (BP)
2	Sally/Box (SB)	Winnie/Tin Case (WT)	Blackbeard/Cylinder (BC)
3	Anne/Cup (AC)	Tigger/Plastic Case (TP)	Redbeard/Pouch (RP)
4	Anne/Box (AB)	Tigger/Tin Case (TT)	Redbeard/Cylinder (RC)

Table 7.4

Participant Allocation and Respective Ordering of Scenarios for Experiment Four

	Participants	Ordering		
Group1	Participants 1-2	SC	WP	BP
(Participants 1-6)	Participants 3-4	WP	BP	SC
	Participants 5-6	BP	SC	WP
Group 2	Participants 7-8	SB	WT	BC
(Participants 7-12)	Participants 9-10	WT	BC	SB
	Participants 11-12	BC	SB	WT
Group 3	Participants 13-14	AC	TP	RP
(Participants 13-18)	Participants 15-16	TP	RP	AC
	Participants 17-18	RP	AC	TP
Group 4	Participants 19-20	AB	TT	RC
(Participants 19-24)	Participants 21-22	TT	RC	AB
	Participants 23-24	RC	AB	TT

Sally-Anne task. The SA experimental procedure used in the current study is identical to that used in Experiments one, two and three. However unlike these experiments and indeed the study conducted by Baron-Cohen et al. (1985), in the current experiment both Sally and Anne had the opportunity to undertake the unexpected transfer. Naturally this also meant that both characters had the opportunity to be in the position of leaving and retrieving their designated objects. As a result, to avoid confusion, the doll protagonists will not be referred to as Sally and Anne but rather as 'mover' and 'retriever'. These terms will be utilised throughout this study so as to minimise confusion. The distance between the box and cup was kept consistently at 45 cm.

Prior to commencing the experimental scenario each child was introduced to the two dolls and then asked to identify each one. Once correct character identification was confirmed the experimental scenario was implemented.

As mentioned before the delivery of the SA scenario differs to that of Baron-Cohen et al. (1985) in that both dolls acted in the role of mover and retriever across (but not within) participants. Firstly the retriever placed the marble in either the cup or the box. The retriever then left the room. At this point the mover moved the marble from one location to the other. The retriever then returned to the room to look for her marble. It was emphasised to the children that the retriever was not in the room when the mover moved her marble. The belief question was then administered. Following the belief question were the reality and memory questions, which were delivered in counterbalanced order across participants.

Winnie-Tigger task. The WT experimental procedure replicated the SA task with the obvious differences of protagonists and locations, in that both scenarios involved unexpected transfer and both characters had the opportunity to act as either mover or retriever. The distance between the two locations remained consistently at 45 cm. Unlike the SA scenario though, the character that left the room after placing their object in the designated location, the retriever, self-cued via auditory recall where they would look for their object upon their return.

Prior to commencement of the scenario each participant was introduced to the two characters and consequently asked to name each one as in the SA task. Once correct character identification had been confirmed the author acted out the scenario. Firstly the retriever placed the sharpener in either the plastic pencil case or the tin case. The retriever then left the room. At this point the mover changed the location of the sharpener. The retriever then returned to the room to look for their sharpener. It was emphasised to the children that the retriever was not in the room when the sharpener was moved. While returning to the room, the retriever spoke to himself remembering where he had left the sharpener. This verbal recall took the form of "I left my sharpener in the 'x'". The belief question was then asked. Following the belief question were the reality and memory questions, which were delivered in counterbalanced order across participants.

Blackbeard - Redbeard task. The BR experimental procedure was identical to the WT procedure with the only difference being the characters and locations and objects to be moved and retrieved. Scripts for all scenarios (SA, WT, BR) are provided in Appendix 7.

7.2.3 Results

In line with canonical procedures for these tests, for all three conditions, participants were only included if they correctly answered both the reality and memory questions. This pre-requisite resulted in three typically developing children and six children with autism being excluded from the study. Table 7.5 provides a summary of the numbers of participants who were successful on the false belief questions and those who failed for all three conditions. For all three conditions a correct false belief response was where the object was left by the retriever, not where the object had been unexpectedly transferred. Chi-squared statistics indicate the degree of association between the two measures in each contingency table. Inspection of these data reveals no between-group differences for all three conditions indicating similar patterns of performance between both groups of participants for the three tasks. The proportion of participants failing the SA task within the autism group (54.17%) is lower than in other reported studies.

The data summarised in Table 7.5 also show that for both the typically developing children and the children with autism the patterns of within-group performance are identical between the two auditory cueing conditions. Of the 24 typically developing participants, 17 passed both the WT and BR conditions, while 7 failed. Similarly, of the 24 children with autism, 15 passed both conditions while 9 failed.

Table 7.5

Performance of Participants in each Condition of Experiment Four

	SA		WT		BR	
Group	Pass	Fail	Pass	Fail	Pass	Fail
Typically Developing	16	8	17	7	17	7
With Autism	11	13	15	9	15	9
Pearson Chi-Square	$\chi^2 = 2.12$		$\chi^2 = .38$		$\chi^2 = .38$	

* p<.05 ** p<.01 *** p<.005 **** p<.001

Table 7.6 illustrates within-group cross tabulations of the SA and the two auditory cued conditions. Phi statistics indicate the degree of association between the two measures in each contingency table; McNemar statistics indicate the significance of the difference in difficulty between the conditions. Upon inspection of these data it can be seen that both the WT condition and the BR condition are correlated with the SA task for both the typically developing children and the children with autism, indicating similar patterns of performance within both groups of children across the different tasks. It would appear that passing the SA task is strongly associated to success on the other two tasks for both groups of children – all 16 typically developing SA passers passed the other two conditions and all 11 SA passers with autism passed the other conditions. Additionally, failing the SA task would appear to mean sure failure for the typically developing participants with only one of the eight failers (representing a 12.50% increase in performance) passing both the WT and BR conditions. This was not necessarily the case for the children with autism though. Of the 13 SA failers, 4 (a 30.77% increase in performance) passed both the WT and BR conditions.

McNemar tests contradict the aforementioned observations by indicating that for the two groups of children both the WT condition and the BR condition were of equal difficulty. Closer inspection however shows that of the 13 children with autism who failed the SA task, 4 passed both of the conditions in which auditory cues were provided. This is in direct contrast to the eight typically developing SA failers, of which only one participant was able to pass the conditions in which auditory cues were provided. While the McNemar statistics do not provide evidence of statistical significance for difference in difficulty between the standard and auditory cued false belief tasks for the children with autism, the direction of the results is suggestive of this possibility.

Table 7.6

Relationship Between Performance on the Sally-Anne and Auditory Cued Conditions of Experiment Four

		WT		BR	
Group	SA	Pass	Fail	Pass	Fail
Typically Developing	Pass	16	0	16	0
	Fail	1	7	1	7
With Autism	Pass	11	0	11	0
	Fail	4	9	4	9

	Typically Developing	With Autism
SA vs. WT	$\Phi = .91$**** McNemar	$\Phi = .71$**** McNemar
SA vs. BR	$\Phi = .91$**** McNemar	$\Phi = .71$**** McNemar

* p<.05 ** p<.01 *** p<.005 **** p<.001

7.2.4 Discussion of Experiment Four

This research was conducted so as to ascertain the effect that memory cues in the form of spoken recall has upon the false belief performance of children with autism. According to the encoding specificity principle as described by Thomson and Tulving (1970) no memory cue, however strongly associated with the to-be-remembered item or otherwise related to it, can be effective unless the to-be-remembered item is specifically encoded with respect to that cue at the time of its storage. Considering this, within the current research participants were provided with auditory cues that were also encoded with the item of question at the same time that the storage of information was taking place. That is, as the doll protagonists were leaving their objects the experimental script provided participants with information that the item was being left in a particular location. After the doll protagonist had left the room and then decided to return to relocate their object, they spoke to themselves, once again providing the participants with the same information as to where the protagonist left the item in question. So the auditory cue provided to the participants was also encoded at the same time that the item was being placed, therefore theoretically allowing for successful cueing to take place.

Despite the provision of auditory cues neither the typically developing children or children with autism showed a statistically significant increase in performance between the standard false belief test and those false belief tests in which auditory cues were provided. Children with autism showed improved performance (30.77%) that was greater than that of the typically developing children (12.50%). So despite McNemar statistics failing to provide statistical significance, the trend of the data does show some added benefit of auditory cueing for those children within the sample with autism. Additionally McNemar statistics for the typically developing children (McNemar, $p = 1.00$) show that there is very little difference in difficulty between the cued and non-cued tests of false belief.

One possible explanation for the failure to find a statistically significant difference in performance between the cued and non-cued tests of false belief for the children with autism lies in the initial experiment that was the impetus to conduct the present study. In the arbitrariness experiment, Experiment One, the central light condition proved easier than the classic unexpected transfer test of false belief for the children with autism and as difficult for the typically developing children. Within the central light condition the last thing that the participants saw was the light (in the absence of an empty landing pad as was the case in the landing pad light condition where the participants were witness to both the light and the empty landing pad) indicating the location to which the train would travel. In addition to this visual input the last piece of auditory information that the participants received ("the plane landed on the x landing pad **but the light is y**") also indicated the location to which the train would travel. However within the current study only auditory cues were provided, rather than both auditory and visual cues. So a more likely explanation is that the auditory cue alone was not adequate to assist the retrieval of information of the children with autism and that a combination of auditory and visual cues are necessary. The movement of the McNemar statistics would also support this in that given auditory cues the performance of the children with autism is beginning to show an improvement given the assistance. Perhaps if visual cues were also provided these differences may have reached statistical significance. Experiment Five will explore this possibility.

7.3 Experiment Five: The effect of multi-modal cues on the performance of children with autism on tests of false belief

7.3.1 Introduction

This study was undertaken in order to further examine the effects of memory cues upon the performance of children with autism on tests of false belief. The findings of Experiment Four failed to provide statistically significant confirmation that the provision of auditory memory cues positively affects the performance of children with autism on such tests. In Experiment Four, despite auditory cues being provided to the children with autism, their performance did not significantly improve. Despite this lack of statistical significance, trends in the data did suggest that cueing may have a positive impact on the false belief performance of children with autism.

The current study investigates the effect of three different cueing conditions: auditory[47], visual, and auditory combined with visual. In addition to the three cueing conditions, participants are also presented with a classic unexpected transfer test of false belief. Three groups of participants are tested: typically developing children; children with learning disabilities; and children with autism. It is hypothesised that similar to Experiment Four that the conditions in which cueing is provided uni-modally will not prove to be significantly different in difficulty when compared to the standard test of false belief for the typically developing children, the children with learning disabilities or the children with autism. Additionally it is hypothesised that

[47] An auditory cueing condition was included to investigate further the possibility that auditory cueing may positively affect the false belief performance of children with autism. Even though auditory cueing had already been investigated in the first memory cueing study, Experiment Four, no statistically significant results were obtained. Additionally it was deemed necessary to re-examine the effects of auditory cueing due to the typically developing children and the children with autism not being matched on VMA in Experiment Four.

for the condition in which cueing is provided multi-modally, that the performance of the children with autism will improve significantly but that the performance of the typically developing children and children with learning disabilities will remain unaltered. This hypothesis arises from the reasoning that failure for the three groups of children are attributable to separate and distinct mechanisms. It is hypothesised that for the children with autism false belief failure is due to peculiarities with the encoding of information and that failure can be improved by the provision of appropriate retrieval cues. Additionally it is held that typically developing children and children with learning disabilities that fail such tests do so as a result of a true false belief inability and as a result are not assisted by the provision of retrieval cues. If one does not have the capacity to develop a conceptual understanding then cues of any type will inevitably prove unhelpful or irrelevant. If children with autism have an absolute deficit in the ability to understand false belief then such assistance will be of no benefit. If however children with autism fail tests of false belief as a result of encoding and retrieval deficiencies then cueing should have the effect of enhancing performance and result in false belief test success. Unlike Experiment Four a third group of participants, children with learning disabilities was included within this study so as to determine whether any effects observed for the children with autism are unique to that population or indeed shared with children with special need diagnoses. The children with learning disabilities operate as a second comparison group for those children with autism so that the notion of uniqueness can be investigated.

7.3.2 Method

7.3.2.1 Participants. Three groups of participants were matched on verbal mental age (VMA): 20 typically developing children (10 boys and 10 girls), 20 children with autism (18 boys and 2 girls) and 19 children with learning disabilities (LD) (10 boys and 9 girls). The children with autism were also matched to the children with learning disabilities according to IQ. The children with autism were matched to the children with learning disabilities according to both VMA and IQ so that differences in IQ could be excluded as possible explanations of differential responding.

The typically developing children all attended a mainstream primary school in Essex. The children with autism attended a special needs school in West London and were all diagnosed as having autism as recorded within Statements of Special Educational Needs held within school records. The LD children attended special schools within the London area. The LD children had levels of disability that ranged from moderate to severe[48] and of unknown aetiology. The LD children were only included if there was no evidence of autism or autistic-like behaviour within diagnoses held within school records. Written consent was obtained from a parent or guardian for all participants. Letters of consent, detailing both the nature and expected duration of the study were written by the author and distributed by the school. An example of a consent letter is provided in Appendix 1[49].

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48 The minimum IQ score for participants with LD was 33, while the maximum IQ score was 114. Clearly this includes children ranging from severe mental retardation to no mental retardation. Categories of mental retardation were obtained from Bernstein, Clarke-Stewart, Roy, Srull and Wickens (1994).

49 For this study the consent letter (although not shown within the example provided in Appendix 1) included children with learning disabilities as a second comparison group.

The 59 children who participated in the study came from an original group of 74. Fourteen children were excluded from the study as a result of not meeting the requirements of Verbal Mental Age (VMA) as measured by the Test for the Reception Of Grammar - TROG (Bishop, 1982). Children were accepted into the study only if they had an absolute minimum VMA of 39 months. The mean VMA of the children with autism was 54.60 months (n = 20, SD = 9.66). The mean VMA of the typically developing children was 52.80 months (n = 20, SD = 5.95). The mean VMA of the LD children was 52.42 months (n = 19, SD = 5.23). Complete details of the mental and chronological ages and IQ[50] of the three groups of participants are set out in Table 7.7. Analysis of these data using a one-way ANOVA revealed a significant difference for chronological age ($F(2,56) = 21.67, p < .001$) and IQ ($F(2,56) = 20.56, p < .001$). Post-hoc Scheffé tests were used to compare pairs of group means in order to assess where the differences lay. Significant differences were revealed in all three pair-wise comparisons of the groups for chronological age. However for IQ, it was found at the 5% level of significance, that the IQ of the typically developing children (M = 97) was higher than that of the children with autism (M = 70.14) and children with LD (M = 56.31) but that the mean IQ of the children with autism and the children with LD did not significantly differ from each other.

[50] IQ as defined by Terman (1916) - (IQ = [mental age / chronological age] * 100).

Table 7.7

Chronological and Verbal Mental Ages of Participants in Experiment Five

	With Autism (N=20)	With Learning Disability (N=19)	Typically Developing (N=20)
Chronological Age (months)****			
Mean	81.10	111.47	55.30
SD	19.25	41.62	8.99
Range	55-119	42-166	39-73
Verbal Mental Age (months)			
Mean	54.60	52.42	52.80
SD	9.66	5.23	5.95
Range	45-84	48-66	39-63
IQ****			
Mean	70.14	56.31	97.00
SD	15.98	28.60	13.15
Range	40.34-101.61	33.33-114.29	73.97-123.08

* $p<.05$ ** $p<.01$ *** $p<.005$ **** $p<.001$ (Analysis of Variance - ANOVA)

7.3.2.2 Materials. The equipment used within this study consisted of an electronic version of the Sally-Anne test of false belief. While the apparatus was electronic it was possible to disconnect it and therefore utilise the identical apparatus manually as in the standard Sally-Anne test of false belief.

The apparatus consisted of a wooden plank[51] painted white measuring 62 cm long and 9.5 cm wide. On either end of the wooden plank was a box measuring 9.5 X 9.5 X 4.0 cm. Within these boxes were sensors and L.E.D. lights. The sensors controlled when sound and light would be emitted. The sensors were activated by placing an object within a small hole that was in the centre of both of the boxes. The distance between these two holes was 45 cm.[52] Connected to the boxes by electrical cables was a control panel. The control panel measured 29 X 16.5 X 13 cm and was used to control when lights and sounds would be emitted and indeed what lights and sounds would be emitted. Also connected to the control panel were two speakers. In addition to the electronic apparatus there were two small dolls named Sally and Anne, an opaque yellow cup, an opaque blue cup and a long metallic key measuring 7 cm in length. A key was used instead of a marble, as it was necessary to have an object long and thin enough so as to be placed within the sensor holes of the sensor boxes on either end of the wooden plank. The experimental apparatus can be seen in Figure 7.4.

The purpose of this apparatus was that it would be possible to provide participants with a range of memory cues in the guise of lights, sounds or a combination of the two. In addition it was possible to disconnect the apparatus and

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[51] A wooden plank was utilised so that electrical and sensor cables could be hidden from view. This added to the automated facade of the apparatus and indeed allowed for structural rigidity.

[52] This is in keeping with the distance between locations where objects would be left by doll protagonists in all other experiments conducted by the author within this thesis.

therefore use it for the purpose of a traditional Sally-Anne test of false belief. The lights and sounds were controlled both by sensors and the experimenter via the control panel, which was hidden as much as possible from the participants.[53]

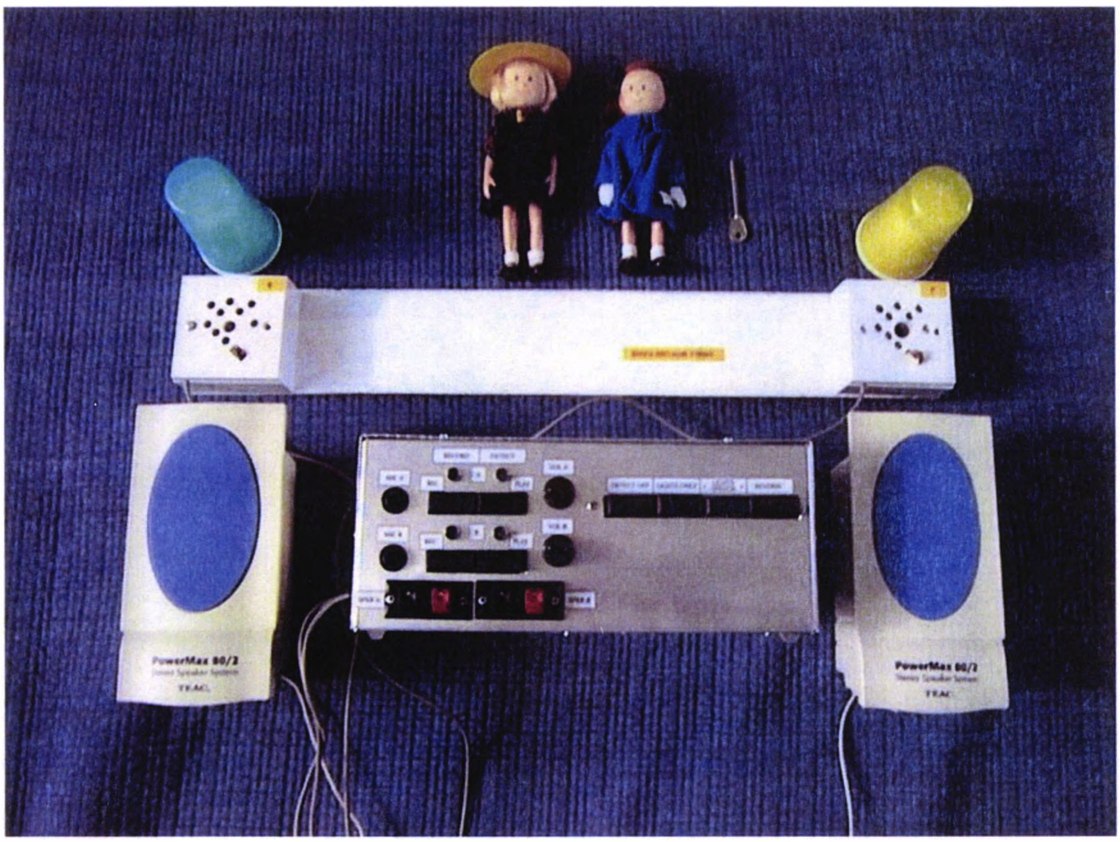

***Figure** 7.5.* Electronic false belief apparatus.

[53] The control panel was placed on the experimenter's knee underneath a table.

7.3.2.3 Design and Procedure. All participants undertook two trials of the four false belief tasks – standard Sally-Anne (SSA), light cued Sally-Anne (LCSA), sound cued Sally-Anne (SCSA) and light and sound cued Sally-Anne (LSCSA)[54]. In total participants undertook eight experimental trials. When including memory and reality questions the number of questions posed to the participants totalled 24. The order of presentation of the different task scenarios was determined using Latin Squares (See Appendix 8).

Standard Sally-Anne task. This task utilised the apparatus described previously (Section 7.3.2.2 / Figure 7.5) but with the electrical conditions omitted. Unlike Baron-Cohen et al. (1985) and indeed other research conducted by the current author, a key instead of a marble was used as the object to be unexpectedly transferred. This was used, as it was necessary to have an object long and thin enough so as to activate the sensors in the three cued conditions. While it was not necessary to have the sensors operating for the SSA scenario it was decided to utilise the same stimuli so as to provide consistency to the participants and to allow for a more valid comparison between the different conditions.

Before commencing the experimental scenario all participants were introduced to the two dolls – Sally and Anne. Correct identification of the two dolls by the participants was a pre-requisite for continuation of the experiment[55]. This was undertaken receptively whereby the participants were required to point to the correct doll when the experimenter gave the corresponding name. Once this was established

[54] Unlike Experiment Four, two trials were utilised here due to the differential nature of the tasks. Due to the provision of different cues the scenarios utilised in Experiment Five were less repetitive than the scenarios of Experiment Four.

[55] No participants failed to correctly identify the two dolls.

participants moved to the experimental procedure. Firstly Sally placed the key under either the blue cup or the yellow cup. Sally then left the room. After Sally had left the room, Anne moved the key from the cup where Sally had placed it to the other cup. Sally then returned to the room to retrieve her key[56]. It was emphasised to the participants at this point that Sally was not present when Anne moved the key. The belief question was then asked. A full version of the SSA scenario is set out in Appendix 9.

Two trials of the SSA task were presented to each participant with the initial location of the key being counterbalanced across participants. The location of the key was changed on the second trial. If the participants correctly answered the belief question "Where will Sally look for her key?" they were then asked memory ("Where did Sally leave her key?") and reality ("Where is the key?") questions in counterbalanced order. Presentation of these questions was also counterbalanced across participants.

Cued Sally-Anne tasks. The apparatus utilised in the three cued Sally-Anne conditions was consistent to that used in the SSA task. Before commencing each condition the participants were re-introduced to the two dolls. Again prior to continuing the scenarios all participants were expected to correctly identify the two dolls. Once correct character identification was established the scenarios were continued.

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[56] Unlike Experiment Four the dolls maintained roles throughout the scenarios. That is Sally was always the doll to place the object, leave the room and then return to retrieve it. As a result Anne was consistently the doll to perform the unexpected transfer.

For all three cued conditions the scenarios were consistent with the SSA task with the exception of two modifications. Firstly, at the point Sally leaves her key under either the blue or the yellow cup, the experimenter altered the verbal information provided to the participants. For the LCSA condition the participants were told that upon Sally's return to the room she would be reminded by a light where to look for her key. For the SCSA condition the participants were told that upon Sally's return to the room she would be reminded where to look for her key by a voice. Finally in the LSCSA condition the participants were told that both a light and a voice would remind Sally where to look for her key upon her return. Secondly upon Sally's return to the room in the three cued conditions, additional information is provided to the participants (and indeed to Sally) as to where Sally should look for her key. In the LCSA condition a light would be illuminated under either the blue or yellow cup, signalling the location where Sally left her key and consequently where she should look for it. In the SCSA condition a voice reminding Sally where she left her key is heard, therefore telling her where she should look for the key. The voice would say either "blue cup" or "yellow cup". In the LSCSA condition both a light and a voice would remind Sally where she left her key and consequently where she should now look for it. In this condition either the light underneath the blue cup would be illuminated at the same time as a voice would say "blue cup" or a light underneath the yellow cup would be highlighted at the same time as a voice would say "yellow cup". The experimenter, using the control panel, controlled the lights and sounds. The sounds were pre-recorded by an anonymous person rather than the experimenter to avoid any possibility of confusing the participants in thinking that it was the experimenter speaking. This variation further added to the automated nature of the apparatus.

In all three cued conditions the point at which Sally returned to the room and was subsequently provided with the memory cue (either the light, voice or light and voice combined), the belief question "Where will Sally look for her key?" was asked. As with the SSA task, if the participants were successful at the belief question, memory ("Where did Sally leave her key?") and reality ("Where is the key?") questions were then presented in counterbalanced order. These questions were also presented in counterbalanced order across the different participants. Full versions of the instructions that were provided to the participants for the three cued Sally-Anne conditions are set out in Appendix 9.

7.3.3 Results

The results for each participant were only included if both memory and reality questions were answered correctly. This was to ensure that false belief failure could confidently be attributed to a lack of ability rather than to not recalling either where the key had been left or indeed where the key was presently. In total five participants were excluded because of failure of memory or reality questions, four children with autism and one child with LD. Table 7.8 provides a summary of the false belief results for the three groups of participants across all four conditions (SSA, LCSA, SCSA, LSCSA). Similar to other tests of false belief, a correct false belief response for the four conditions was the identification by participants of the location that Sally left her key rather than where Anne had relocated it. Chi-squared statistics indicate the degree of association between the two measures in each contingency table. Inspection of the data in Table 7.8 highlights between-group differences only for the children with autism and the typically developing children on the LSCSA condition. Children with autism were more likely to pass the LSCSA condition when compared to typical children that were matched on VMA. In this sample the proportion of children with autism that pass the LSCSA condition is .80, while the proportion of typically developing children that pass the LSCSA condition is .45. Almost twice as many children with autism passed this condition when compared to typically developing children.

Table 7.8

Performance of Participants in each Condition of Experiment Five

Group	Standard Sally-Anne (SSA) Pass	Fail	Light Cued Sally-Anne (LCSA) Pass	Fail	Sound Cued Sally-Anne (SCSA) Pass	Fail	Light and Sound Cued Sally-Anne (LSCSA) Pass	Fail
Typically Developing (TYP)	9	11	9	11	10	10	9	11
With Autism (WA)	5	15	8	12	10	10	16	4
With Learning Disabilities (LD)	7	12	8	11	11	8	11	8

Comparison	SSA	LCSA	SCSA	LSCSA
TYP vs. WA	$\chi^2 = 1.76$	$\chi^2 = .10$	$\chi^2 = 1.00$	$\chi^2 = 5.23$*
TYP vs. LD	$\chi^2 = .27$	$\chi^2 = .33$	$\chi^2 = .24$	$\chi^2 = .65$
WA vs. LD	$\chi^2 = .64$	$\chi^2 = .02$	$\chi^2 = .24$	$\chi^2 = 2.24$

* $p<.05$ ** $p<.01$ *** $p<.005$ **** $p<.001$

Within-group contingency tables are set out in Table 7.9. Phi statistics indicate the degree of association between the two measures in each contingency table; McNemar tests indicate the significance of the difference in difficulty between the conditions. Inspection of these data show that all tasks are correlated for all three groups of children and that all conditions do not differ significantly in difficulty, with one exception. For the children with autism the SSA task is not correlated with the LSCSA condition indicating dissimilar patterns of responding. Furthermore McNemar statistics indicate that for the children with autism the LSCSA condition is significantly easier than the SSA task. Eleven of the 15 SSA failers and all 5 of the SSA passers passed the LSCSA condition. Interestingly for the children with LD the proportion of passers and failers is identical for the SCSA condition and the LSCSA condition, neither condition proving to be significantly easier than the SSA task. However a trend can be observed when comparing the differences in difficulty of the SSA task and the LCSA condition and between the SSA task and the other two cued conditions. It would appear that the provision of an auditory cue or both a visual and auditory cue has a positive effect upon false belief performance for the participants with LD. It should be noted however that this difference, although observable, did not reach a level that was statistically significant.

Table 7.9

Relationship Between Performance on the Cued and Non-cued False Belief Tasks of Experiment Five

		LCSA		SCSA		LSCSA	
Group	SSA	Pass	Fail	Pass	Fail	Pass	Fail
TYP	Pass	9	0	9	0	9	0
	Fail	0	11	1	10	0	11
WA	Pass	5	0	5	0	5	0
	Fail	3	12	5	10	11	4
LD	Pass	7	0	7	0	7	0
	Fail	1	11	4	8	4	8

Please Note: Phi and McNemar statistics are continued on the next page.

Table 7.9 continued

Relationship Between Performance on the Cued and Non-cued False Belief Tasks of Experiment Five

	TYP	WA	LD
SSA vs. LCSA	Φ = 1.00**** McNemar	Φ = .71*** McNemar	Φ = .90**** McNemar
SSA vs. SCSA	Φ = .91**** McNemar	Φ = .58* McNemar	Φ = .65** McNemar
SSA vs. LSCSA	Φ = 1.00**** McNemar	Φ = .29 McNemar***	Φ = .65** McNemar

* $p<.05$ ** $p<.01$ *** $p<.005$ **** $p<.001$

Key:

TYP Typically Developing

WA With Autism

LD Learning Disabilities

SSA Standard Sally-Anne

LCSA Light Cued Sally-Anne

SCSA Sound Cued Sally-Anne

LSCSA Light and Sound Cued Sally-Anne

In Table 7.10 Phi statistics indicate the degree of association between each of the cued conditions while McNemar tests indicate the significance of the difference in difficulty between the cued conditions for the three groups of participants. Inspection of these data reveals that for all groups of participants the three cued conditions are correlated, indicating similar patterns of responding, with one exception. For the children with autism the LCSA condition did not correlate with the LSCSA condition. Similar to the SSA task and the LSCSA condition, the pattern of responding of the children with autism was significantly different. McNemar statistics reveal that for the typically developing children and the children with LD all cued conditions did not influence to a significant degree the difficulty of the task. This was not the case for the children with autism. For the children with autism there was no significant difference in difficulty between the LCSA and SCSA conditions. However the SCSA condition was shown to be significantly more difficult than the LSCSA condition. Similarly the LCSA condition was shown to be significantly more difficult than the LSCSA condition. So for children with autism the condition that provided the greatest amount of cueing, the LSCSA condition, was shown to be significantly easier than not only the SSA task, but also the LCSA and SCSA conditions. This was not the case for either the typically developing children or the children with LD, suggesting that the combined light and voice cueing assisted the children with autism in a way that appears to be autism specific.

Table 7.10

Phi and McNemar Statistics for the Relationship Between the Different Cued False Belief Tasks of Experiment Five

	TYP	WA	LD
LCSA vs. SCSA	Φ = .91**** McNemar	Φ = .61** McNemar	Φ = .73*** McNemar
LCSA vs. LSCSA	Φ = 1.00**** McNemar	Φ = .41 McNemar*	Φ = .73*** McNemar
SCSA vs. LSCSA	Φ = .91**** McNemar	Φ = .50* McNemar*	Φ = 1.00**** McNemar

* p<.05 ** p<.01 *** p<.005 **** p<.001

Key:

TYP	Typically Developing
WA	With Autism
LD	Learning Disabilities
SSA	Standard Sally-Anne
LCSA	Light Cued Sally-Anne
SCSA	Sound Cued Sally-Anne
LSCSA	Light and Sound Cued Sally-Anne

7.3.4 Discussion of Experiment Five

The results of the current study support both hypotheses outlined in the introduction to this study. Firstly it was hypothesised (prompted by the findings of Experiment Four), that conditions in which cueing is provided uni-modally would not prove to be significantly different in difficulty when compared to the standard test of false belief for typically developing children, children with learning disabilities or children with autism. This was the case. For all three groups of children there was no significant difference in difficulty between the standard test of false belief and the light-cued condition or between the standard test of false belief and the voice-cued condition. This replicates the findings of Experiment Four where typically developing children and children with autism found the standard test of false belief and a modified test of false belief that included auditory cueing (in the form of spoken recall) to be non-significantly different in difficulty. The performance of both groups of children did not improve significantly when auditory cues were provided.

Secondly it was hypothesised that for scenarios in which cueing is provided multi-modally, that performance of children with autism will improve significantly but that performance of typically developing children and children with learning disabilities will remain unaltered. The latter hypothesis was based on the belief that the mechanisms leading to failure for the three groups of children are separate and distinct. It was hypothesised that for children with autism, false belief failure is linked to difficulties in the encoding and retrieval of information and that failure can be improved by the provision of appropriate retrieval cues. Conversely typically developing children and children with learning disabilities who fail tests of false belief do so as a result of a true false belief inability and therefore cannot be assisted by the provision of retrieval cues. Again the results of the current study support this hypothesis. Of the three groups of participants, only the performance of the children with autism was shown to significantly improve as a result of a combination of light and voice cues that were provided to them. For the children with autism the condition that provided them with multi-modal cueing was shown to be significantly easier than the standard test of false belief. For the typically developing children and children with learning disabilities multi-modal cueing did not significantly improve performance. For these two groups of participants the condition in which both auditory and visual cues were provided was shown to not significantly differ in difficulty to the standard test of false belief. The finding that the children with autism benefited from the multi-modal cueing while the typically developing participants did not is surprising considering that the participants with autism had lower IQ than the typically developing participants. However the positive effect of the multi-modal cues cannot be attributed to level of IQ as the children with learning disabilities, who along with children with autism had low IQ, performed similarly to the typically developing children when provided with multi-modal cues.

From these findings it is possible to conclude that the provision of multi-modal cues assisted the children with autism in a manner that is likely to be specific to that population. Furthermore the effectiveness of retrieval cues shows the importance of memory in false belief performance, especially for individuals with autism.

7.4 Discussion of Experiments Four and Five

To guide this discussion four very important questions need to be posed:

1. Why, in Experiment Five, did a false belief condition in which cues were provided multi-modally (light and voice) result in significantly improved success for children with autism when compared to tests of false belief that provided cues uni-modally (either light or voice)?
2. Why, in Experiment Five, did a false belief condition in which cues were provided result in significantly more success for children with autism when compared to a test of false belief that provided no cues?
3. Why, in Experiment Five, did a false belief condition in which cues were provided result in significantly more success for children with autism but not typically developing children or children with learning disabilities when compared to a test of false belief that provided no cues?
4. What does the significantly improved performance of the children with autism on the false belief test, where cues were provided, suggest about how children with autism encode information?

In Experiment Five it was shown that in a false belief condition that provided participants with a combination of light and voice cues so as to aid success on the false belief question, the performance of the participants with autism was shown to significantly improve. This was in comparison to tests of false belief that provided participants with either a light or a voice cue and indeed when compared to a false belief test where no cues were provided. What can explain why the light and voice combined cueing condition assisted the children with autism while the other cueing conditions did not significantly affect their performance? One possible explanation could be stimulus overselectivity (Lovaas, Schreibman, Koegel & Rehm, 1971) that occurs when individuals who are presented with a complex stimulus respond to only one or a reduced number of stimulus components; and the encoding specificity principle (Tulving & Pearlstone, 1966; Tulving & Osler, 1968; Thomson & Tulving, 1970) which suggests that cues for memory retrieval cannot be effective unless those same cues are encoded with the information to be remembered at the time of its storage.

Lovaas, Schreibman, Koegel and Rehm (1971) first coined the term stimulus overselectivity in an attempt to explain particular responding by children with autism in a study investigating selective responding. Within this study, children with autism, children with retardation, and typically developing children were taught to respond via reinforcement to a complex stimulus involving a combination of auditory, visual and tactile cues. When the stimulus was presented, participants were taught to press a bar for which reinforcement (candy) would be delivered. Having been taught the bar pressing response in the presence of the complex stimulus, participants were presented with the individual components of the complex stimulus to see which component or components acquired control over the bar pressing behaviour. The children with autism responded primarily to one stimulus component, the typically developing children to all three components and the children with retardation in-between these extremes. Lovaas et al. (1971) explained the performance of the participants with autism in terms of stimulus overselectivity, whereby their responding was under the control of a limited number of cues. The participants with autism overselected a particular cue to attend to, therefore only being able to respond in the presence of the particular cue that was overselected for attention.

Following the pioneering research of Lovaas et al. (1971), other research investigating stimulus overselectivity and autism has shown that individuals with autism: have difficulty responding to multiple visual cues (Koegel & Wilhelm, 1973); have difficulty responding to multiple auditory cues (Reynolds, Newsom & Lovaas, 1974); show stimulus overselectivity even when components are initially taught separately and then combined (Koegel & Schreibman, 1977); are likely to be deficient in observational learning due to stimulus overselectivity (Varni, Lovaas, Koegel & Everett, 1979); experience difficulties with generalisation (Rincover & Koegel, 1975). More recent research conducted by Rincover and Ducharme (1987) investigated the variables that may influence stimulus overselectivity – diagnosis, the location of stimulus cues and mental age. In terms of autism, perhaps the most informative finding was that concerning the location or placement of stimulus cues. Comparing two complex stimuli, one termed 'within-stimulus' where the cues were physically connected and the other labelled 'extra-stimulus' where the cues were physically separated, it was found that the participants with autism responded overselectively only in the extra-stimulus condition. In non-behavioural terminology the participants with autism focused on one element of a situation when the elements were separated by space, but not when the elements were combined.

Translating this to false belief tests, participants see where a character leaves an object (Sally places her key under the yellow cup) and are told via the false belief test script where a character leaves an object ("...Sally puts her key under the yellow cup..."). Considering the findings reported by Rincover and Ducharme (1987) because the visual and auditory information is not connected in space, the participants with autism are likely to attend to either the visual information or the auditory information, but not both. That is the participants with autism overselectively attend to and encode only one component of the stimulus situation. Combining this with the encoding specificity principle, unless the same information provided to and subsequently encoded by participants within the false belief script is also given to them under recall conditions, the cues are likely be ineffective. It follows then that only the participants that encoded the auditory information would benefit from the auditory cues and similarly only the children that encoded the visual information would benefit from the provision of visual cues. However if both visual and auditory cues were provided, children that encoded either the visual or auditory information would benefit. This was shown to be the case for the children with autism. A significantly greater number of participants were successful at the false belief test when both visual and auditory cues were provided to them. To summarise, the children with autism showed a significantly improved performance when both visual and auditory cues were provided to them. Even if the information was encoded overselectively (that is either the visual or the auditory information), the provision of combined modal cues aided retrieval. The notion of stimulus overselectivity and the encoding specificity principle support this finding.

It is equally important to look at the way that the children with autism responded to the false belief question in the current studies (and indeed how false belief failers with autism typically respond) when appropriate cues were not provided to them. That is when either no cue was provided or indeed uni-modal cues were provided. In almost all cases children with autism respond with the location that the object was moved to. As suggested by the encoding specificity principle no amount of cueing, however strong, will assist recall if those same cues were not present at the time of storage. But why would children with autism revert to a response of where the object currently is rather than where an object was left? An explanation can be provided in terms of recency. The information related to where the marble was moved to, and therefore currently is, is the last piece of information to be encoded and stored within the false belief scenario. Considering that the false belief question is always the first to be delivered, if one is to accept that the children with autism did not encode the scenario information appropriately to solve the false belief question, then children with autism are likely to default to the information provided to them most recently. That is, the place to which the object was moved. This contention is supported by memory research into how children with autism employ short-term memory to process auditory and visual stimuli. Such research has often shown strong recency effects, such as in the recall of phrases (Hermelin & Frith, 1971; Boucher, 1978) or in the manner in which they process visual stimuli (Hermelin & O'Connor, 1975). So it may be argued that a stronger recency effect in this group results in information about where an object currently is in a false belief scenario being reverted to and utilised by children with autism in order to answer the false belief question. If however an appropriate level of cueing is provided, as suggested by the encoding specificity principle, then (as it was shown in the results of the current studies) children with autism will significantly improve their false belief performance.

While stimulus overselectivity and the encoding specificity principle may provide a persuasive explanatory account for why children with autism were significantly more successful on a false belief test that provided cues multi-modally versus identical tests that provided cues uni-modally, the encoding specificity principle cannot explain why the same children responded to the multi-modal cues in the first place. That is the encoding specificity principle cannot explain why children with autism were more successful on a false belief test that provided them with cues versus a false belief test that provided them with no cues. The central question remains: “Why were the cues successful in aiding the false belief performance of the children with autism?” It can be argued that because the children with autism were aided by the provision of cues that they had the information stored in their memory, but because this information was encoded inadequately they could not retrieve it without the assistance of cues. As discussed in the introduction to this study, memory involves three basic processes – encoding, storage and retrieval. Encoding was described as the putting of information into memory and the transformation of this information so that it can be successfully retained. Storage was described as how information is held within memory so that it can be accessed as and when required. Finally retrieval was described, as the process of ‘getting back’ information that is needed so as to act, respond and behave appropriately in different situations and contexts. When considering autism and the performance of children with autism on tests of false belief, the storage of information is unlikely to be deficient. If the information concerning where an object was left and where an object currently is, is stored inappropriately, the memory and reality questions would be impossible to pass. Having raised this point, the information that is required to succeed at the false belief question can be considered identical to the information that is required to pass the memory question. That is, where an individual left an item before it was unexpectedly moved without their awareness. Then again, if this information were only encoded as where the item was left and not as where someone may look for the item in the future, then it would be possible to pass the memory question but still fail the false belief question. Considering this argument it becomes likely that children with autism may not be encoding information gathered within false belief scenarios in ways that will allow them to solve problems in the future. Perhaps the children with autism who fail tests of false belief only encode the information they are presented with in the identical form that it is initially provided, rather than encoding it as a generic piece of information that can be used in many ways to answer questions and solve problems. Wing (1976) provides support for this argument. Wing (1976) states that even though children with autism can encode and subsequently store information within memory for extensive periods of time, the way in which the information is encoded and stored is different from how typically developing children encode and store information. Wing (1976) clarifies this by stating that when children with autism encode and store information they do so without interpreting it or changing it in any way. So in terms of false belief scenarios in general, and memory, reality and false belief questions in particular, the children with autism who fail the false belief question but pass the memory and reality questions could well be encoding and storing the information that is needed to pass all three questions in the way that the information is initially presented, that is where an object was left and where an object currently is, and not as both where as object was left and where someone may look for that object in the future (even if the object is unexpectedly moved).

The claim that when children with autism encode and store information they do so without interpreting it or changing it in any way can also be explained in terms of categorisation. Explained by Klinger and Dawson (1995) "categorisation is a mental process that allows individuals to integrate new information with previous experiences" (p.119). Very rarely are categories directly taught. Rather when presented with novel stimuli, individuals abstract category information from previous experiences so as to successfully identify what the new stimulus is. It is suggested that this process is made easier by storing summary images or prototypes in memory (Posner & Keele, 1968, 1970; Rosch, 1978). What this prevents is the need to store all individual category members into memory. Instead a single prototype is stored into memory that possible new category members are compared against to ascertain category membership. For example if one has a stored prototype of what a horse is, it is likely that a novel horse will be categorised as belonging to the horse category because of its similarities to the prototype. Klinger and Dawson (1995) hypothesised that children with autism are deficient in the ability to form categories using abstraction-based prototype strategies and argued that children with autism rely solely upon a concrete rule-based approach to understanding the world around them. To test their hypothesis, Klinger and Dawson (1995) compared children with autism, children with Down syndrome and typically developing children on rule-based and prototype-category learning. Klinger and Dawson (1995) found that both the children with autism and the children with Down syndrome were able to categorise when provided with concrete rules to follow, however in the absence of a concrete rule, both groups had difficulty categorising. Klinger and Dawson (1995) therefore suggested a specific impairment in the ability of both groups of children to form an abstract summary representation, or prototype, when categorising. Due to the inability to categorise according to prototypes children with autism are similarly likely to be unable to make inferences based on past experience. So, when encoding information, because children with autism encode according to how information is initially and specifically presented, this information is unlikely to be successfully used in a generic way so as to make inferences in the future. In terms of false belief, because the children with autism encode the information as specifically where Sally left an object and where

Anne moved the same object to (and therefore where that object currently is), this same information cannot be used to answer a question as to where Sally will look for her object in the future, given that the object had been unexpectedly moved by Anne without her awareness. The information is encoded specifically not generally therefore preventing inferences to be made. This may explain why the children with autism successfully pass the memory and reality questions but still fail the false belief question. In order to answer the memory and reality questions participants need to know where an object was left and where an object currently is, which is precisely how the information is presented, while to pass the false belief question the same information needs to be utilised in a general manner. However if the information is only available in the specific form it was presented then answering the false belief question accurately would prove impossible.

Research contradictory to the findings of Klinger and Dawson (1995) has recently emerged. Molesworth, Bowler and Hampton (in press) conducted a series of experiments investigating the categorisation abilities of children with high-functioning autism and typically developing controls. Using a similar technique to Klinger and Dawson (1995), Molesworth et al. (in press) found that the children with autism were unimpaired on tasks that require categorisation according to prototypes and stands in contrast to previously reported predictions of impaired prototype effects in autism. Molesworth et al. (in press) provide some methodological differences between their studies and the study of Klinger and Dawson (1995) that may provide an explanation for the conflicting results. These differences were: in the Klinger and Dawson (1995) study participants were required to make a decision on category membership whereas in the studies presented by Molesworth et al. (in press) participants were only expected to make a recognition decision by deciding whether or not they had seen the stimulus before; both groups included in the study by Klinger and Dawson (1995) had developmental delay, whereas neither group in the Molesworth et al. (in press) studies did; the verbal mental ages of the participants with autism in the study presented by Klinger and Dawson (1995) were significantly lower than those of the participants recruited by Molesworth et al. (in press). Molesworth et al. (in press) however did not (overtly) mention one crucial difference between the two studies. During the familiarisation trials in the Klinger and Dawson (1995) study participants were first shown a category member and told its' name (e.g. Dak). Afterwards category members and non-category members were displayed in pairs. Participants were asked to identify the category member on each trial by touching it. Molesworth et al. (in press) employed a different familiarisation technique - participants had to sort the familiarisation stimuli into their respective categories (e.g. animals and birds). It has been documented that individuals with autism are unimpaired on tasks that require sorting of category stimuli (Tager-Flusberg, 1985; Ungerer & Sigman, 1987). The fact that the participants within the study conducted by Molesworth et al. (in press) sorted the familiarisation stimuli may have provided them with an advantage. To sort stimuli one must group according to similarity; to abstract prototypes one must also focus on similarity so as to be able to determine an average or a prototype. Adopting the categories employed by Molesworth et al. (in press) participants were familiarised to the stimuli by grouping animals separately from birds and monsters separately from insects. The familiarisation conditions of the two studies differ markedly both procedurally and perhaps more importantly from the perspective of encoding. Participants in the Klinger and Dawson (1995) study were familiarised to individual stimuli separately while the participants in the Molesworth et al. (in press) study were familiarised to the stimuli on a group basis. It is likely that the participants that were familiarised to individual category members encoded this information as it was presented, separately. It is equally likely that the participants that grouped category members encoded the information again as it was presented (via sorting), at a group level. Resulting from group encoding is the possibility that commonalities are more likely to be identified between individual stimuli.

Sorting tasks facilitate immediate generalisation, as in order to sort one must ascertain commonality. Related to this argument are the differing requirements of the familiarisation conditions for successful development of a prototype. If items are presented independently of each other, individuals must actively seek commonality between individual items from memory, whereas commonality is a pre-requisite for successful sorting. In summary while it may appear that Molesworth et al. (in press) provide evidence for an unimpaired prototype effect in autism, what is more likely is that a means of reducing the prototype effect impairment in autism was discovered. If individuals with autism encode information they are presented with, in the identical form that it is initially provided, rather than encoding the information generically, it is conceivable that sorting related stimuli may allow for a more general comprehension of what something is, as sorting allows for the encoding of multiple yet slightly differing pieces of information at the same time. To illustrate this, consider the following example. To successfully sort a tall thin orange mug, a short fat green mug, a white mug with an elongated handle and a yellow mug with a handle close to the beaker, a black car with four doors, a purple car with two doors, a silver car with an open top and a brown car with a hatchback, one must derive commonality between the associated objects. In this case the most obvious similarity between the mugs are the handles while the commonality between the cars is the fact that all have four wheels. This allows me to form a prototype more easily than just being presented with one mug and one car, which if I encode information statically in the way that it is presented, is not at all useful in the derivation of a prototype, for as far as I am aware a mug is that particular mug and a car is that particular car. Another possibility is that the sorting of stimuli provided participants with indirect rules to follow as to the categorisation of the groups of stimuli, for example mugs have handles and cars have four wheels. To investigate the influence of the different familiarisation techniques with regards to prototype effects, one would have to directly compare individual item familiarisation (like in the study by Klinger and Dawson, 1995) and group familiarisation via sorting (similar to that utilised by Molesworth et al., in press).

The possible inefficient encoding of information by children with autism is given further support when considering stimulus overselectivity. Recall that stimulus overselectivity is "a problem of dealing with stimuli in context" (Lovaas, Schreibman, Koegel & Rehm, 1971, p.219), whereby children with autism respond to only a limited number of cues in their environment (Lovaas, Koegel & Schreibman, 1979) and more specifically the effect that stimulus overselectivity has upon stimulus generalisation, that is, the extent to which a behaviour learned in one situation transfers to new and possibly different situations (Lovaas et al., 1979). So, if children with autism only select a particular or specific part of a situation to focus upon when they are learning, transfer to new situations will be limited, because only those particular parts will be available for use. Translating this to tests of false belief, if children with autism focus specifically upon where an object if left and subsequently where an object is moved to, then when presented with a new situation of where someone may look for that object in the future, because this information is not available for use, children with autism will consequently fail.

While inefficient encoding strategies may provide some answers as to why the children with autism in Experiment Five showed significant improvements in levels of performance on tests of false belief where cues were provided versus tests where cues were absent, what accounts for the typically developing children and children with learning disabilities not benefiting from the identical cues? When considering encoding and retrieval, and cues that can be of assistance to the retrieval process, it is unlikely that cues will be successful in aiding retrieval unless one has the information stored within memory. That is, if the information is not there then it cannot be cued for retrieval. From a slightly different perspective, if an individual claims to know something and they are subsequently cued to provide a contradictory response, they will tend not to provide the response that contradicts what they apparently know to be the case. In order to clarify this argument an example may be helpful: If a person knows that the capital of Australia is Canberra, if they are cued to respond "Sydney" when asked what the capital of Australia is, they are highly unlikely to respond "Sydney", unless of course they do not have the correct information or what they consider to be the correct information available to them. Returning to false belief questions, because typically developing children prior to the age of four years do not possess the ability to understand the minds of others and in fact truly think that an individual will look where an item currently is and not where they left it, they should not respond accurately with a cue that tells them that the individual will in fact look for the item in the place that they initially left it. This was the case in Experiment Five. The typically developing children and indeed children with learning disabilities that failed the standard false belief test also failed the modified false belief tests that provided them with cues as to what the correct response was. For these participants there was no significant difference in difficulty between the standard false belief test and the tasks that provided them with cues. It might be argued then that the typically developing children and children with learning disabilities, because they truly thought that Sally would look where the object had been moved to, rather than where she had left it, failed to take up the cues so as to respond accurately. On the whole, the children with autism however, successfully utilised the cues within the light and voice-cued false belief task. For the children with autism the light and voice-cued false belief task was significantly easier than the standard test of false belief. Given the arguments offered this far it could be that the children with autism had the appropriate information within memory so as to correctly pass the false belief question but because of inadequate encoding of the information, they failed, unless they were provided with appropriate cues to retrieve the information. It is conceivable that the children with autism knew all along where the character in the false belief task would look for their item but because they could not retrieve the correct information as it was encoded in a different manner, when asked the false belief question, they failed. It seems reasonable to assume that if the children with autism (like the comparison participants) truly believed that the character would look where the item was moved to rather than where they left it, no amount of cueing would change their belief. If I truly believe that the capital of Australia is Sydney no amount of cueing telling me that the capital is indeed Canberra would alter my response to the question "What is the capital of Australia?" This further supports the argument made earlier that children with autism fail tests of false belief not because they lack a theory of mind but rather because they encode information specifically in the way that it is presented to them.

Typically developing children possess typical memory abilities and therefore encode information in ways that allows them to potentially answer questions and solve problems in the future. In particular typically developing children encode and store information in a manner that allows them to interpret and change it so as to solve problems effectively. They encode information in a generalised fashion and not simply in the manner in which it is initially presented. This appears to be in contrast to how children with autism tend to encode and subsequently store information within memory.

There are however alternative explanations of the results of the current experiments. In general these explanations centre on potential difficulties that children with autism have with the utilisation of episodic information. Recall from the introduction that episodic memory is thought to be that memory that is involved in the remembering of past events, while semantic memory is considered to be the memory for known facts. Bowler, Gardiner and Grice (2000) clarify this:

> One state, that of remembering, involves bringing back to mind contextual details of previous events and experiences that include an awareness of one's self, usually at a particular time, and in a particular place. The other state, that of knowing, involves no such remembering, but is rather a more abstract awareness of knowledge (p.295).

In tests of false belief it becomes evident from the clarification provided by Bowler et al. (2000), that the false belief question could be regarded as requiring episodic memory abilities in order to pass it, that is participants have to truly remember the information whereas the reality and memory questions could be regarded as only requiring semantic information so as to pass. That is, in order to pass these questions participants only have to know where an object currently is and know where that same object was left respectively. Participants do not necessarily need to remember this information, remember this information that is, in terms of experiential awareness or as a general event. This could explain why children with autism tend to fail false belief questions whilst at the same time passing the associated reality and memory questions. This becomes even more likely when considering the findings of research that was discussed within the introduction of the current two studies that suggest that children and individuals with autism are characterised by impairments in episodic memory. Research has shown individuals with autism to be impaired on tests of free recall but unimpaired on tests of cued recall (Bennetto et al., 1996; Boucher & Lewis, 1989; Tager-Flusberg, 1991). These findings may have important implications due to the types of information that assist in the two types of recall. Free recall depends much more on episodic trace information, information for which one is experientially aware as no cues are provided. Cued recall, because cues are provided, is rich in the other type of information, semantic cue information. Additionally research has provided evidence that individuals with autism could possibly be impaired in the retrieval of information from episodic memory (Bowler et al., 2000). Furthermore research conducted by Bennetto, Pennington and Rogers (1996) suggests that individuals with autism have deficits in certain episodic memory tasks and particularly on those episodic memory tasks that place greater demands on executive function. It would appear that perhaps individuals with autism have specific difficulties with the encoding and / or retrieval of episodic events or rather display a general impairment in episodic memory. While it is difficult to conclusively determine the latter from the findings of the current experiments, what becomes more likely is that there is a deficit in the encoding of episodic information by children with autism.

It is possible to combine several of the explanations presented here. Episodic memory, free recall, abstraction-based categorisation and autonoetic awareness can all be considered to be related as could cued recall, semantic memory, rule-based categorisation and noetic awareness. While many of the concepts mentioned just now have been covered previously, it is necessary to revisit them so as to relate the current findings to research investigating the aforementioned areas as well as to provide a integrated argument and explanation of the current findings.

A connection has been made between episodic memory and free recall for free recall relies heavily upon episodic trace information (Tulving, 1985; Perner & Ruffman, 1995). A further connection has been made between episodic memory and a state of consciousness known as autonoetic consciousness (Tulving, 1985). Autonoetic consciousness involves a degree of experiential awareness, that is it involves the bringing back to mind contextual details of previous events and experiences. In this sense autonoetic consciousness can be said to involve the reliving of experiences so as to potentially solve problems, or the reliving of experiences so as to use these general experiences to understand a wide array of associated situations. Finally a link can be merged between autonoetic consciousness and categorisation using abstraction-based prototype strategies, where individuals integrate new information with previous experiences (Klinger & Dawson, 1995). This link can be assumed due to the relationship that abstraction has with previous experience, whereby abstraction requires one to abstract meaning from experience. From this it can be argued that there is a common thread between episodic memory, free recall, autonoetic consciousness and abstraction-based categorisation, for all rely to some extent upon general information of experiences stored within memory.

It is also possible to make connections between semantic memory, cued recall, noetic consciousness and rule-based categorisation. Connections have already been made between semantic memory and cued recall whereby cued recall relies less on episodic trace information due to the fact that cues are provided (Tulving, 1985). Similarly Tulving (1985) associates semantic memory to a state of consciousness known as noetic consciousness, where individuals are aware that an event has happened but whereby this awareness is more fact-based rather than experiential in nature. When considering categorisation one can see a relationship between rule-based categorisation and noetic consciousness, for rule-based categorisation relies predominantly upon facts, rather than general experiences or prototypes (Klinger & Dawson, 1995).

Research has provided evidence that individuals with autism: are impaired on tasks that require free recall (Bennetto, Pennington & Rogers, 1996; Boucher & Lewis, 1989; Perner & Ruffman, 1995; Tager-Flusberg, 1991); display impairments in episodic memory (Bennetto, Pennington & Rogers, 1996; Boucher & Lewis, 1989; Bowler, Gardiner & Grice, 2000); show impairments in remembering versus knowing hence impairments with autonoetic consciousness (Bowler et al., 2000); show impairments in abstraction - based categorisation (Klinger & Dawson, 1995); show stimulus overselectivity (Lovaas, Koegel & Schreibman, 1979; Lovaas, Schreibman, Koegel & Rehm, 1971); have problems with stimulus generalisation (Rincover & Koegel, 1975). Taking these findings into account, the results of the current experiments can be best explained in terms of impairments that children with autism have with the encoding of information. More specifically the findings reported here provide evidence that children with autism, when encoding information, do so according solely to how the information is initially presented without changing it or altering it in any way. This information appears to be encoded in isolation and can only be used to understand the exact experience in which the information was initially encoded, rather than encoding the information as a generic event or prototype that can be used to understand an array of related situations. In terms of the false belief tests reported here, it would appear that children with autism encode the information that Sally left her key under the yellow cup and that Anne moved the key to the blue cup (so that is where the key is currently) in a raw, perhaps overselective manner, rather than encoding the information in a connected way that could be drawn upon so as to successfully solve the false belief dilemma. This line of reasoning may form the basis for a plausible account of why the children with autism passed the memory and reality questions yet failed the false belief question, that is, unless they were provided with appropriate cues to retrieve the information. That children with autism showed significantly improved performance when cues were provided to them, suggests that they did have the appropriate information available to them, but because the information was encoded as specific rather than general events, the same information could not be used to solve the false belief question.

It is possible to suggest, from the findings of the current studies, that multi-modal (auditory and visual) cues enhance the false belief performance of children with autism. Multi-modal cues were not found to enhance the false belief performance of typically developing children or children with learning disabilities. As mentioned before, this suggests a likely autism-specific deficit in memory. Low IQ can be excluded as a mediating variable as the children with learning disabilities performed similarly to the typically developing children, yet, like the children with autism, had low IQ. In particular, it is argued that the results of the current experiments can be best explained in terms of an autism-specific deficit in the encoding of information. Preliminary suggestions by Boucher and Lewis (1989) and preliminary evidence provided by Tager-Flusberg (1991) however suggest that memory difficulties in autism are likely to be more related to retrieval strategies rather than the encoding of information. However the arguments provided by Tager-Flusberg (1991) are largely based on findings that children with autism are unimpaired on cued recall tasks rather than considerations of whether the retrieval of episodic information by children with autism can be assisted by the provision of appropriate cues. Additionally research investigating the categorisation abilities of individuals with autism suggests that there is impairment in the way that individuals with autism encode new information. Mesibov, Adams and Klinger (1997) make the point that typically, when learning a new category, one does not memorise every example one sees. Rather people abstract across different examples so as to form a prototype. Klinger and Dawson (1995) suggest that individuals with autism, while able to form categories using rule-based strategies (as often shown via their indifferent performance when compared to controls on the Wisconsin Card Sorting Task - WCST), are unable to form categories using abstraction-based prototype strategies. This notion of categorisation and abstraction-based prototype strategies may provide support for the argument that for children with autism the false belief question may be difficult without cues, as the information for a correct answer to the false belief question was encoded in a manner that does not allow the child to abstract understanding and make inferences about where that same object may be located in the future.

It would be interesting to compare tests of false belief where cues are provided and tests of false belief where no cues are provided; free recall tests and cued recall tests; and tests of abstraction-based prototype categorisation and rule-based categorisation to see if there are correlations among the different tests for children with autism and, of course, controls. Finding a correlation between cued tests of false belief, cued recall and rule-based categorisation and between standard tests of false belief, free recall and abstraction-based prototype categorisation specifically for participants with autism would greatly support the findings reported here as well as clarifying the memory difficulties of children with autism in general. Such a correlation would suggest a specific impairment in autism with the encoding of episodic information. At present, from the studies outlined here, it is only possible to propose an autism-specific deficit in the encoding of generic information, even though the false belief information may well be considered to be episodic in nature.

On the basis of the findings yielded from the studies this far, there appears to be a growing body of evidence to suggest that an autism-specific deficit in encoding may be mediating performance in complex cognitive tasks, such as the Sally-Anne test of false belief.

Chapter Eight

General Discussion

The discussion to follow will be divided into three sections. Firstly the studies outlined within the main body will be reviewed. In addition the findings of the individual studies will be related to current accounts of autism. Secondly the findings of studies reported will be contextualised within the broad domain of autism research. Finally propositional accounts of deficits in autism, based on the findings of the current studies as well as published research will be provided.

The collection of investigations reported here were triggered by an innovative proposal by Bowler, Briskman, Gurvidi and Fornells-Ambrojo (in press) and driven by unresolved concerns related to the adequacy of the theory of mind-deficit account of autism. Within their research Bowler et al. (in press) successfully constructed a non-mental state mechanical analogue of the unexpected transfer test of false belief. The constructed analogue was found to be strongly correlated with and of equal difficulty to the Sally-Anne test of false belief for three groups of participants – children with autism, children with moderate mental retardation and typically developing children. This finding led Bowler et al. (in press) to suggest that, irrespective of the diagnoses of the participants, failure of the unexpected transfer test of false belief might not, as is so widely claimed, be due to a specific failure to understand mental states, but rather due to some general difficulty in understanding the signal-mediated behaviour of goal-directed agents.

Experiment One set out to replicate the findings of Bowler et al. (in press) in order to provide further weight to the proposition that arbitrariness has a mediating effect upon performance of false belief tasks in individuals with autism. Despite variation to the Bowler et al. (in press) protocol, this replication yielded findings consistent with their study. The false belief analogue in Experiment One involved the use of a train apparatus. Participants were required to predict the destination of a train (that was to collect goods from a plane), which was directed by lights presented either in the middle or at the end of a straight piece of track or else by means of a sound. In all three conditions a plane landed at either a blue or a yellow landing pad. At this point either a blue or yellow light was displayed or a landing pad-specific sound was heard. The plane and the landing pad were then covered and the participants were asked to predict the destination of the train, with the knowledge that the train was automated and directed by only the light or the sound. As well as the train tasks participants were presented with a standard unexpected transfer test of false belief. It was found that the train condition that provided light signals to participants from the ends (landing pads) of the train track correlated the most strongly with the standard test of false belief for both typically developing children and children with autism. In addition the landing pad task and the test of false belief did not significantly differ in difficulty for both groups of participants, hence showing that the landing pad task was a good analogue of the false belief test. When examining the degree of difficulty between all conditions it was found for the typically developing participants that no train task differed in difficulty when compared to the test of false belief. However for the participants with autism the condition where the lights were presented in the middle of the train track was significantly easier than the test of false belief, while the sound condition was significantly more difficult.

At the outset these results would appear to, and in some instances do, provide support for the executive dysfunction hypothesis of autism (Pennington, Rogers, Bennetto, McMahon-Griffith, Reed & Shyu, 1998; Russell, 1998a, 1998b; Russell, Jarrold & Hood, 1999; Hughes & Russell, 1993; Biro & Russell, 2001). In particular the assertion that executive dysfunction accounts for poor performance of individuals with autism due to the presence of arbitrary rules[57]. Arbitrary rules in this sense refer to rules that do not provide a natural causal link to an outcome. In Experiment One, because the landing pad condition was shown to be a good analogue of the false belief test, the two tasks can be considered to be equally arbitrary. What then of the condition where light signals were presented in the middle of the train track and indeed the sound condition. As previously mentioned only the children with autism found these two tasks to be of differing difficulty when compared to the test of false belief. So it may be inferred that the differences between these conditions when compared to the landing pad condition (because the landing pad condition was shown to be a good analogue of the false belief test) might provide a fruitful starting point from which to develop an explanation for why children with autism find false belief tests difficult to pass. Arbitrariness was proposed as the mediating variable. In the sound condition, the rules attached to this task were considerably more arbitrary than the rules attached to the landing pad task. In the central light condition the difference in arbitrariness (when compared to the landing pad light condition) was not so clear. It is reasonable to assume however, that a condition in which light signals are placed at the correct destination will be less arbitrary than a condition where light signals are placed in an unrelated, non-causal location. That is, there is a greater causal link when the light is presented at the same location to which the train should travel.

Considering the difference between the two conditions when compared to the false belief test for the children with autism, it is possible to explain the fact that the sound condition was more difficult than the landing pad condition because of an increase in

[57] Russell (1998b) makes the point that children with autism are impaired only on executive tasks that contain arbitrary rules.

arbitrariness. The same cannot be said though for the difference between the landing pad and central light conditions. It may be that for the children with autism the central light condition was less arbitrary than the landing pad light condition, but this would be deviating from a wide consensus of what dictates arbitrariness. So while the results of Experiment One provide some support for the executive dysfunction hypothesis of autism, the support is not conclusive.

The weak central coherence explanation of autism (Frith, 1989) can also be utilised to explain some of the findings of Experiment One. This account suggests that because individuals with autism have a weakened drive for central coherence, the same individuals are said to be deficient in the processing of wholes rather than parts of stimuli. Relating a weak drive for central coherence to Experiment One, it becomes evident that for the sound condition the participants with autism may have only processed the sound as a sound and not as a link to where the train would travel. This could explain why the participants with autism passed the memory question but still failed the false belief question, as the sound was processed only as a sound and not as a whole experience that may be used to solve the false belief problem. The question of how the central coherence explanation can account for the relative ease of the central condition and the relative difficulty of the sound condition when compared to the landing pad condition remains. In both the landing pad and central conditions the same signals were provided to the participants – a light. If the participants only processed the light as a light and not as a signal for a train to travel to a destination, then the two conditions would have been equally difficult. The same can be said for the sound condition, in that a similar amount of information was provided to the participants albeit via a different modality. So why was the sound condition significantly more difficult than the landing pad condition and the central condition for the participants with autism? The central coherence explanation cannot adequately account for these findings.

As both the executive dysfunction hypothesis and central coherence explanation of autism failed to adequately account for the findings just discussed, alternative explanations were sought. In particular it was considered fruitful to investigate attentional differences between the two conditions and differences between the types of information and the manner in which the information was presented within the two conditions. Prior to this exploration the role of arbitrariness in tasks that involve auditory cues was investigated.

To further explore the possible effects of differing levels of arbitrariness of auditory information on the performance of children with autism on tests of false belief, the sound condition from Experiment One was replicated along with conditions that differed according to levels of arbitrariness. In Experiment Two, children with autism and typically developing children were presented with three train tasks: a task where signals took the form of high/low tones (as in Experiment One); a task that utilised multiple and continuous tones; and a task that provided participants with pre-recorded voice information indicating the location that the train was to travel; as well as a standard test of false belief. All of the children with autism, including the standard false belief passers failed both the high/low and multiple/continuous conditions, suggesting that both tasks were more difficult than the test of false belief for these children. The voice condition however was shown to be significantly less difficult than the test of false belief for the children with autism. If the discussion was to end here it could be argued that the arbitrary component of the executive dysfunction hypothesis could be used to explain the differential responding by children with autism. However both the children with autism and the typically developing children found the voice condition significantly easier than the test of false belief. It may be reasonable to use this finding to rule out arbitrariness as an explanation of why children with autism find tests of false belief particularly difficult. If arbitrariness was the discriminating variable then typically developing children should not have also found the voice condition significantly easier than the test of false belief. These conclusions do however need to be treated with some caution as for the typically developing children the sound condition in Experiment One and all sound conditions in Experiment Two did not correlate with the standard test of false belief. Therefore it may be that for the typically developing children the train conditions that utilised sound signals were not valid analogues of the false belief test. Additionally for the children with autism correlations could not be obtained between the high/low condition and the false belief test or between the multiple/continuous condition and the false belief test due to all participants with autism failing the two sound conditions.

In Experiment One it was suggested that one of the obvious differences between the landing pad condition (false belief analogue) and the central condition was that of distance between signals. It was further suggested that the relative ease of the central condition for the participants with autism when compared to the landing pad condition could be explained in terms of reduced attentional requirements. Experiment Three was conducted to explore the effect of distance between competing false belief stimuli (the location an object was left and the location where the same object was moved to) on the performance of children with autism. Children with autism and typically developing children were presented with three different false belief scenarios: one where the locations were immediately next to each other; a condition where the locations were 45 cm apart (similar to standard tests of false belief); and one where the locations were 120 cm apart (the distance between the two landing pads in Experiments One and Two). It was hypothesised that if attentional requirements affect the performance of children with autism on false belief tests that the condition in which the locations were immediately next to each other would prove easier. In contrast to the predictions of the hypotheses, both the children with autism and the typically developing children responded similarly across all of the conditions. Equal numbers of typically developing participants passed and failed all conditions and equal numbers of children with autism passed and failed all conditions. This finding suggested that added or reduced attentional distance requirements have no effect on false belief performance for children with autism, or typically developing children.

Stated on multiple occasions the central condition in Experiment One was demonstrated to be significantly easier than the false belief analogue condition (landing pad condition) for children with autism but not for typically developing participants. This gave rise to the possibility that the difference between the two conditions may provide some explanation as to why individuals with autism find tests of false belief difficult. One observed difference between the two conditions was the manner in which information was provided to participants. While the content of the information provided to the participants was identical (e.g. "the plane landed at the blue landing pad, but the light is yellow") the contexts were slightly different. In the landing pad condition participants were shown the landing pad where the plane landed and then re-directed to an empty landing pad alongside which was an illuminated light signal. In the central condition participants were also shown the landing pad where the plane landed but then re-directed to the centre of the track where only an illuminated signal was placed. A possible explanation for the differential responding of the children with autism was given in terms of memory and more specifically in terms of retrieval cues. Within the central condition the last thing that participants saw was the light (in the absence of an empty landing pad in comparison to the landing pad light condition where the participants were exposed to both the light and the empty landing pad) indicating the location to which the train would travel. In addition the auditory information that the participants received ("the plane landed on the x landing pad **but the light is** y") also indicated the location to which the train would travel, again in the absence of any possible confusion caused by observing an empty landing pad. Given the findings of Experiment One and the possible explanation of improved performance being due to cue effects, two further experiments, Experiment Four and Experiment Five, were designed examine the possibility that either the auditory or visual cue was responsible for the improvement in false belief performance. The design of Experiment Five also tested for the possibility that improved performance was due to a combination of the visual and auditory cues provided to the participants. In Experiment Four children with autism and typically developing children were presented with a standard test of false belief and false belief tests that provided them with auditory cues in the form of spoken recall (e.g. when returning the character would remark "I left my 'x' in the 'y'"). For both groups of participants the auditory cues had no significant effect on performance when compared to the false belief test that provided no auditory cues. In Experiment Five children with autism, children with learning disabilities and typically developing children were tested on a standard false belief test and three false belief tests that included cues. One test provided participants with a visual cue, one with an auditory cue and one with both an auditory and visual cue. Similar to Experiment Four, the auditory cue had no effect upon the performance of the three groups when compared to the non-cued test of false belief. This was also the case for the light-cued false belief task. However the children with autism found the false belief task with a combination of auditory and visual cues significantly easier than the standard test of false belief. Neither the children with learning disabilities nor the typically developing participants found the combined cues to be of significant assistance. In summary, the children with autism were successfully aided in answering the false belief question when combined auditory and visual cues were provided to them, whilst control group performance did not improve. The combination of auditory and visual cues affected performance of children with autism only.

When considering existing theories of autism, it becomes evident that no one explanation can account for these findings. Accounts of why multi-modal cues were effective for the children with autism in answering the false belief question remain open. While the weak central coherence explanation may provide a partial account of why the false belief information was not available to the children with autism (they only processed parts of the information rather than processing the information as a whole event), the same explanation cannot account for why the cues were effective. Similarly the executive dysfunction hypothesis can provide some rationale as to why the individuals with autism found the tasks difficult without the cueing (due to their executive nature) but again it cannot account for why the cues were effective, that is unless it is further postulated that the cues reduced the need to hold in mind an arbitrary rule. The question of why visual and auditory cues alone did not provide the same assistance remains unanswered. Furthermore the theory of mind-deficit account of autism is brought into question as if the children with autism were truly deficient in their understanding of false belief they, like the control participants, would have failed the task regardless of whether cues were provided or not.

While already-existing explanations of autism can partially explain the individual findings reported here, no single theory or explanation to date can fully account for the results obtained within the collection of studies reported. As previously discussed, both the weak central coherence explanation and executive dysfunction hypothesis can help to explain aspects of the findings. Recall that the weak central coherence argument may be drawn upon to explain why the children with autism found the sound condition in Experiment One significantly more difficult than the analogue condition however this account fails to explain why the central condition was significantly easier than the analogue condition. Of course it could be suggested that the children with autism processed the empty landing pad in the landing pad condition and not the light, however this is a vague possibility. Similarly while the central coherence explanation of autism can account for why the children with autism could not answer the false belief questions in Experiment Four and Five without the provision of cues it cannot account for why the provision of cues significantly improved their performance. Turning to the executive dysfunction hypothesis of autism, arbitrariness may explain why the sound condition in Experiment One proved significantly more difficult for the children with autism than the analogue condition but again cannot explain why the central condition was significantly easier than the analogue condition, unless one attempts to argue that the landing pad condition was more arbitrary than the central condition. This post-hoc account is somewhat unsatisfactory. Additionally the inconclusive findings of Experiment Two, suggest that both the participants with autism and the typically developing children were more successful when arbitrariness was reduced, therefore ruling out arbitrariness as an autism–specific explanation for false belief failure. Finally the executive dysfunction hypothesis, while providing tenuous evidence as to why combined cues were successful in assisting the children with autism in Experiment Five, cannot fully account for why the cues when provided separately failed to have a similar effect.

The combined results of the studies reported here cannot be explained by any one existing theory or account of autism. This leaves two plausible options: to explain the findings by the utilisation of a combination of theories or rather to postulate a new theory or explanation of autism. Consequently, to account for the findings reported here, a speculative hypothesis of autism was developed. Termed the Encoding Overselectivity – Retrieval Specificity hypothesis of Autism (EO-RSA), it is suggested that: 'because children with autism encode information in an overselective, therefore specific and limited manner and subsequently retrieve information in the same specific manner, the information available to them at any given time is available only in the initial form that it was first witnessed – limited, specific and rigidly context bound'. Expanding slightly, this explanation focuses upon the difficulties that individuals with autism have in terms of the encoding of information and the subsequent retrieval of information. It is suggested that individuals with autism encode information in an overselective and restrictive manner, typically in the way in which information is initially presented. This does not pose difficulties if the information itself is specific and unitary. However if the information is general and transcends several knowledge domains, children with autism tend to encode the information according to self-imposed rules or attend to specific elements of the stimulus and encode accordingly. The inability to make inferences from past experience is prevented, as information is only available for retrieval if it is cued by a context and content specific stimulus. Because information is encoded as unitary, isolated and discrete chunks of information the same information can only be utilised in situations identical to that which it was initially encoded and stored.

While the EO-RSA was inspired by the results of the studies reported here, it is also given strength by inferences made from clinical observations that individuals with autism tend to encode and store information into memory only in the exact form that information is initially presented (Wing, 1976) and research that shows: individuals with autism are deficient in abstraction-based prototype categorisation (Dawson & Kilnger; 1995; Plaisted, O'Riordan, Aitken and Killcross, submitted (cited in Plaisted, 2000; 2001); Plaisted and O'Riordan, submitted (cited in Plaisted, 2000; 2001); individuals with autism have difficulties with generalisation (Jordan, 2002; Frith, 2000; Maddock, 1997; Plaisted, 2001; Plaisted & O'Riordan, submitted (cited in Plaisted, 2000; 2001); Siegel, 1996; Taylor, 1997); individuals with autism show stimulus overselectivity (Lovaas, Koegel & Schreibman, 1979; Lovaas, Schreibman, Koegel & Rehm, 1971); individuals with autism process parts of information rather than wholes (Frith, 1989); children with autism are reported to operate from recency (Boucher, 1978; Hermelin & Frith, 1971; Hermelin & O'Connor, 1975); cues for memory retrieval cannot be effective unless those same cues are encoded with the information to be remembered at the time of its storage (Tulving & Pearlstone, 1966; Tulving & Osler, 1968; Thomson & Tulving, 1970).

The EO-RSA can not only account for the results of the studies outlined here but can also provide insight into the wide range of behaviours observed in, and difficulties experienced by, individuals diagnosed with autism. Prior to describing how the EO-RSA can largely account for autism, it is first necessary to further justify how this explanation may account for the results of the empirical studies presented here. For Experiment One where it was found that the central condition was significantly easier and the sound condition was significantly more difficult for the children with autism when compared to the analogue condition (landing pad condition) the EO-RSA can provide an explanation. In the central condition the only information available for encoding was the visual presentation of the light and the experimenter's verbal input indicating the colour of the light. In comparison, within the landing pad condition the information available was the light, the verbal input and ALSO an empty landing pad. It is possible that the children with autism overselectively encoded the landing pad information by choosing the empty landing pad and not the colour of the light or the landing pad as the focus of encoding. Because children with autism are reported to be disproportionately influenced by recency (Boucher, 1978; Hermelin & Frith, 1971; Hermelin & O'Connor, 1975) the first piece of information retrieved when asked the false belief question would be a visual representation of an empty landing pad, but because the landing pad was at this stage covered, they could not respond in that manner. Therefore they would have defaulted to the next most recent piece of information – "the plane landed on **blue**", therefore responding inaccurately with the colour of where the plane had landed and not with the colour of the signal. Conversely in the central condition the only information available was the light and the verbal input, and again, considering the recency hypothesis, the last thing that the children with autism were likely to encode was either the colour or the name of the colour or indeed both, therefore when asked the false belief question, retrieved the last piece of information encoded – the visual representation of the colour or the name of the colour, therefore passing the false belief question. The increased difficulty of the sound condition can be explained by the EO-RSA. If the recency hypothesis is to hold it should withstand further scrutiny. In the sound condition the last piece of information encoded was either "high" or "low". So when asked the false belief question either high or low would have been the first information retrieved, but because the EO-RSA claims that children with autism have difficulty making inferences, therefore rendering "high" or "low" useless, they reverted to the next most recent piece of information, that is where the plane landed, consequently failing the false belief question. The sound provided no discernable assistance with this decision due to the fact that the sound was encoded only as a sound and not as a signal. Additionally, because the sound was not physically connected to the stimulus situation, it was retrieved just as a sound and therefore not as a useful basis from which to make inferences.

In Experiment Two it was found that the voice condition was significantly easier than the standard test of false belief for children with autism (and typically developing children). This can be explained again by a combination of the EO-RSA and the tendency for children with autism to respond to stimulus presented most recently. In this condition, where the plane lands on the yellow landing pad for example, the last piece of information provided to participants is "blue landing pad".

Similarly because of recency the first piece of information to be retrieved by the children with autism when asked the false belief question would be the last piece of information to be encoded - "blue landing pad", therefore successfully passing the false belief question.

Experiment Three investigated the effects of reduced and added attentional requirements in the form of distance between false belief stimuli on the performance of children with autism on tests of false belief. The results of this study did not reach significance therefore the opportunity will be taken here to explain, according to the EO-RSA, why children with autism find false belief tasks in general to be difficult. In standard unexpected transfer tests of false belief it is likely that children with autism overselectively encode the information of where Sally leaves her item and where Anne moves the same item to, as just that – where an item is left and where an object is moved to and therefore currently is. Where Sally would look for her item is not encoded because it is not provided. Furthermore because children with autism according to the EO-RSA do not encode information as general events but rather as specific isolated incidents (where Sally left an object and where Anne moved an object to), they will be unable to retrieve the information so as to make inferences, consequently failing to solve the false belief problem. Again, due to the recency effect, the children with autism are likely to revert to the last piece of stored information that is where Anne moved the item.

The results of Experiments Four and Five can also be explained by the EO-RSA. In these experiments it was found that false belief conditions that provided participants with independent auditory or visual cues did not significantly improve the performance of the children with autism. When auditory and visual cues were combined however, the performance of the children with autism significantly improved when compared to standard tests of false belief, while the performance of control participants remained unaltered. When considering standard tests of false belief it is clear that the information provided to participants is a combination of visual and auditory information. Because the information is provided this way it is likely to be encoded this way (although considering stimulus overselectivity the children with autism are likely to selectively encode either the visual information or the auditory information, but not both). The children with autism like the control participants are given visual information (Sally and Anne placing the object) and auditory information ("Sally puts her key under the yellow cup"/"Anne moves the key to the blue cup"), however because the children with autism encode the information in this manner only, they do not make inferences from it. Children with autism do have the appropriate information available to them, however because it was not encoded in terms of where Sally will look for her key, cues are needed to successfully answer the false belief question. This was shown to be the case for the children with autism only. The control children still failed despite the cues, suggesting that they truly lack the ability to understand false belief. Although auditory and visual cues were provided independently this did not have a discernable effect for the children with autism. This finding can be accounted for in terms of stimulus overselectivity and the encoding specificity principle. As children with autism overselectively encoded either the visual or the auditory information only cues that provided them with a combination of the visual and auditory information would result in increased successful group performance. It seems reasonable to suggest that the participants that overselectively encoded the visual information were aided by the visual component of the combined cues and the children that overselectively encoded the auditory information were aided by the auditory component of the combined cues. Given this proposition it can be argued that the children with autism did not truly think that Sally would look for her object where Anne moved it to, rather, due to overselective encoding and specific retrieval they are unable to access the information in a context independent manner necessary to solve the false belief dilemma. Similar to the other studies reported here, when appropriate cues were not provided to the children with autism they reverted to the most recent information that was encoded: that is where Anne moved Sally's object.

The EO-RSA is proposed as a conceptualisation that may fruitfully be utilised to account for many aspects of the complex and multi-faceted sequelae associated with autism. In particular the EO-RSA can provide an explanatory account of: difficulties with generalisation; inability to extract meaning from experience; social deficiencies; imaginative play and general imagination difficulties; repetitive behaviours; insistence on sameness; false belief failure; low tolerance of change; and language and communication impairments.

Each of the difficulties just mentioned will now be explained in terms of the EO-RSA. Firstly, problems with generalisation can be accounted for by the EO-RSA. Generalisation is the extent to which behaviour learned in one environment is transferred to new and different environments (Lovaas, et al., 1979). So in order to generalise information one must encode the information and then retrieve the same information when encountering a potentially similar situation but in a different context. However, because it is suggested that individuals with autism encode information specifically and according to particular contexts, the information encoded by individuals with autism will not be available for generalisation. To clarify this an example may be helpful. Imagine for example a child with autism is taught the word 'cup' in the presence of a red cup. These pieces of information are likely to be encoded specifically, that is cup = red cup. If then the same child is presented with a blue cup, because cup was only encoded as that red event, the presence of the blue cup is unlikely to retrieve the information of cup, therefore resulting in an inability to generalise. Further if there were multiple pieces of information to encode, the EO-RSA would predict that children with autism would be likely to choose the information to encode idiosyncratically. Rincover and Koegel (1975) provide an example of this where they report on a child with autism who was taught by one teacher to touch his nose upon request. This particular teacher was successful in this training, however when a new teacher asked the same question of the child, he did not respond. It was subsequently determined that this was because the second teacher failed to provide the child with an incidental hand movement, that the first teacher had inadvertently given. Upon identifying this absent cue the second teacher performed the same hand movement to the child, resulting in the trained response. In this situation the child with autism idiosyncratically chose to encode the irrelevant information of the incidental hand movement with the request to touch his nose, therefore not being able to generalise the request, unless of course others provided the identical hand movement with the request to touch his nose. As a result of overselective encoding the skill was not generalised. There are many examples of individuals with autism finding generalisation difficult (Jordan, 2002; Frith, 2000; Maddock, 1997; Plaisted, 2001; Plaisted & O'Riordan, submitted; Siegel, 1996; Taylor, 1997). Plaisted (2001) relates the poor generalisation abilities of individuals with autism to deficits in categorisation and more specifically to deficits in abstraction-based prototype categorisation. Abstraction-based prototype categorisation refers to the ability to categorise by having in mind a generic prototype against which possible new category members are assessed. Plaisted (2001) found that individuals with autism are unable to categorise in this manner. This too can be explained by the EO-RSA. When encoding information if individuals encode a particular object as that particular object and nothing else, then the presence of a similar but different object is unlikely to retrieve the previously encoded information. Furthermore it is suggested by the EO-RSA that children with autism do not encode pieces of information generically, therefore developing an abstracted prototype becomes impossible as does categorising according to a prototype. Klinger and Dawson (1995) also found that children with autism have difficulties with abstraction-based prototype categorisation, but additionally found that the same children with rule-based categorisation experience fewer difficulties. This can also be explained by the EO-RSA, especially as stated by Klinger and Dawson (1995), that unless a concrete rule is provided, children with autism "focus on a single, idiosyncratic feature of the stimulus rather than encoding all the features of the whole figure" (p.133). Concrete rules would allow for categorisation, as the EO-RSA suggests, children with autism focus on particular characteristics when encoding, in this case if a specific rule is provided, children with autism should show no particular difficulty in application. This has been shown to be the case. Basically in order to generalise individuals must encode information generically so that other events can be assessed against it. But if information is encoded rigidly and specifically, generalisation becomes impossible (e.g. "that blue thing you are holding is not a cup, only what I know to be a cup is a cup and my cup does not look like that!"), hence the EO-RSA provides an explanatory account of why children with autism find generalisation difficult and at times impossible.

Closely related to difficulties with generalisation, it is often reported that children with autism find it difficult to extract meaning from their experiences (Frith, 1989). This difficulty has been explained in terms of difficulties in experiencing events subjectively (Sacks, 1995), difficulties with an 'experiencing self' (Powell & Jordan, 1993), a poorly developed sense of agency (Russell, 1996) and problems with personal episodic memory (Bowler, Gardiner, & Grice, 2000; Jordan & Powell, 1992, cited in Jordan, 2002). To extract meaning from experience one necessarily has to encode experiences as generic events. Otherwise, if encoded specifically as an isolated event and therefore retrieved specifically as an isolated event, unless the meaning one wants to extract directly concerns that isolated event then extraction will become impossible. It is suggested that individuals with autism, because they encode situations as specific isolated moments in time, cannot use this information unless an identical situation arises that needs explaining. Therefore the EO-RSA implies that individuals with autism rather than exhibiting the difficulties just described tend not to be able to extract meaning from experiences because experiences are encoded as isolated and discrete chunks of information that are only of use if those identical situations arise in the future. This could perhaps be explained by an inability to relive experiences in a subjective way, however this inability still needs to be explained. It is proposed that the EO-RSA may provide a suitable explanatory account. It is not that individuals with autism cannot relive experiences but rather when they do relive experiences or retrieve information it is solely in the manner in which the experience was first encoded, therefore only being of use in understanding or making sense of identical scenarios.

One of the key defining characteristics of autism is poor socialisation skills and abilities. Dawson and Lewy (1989) and Klinger and Dawson (1992) suggest that the specific social impairments exhibited by individuals with autism result from an inability to process social information because of its novel and unpredictable nature. Furthermore Klinger and Dawson (1995) point out that it is categorisation that allows people to make inferences about new situations based on previously experienced situations and that without such categorisation skills and subsequent abilities to make inferences, people would find new situations highly unpredictable and confusing. The reasoning of Klinger and Dawson (1995)[58] is consistent with the EO-RSA account of the nature of autism. Because individuals with autism (as suggested by the EO-RSA) encode information and situations as isolated and discrete events, such information will only be useful in understanding consequent social situations that are essentially the same. However because social situations are rarely, if ever, identical most social situations are confusing for individuals with autism. This is exemplified in a quote by Donna Williams (1992) cited by Klinger and Dawson (1995) where she explains the constant battle of having to learn a new set of rules for every unique situation.

Imagination and pretend play skills are also highlighted as being deficient in individuals with autism (Baron-Cohen, 1987,1989; Jarrold, Boucher & Smith, 1996; Leslie, 1987; Wing, 1996; Wing, Gould, Yeates & Brierley, 1977). Wing (1996) describes this feature of autism thus: "Children with autistic disorders do not develop

[58] Klinger and Dawson (1995) relate the social difficulties of individuals with autism to problems they have with categorisation, while the EO-RSA relates the problems of socialisation AND categorisation of individuals with autism to encoding and retrieval peculiarities.

pretend play and imaginative activities in the same way as other children. Many never have any kind of pretend play" (p.44). Pretend play involves the use of a real or fictitious object to represent another (Happé & Frith, 1995). The EO-RSA provides an explanatory account of this phenomenon. The EO-RSA would predict that children with autism encode information specifically and rigidly and consequently retrieve information in the same way. To be able to pretend play one must be able to think of an object in a propositional way, however if what an object is used for is the only way that it is encoded then it would be impossible to utilise it in pretend play. For example unless one encodes a banana as something that is held to an ear, it is unlikely to be used, as a telephone would be. This does not mean that children with autism can never engage in pretend play for, as pointed out by Wing (1996), some do. However what it does suggest is that unless the information concerning objects is encoded in a pretend fashion, they are unlikely to be used in a pretend manner. Coupled with the notion of recency, as the most recent encoding of what objects are used for is unlikely to be pretend-based, this will not be the first item of information retrieved by children with autism. An experiment conducted by Jarrold, Boucher and Smith (1996)[59] that showed that cueing pretend play did not increase pretend play acts by children with autism may be interpreted as evidence to challenge the EO-RSA proposition. In this study participants were cued with props that were modelled in pretend acts by the experimenter. After modelling pretend acts, the experimenter asked the participants to show what they could pretend to do with the same props. However in the analysis of their results, Jarrold et al. did not score pretend acts that matched those that were previously modelled. The EO-RSA can provide answers to why the participants with autism did not engage in different pretend acts from those that were modelled by the

[59] This study is discussed in detail in Section 2.3.7.

experimenter. The pretend acts according to the EO-RSA were likely to be encoded as they were presented. Additionally because the information concerning the props were likely to be retrieved in the identical fashion that they were encoded, different pretend acts from those modelled by the experimenter would be impossible for the children with autism to perform.

It is undisputed that individuals with autism are characterised by language and communication impairment (for a review see Frith, 1989). To an extent, language and even more so communication can be considered to be similar to socialisation in that very rarely are language and communication situations identical. Even though the content of language (words) may be similar in particular situations, the people, contexts, and environments are rarely identical. Again considering the impact of the EO-RSA with regard to the encoding and retrieval of information, and the associated inability to generalise, it seems reasonable to predict that individuals with autism will be impaired in their use of language. Some examples may clarify this proposition. If, when a child with autism encodes the question of "What is your name?" with the response "Paul", when asked, "What are you called?" they are likely to fail to respond. In a further example provided by Rincover and Koegel (1975), if a child encodes the information of "Touch your nose" with an idiosyncratic piece of information such as an incidental hand movement, the response of nose touching will not occur without the hand movement. This is often displayed when children with autism are tested on standardised tests. Frequently the author has, when testing children with autism, been told by the child's parents, "Oh he knows that but you did not ask it in the same way that I do". This too highlights the possibility that when individuals with autism encode language it is encoded specifically and rigidly and will only be retrieved when presented with the unique and particular cue. However because language and communication situations are rarely identical, as illustrated by the very simplified examples provided, language will either not be retrieved or the wrong type of language will be retrieved - often the last piece of language information that was encoded. The characteristic deficit of language skills can be related to the complex nature of language and its ever-changing content and context. It may be that until situations arise that include identical, potentially idiosyncratic stimuli that have been encoded in the past, that children with autism will not respond, or rather as Williams (1992) states, return to repetitive and known behaviours so as to cope. Language is ever-changing and if individuals with autism cannot make sense of it according to their rigidly, often idiosyncratically encoded pieces of information, then they will not respond. The EO-RSA principle can also account for language peculiarities in autism such as echolalia. Myklebust (1995) identifies two main forms of echolalia – immediate and delayed. It is widely accepted that echolalia involves the repetition of what has been said by others, however it has additionally been suggested that echolalic behaviour is not a means of communication (Frith, 1989; Fine, Bartolucci, Ginsberg, & Szatmari, 1991). It can be argued that when children who are echolalic encode words or sounds, that they encode them just as a collection of sounds. Because these same sounds are retrieved identically without meaning they are similarly used without meaning. A good example of delayed echolalia is what may be termed here as 'video-speak', where individuals with autism recite dialogue from media sometimes hours or days after exposure. This can also be explained by the EO-RSA. When watching a video for example, if only particular sounds are encoded, these may be retrieved on an ad-hoc basis, without any recourse to meaning. Alternatively the sounds may have been encoded along with some idiosyncratic stimuli, such as a concurrent noise outside, so that every time that noise is heard the child will echo what was said on the video. This example may seem trivial however when considering the case of nose touching provided by Rincover and Koegel (1975), this phenomenon is illuminating. Echolalia can be understood in terms of the EO-RSA in that the sounds or words echoed are retrieved in a non-meaning dependent way as they are expressed as sounds triggered by idiosyncratic stimuli. The fact that children with autism have been shown to be able to repeat nonsense sentences better than controls (Hermelin & Frith, 1971) also supports this hypothesis. Because children with autism may encode sentences as a collection of sounds, these sounds may be retrieved in the manner in which they were encoded. Children with autism may not try to find meaning behind the sentences or encode them in any other way – just as a collection of sounds, hence the relative ease of retrieval.

The EO-RSA may also explain the repetitive behaviours of individuals with autism. As a result of the difficulties in understanding their world; impairments in generalisation and language; impairments in making inferences about new situations; and overall changing nature of environments it makes sense that individuals with autism will, as Wing (1996) highlights, revert to activities that they do know and that do not change – their repetitive behaviours. Williams (1992) states that she engaged in repetitive behaviours as a means of coping with new, unknown and therefore previously un-encoded situations. Williams (1992) highlights this point when she says: "The constant change of things never seemed to give me any chance to prepare myself for them. Because of this I found pleasure in doing the same thing over and over again" (p.44). Similarly the EO-RSA can explain the autistic insistence of sameness and the tendency for individuals to be intolerant of change. If situations are the same as they were previously encoded, then individuals with autism are likely to recognise and respond to them, finding comfort in these known situations. If however the situation changes and is presented in an unfamiliar way, individuals with autism are likely to experience distress and revert to a repetitive behavioural repertoire.

The preceding discussion attempted to examine the explanatory value of the EO-RSA across a wide range of behaviours and characteristics exhibited by individuals with autism. Furthermore it is proposed that the EO-RSA may provide an account for Wing's (1988) diagnostic criteria for autism - the triad of impairments in autism. While the EO-RSA can account for many of the difficulties experienced by individuals with autism, it is not wholly comprehensive. Two areas the EO-RSA cannot fully account for is the unusual display of emotional expressions that is often exhibited by individuals with autism (Mesibov, Adams & Klinger, 1997) and difficulties that individuals with autism have with the processing of emotional information.

Mesibov, Adams and Klinger (1997) note that individuals with autism often cry for no apparent reason and laugh when clearly anxious, resulting in the authors' contention that the emotional expressions of individuals with autism are inconsistent in reflecting their underlying feelings. While underlying feelings of anxiety may possibly be explained by the EO-RSA, the reason as to why individuals with autism often resort to inconsistent emotional responses cannot. It may be that individuals respond to the emotion of anxiety differently. That is there are many possible emotional expressions of anxiety, and as such individuals with autism may not consistently encode identical responses to anxiety. In such situations where no one particular response is retrieved, a more common or indeed the last emotion encoded may be retrieved. This in turn is likely to be one of the more basic emotional responses, for example laughing. Clearly the explanation just given is largely theoretical and would be extremely difficult to test directly.

It may be argued that because emotions, like language, are not consistent across individuals and contexts, that individuals with autism find it difficult to understand them because particular emotions have not been previously encoded in the manner that they are re-experienced or that elements of the emotional situations were overselectively encoded, for example what the individuals experiencing emotion are wearing. Weeks and Hobson (1987) found that individuals with autism were more likely to sort pictures of emotional expressions according to non-emotional variables, for example the type of hats that the individuals within the pictures were wearing. The EO-RSA can provide some explanation for this in that the non-emotional variables could have been idiosyncratically encoded rather than the emotional states. This proposition appears to be supported by the work of Rincover and Ducharme (1987) that found that children with autism overselectively attend to situational cues if cues are separated in space. In the example by Weeks and Hobson (1987) the hats and the expressions of the individuals are separated by distance. This may account for why individuals with autism find it difficult to interpret some emotions and difficult relative to controls to match or sort emotional stimuli. At a deeper level, the EO-RSA cannot explain why individuals with autism tend to be lacking in empathy. Empathy involves an emotional understanding of what another may be thinking and feeling (Bernstein et al., 1994) and may be regarded as the power of identifying oneself mentally with, and so fully comprehending, a person or object of contemplation.

Baron-Cohen (1999) associates empathy with mindreading and postulates that an inability to empathise may be due to an inability to read the minds of other people. From an intersubjective point of view, Hobson (1992) argues that individuals diagnosed with autism have difficulties perceiving and understanding other people's emotions, due to an inability to emotionally engage with other people. These are just two explanations for why individuals with autism may be lacking in empathy. Considering empathy and the explanations just provided, it becomes clear that the EO-RSA cannot directly provide explanations to account for a lack of empathy by individuals diagnosed with autism.

Empathy could however be investigated from the perspective of the EO-RSA. For example individuals with high-functioning autism could be shown a series of pictures or videos of people in emotional situations and then asked to interpret how the individuals are feeling and whether they themselves have experienced those feelings. It would be necessary to then ask in what situations they (if they had) had experienced those feelings and furthermore asked what they felt when they saw the pictures or videos, for true empathy involves more than understanding how someone may feel in a particular situation, it actually involves placing ourselves within the experience. The EO-RSA would predict that individuals with autism would be able to empathise only to the extent that salient features were previously experienced by the individual with autism.

The brief discussion of prediction in terms of empathic understanding and the EO-RSA leads to an imperative component of theory postulation – testable predictions. What does the EO-RSA predict in terms of the behaviours and cognitive abilities of individuals with autism? The most obvious and most related to this thesis is that individuals with autism would succeed at tests of false belief if the false belief information is encoded as where an object would be looked for rather than where it had been left. Within the classic unexpected transfer test of false belief, if when a character leaves an item in a particular location, it is made explicitly clear that this is where the character will look for the item in the future, false belief performance of the individuals with autism should improve. Improvements in false belief performance should also be witnessed if appropriate cues are provided to participants with autism. The photographic cueing study conducted by Bowler and Briskman (2000) cited previously, could be repeated by ensuring that the participants overtly view the photograph as well as hearing the experimenter claim that the protagonist is looking at the photo of the item in the location where it was left. This would ensure that the cues are identical to the information that is encoded at the time of storage. That is both visual and auditory information related to where the character will look for the item. Even if the participants with autism overselectively encode either the visual or the auditory information as both are provided as cues, improved performance would be predicted. To investigate the effect that recency has upon false belief performance, the belief, reality and memory questions could all be counterbalanced so that for a third of the participants the memory question is asked first. This would be then followed by the belief question and ending with the reality question. If recency was the mediating variable within the false belief performance of individuals with autism then the memory question being posed first, just before the belief question, should cue a correct false belief response. Memory information in this scenario would be drawn upon if the false belief information could not be successfully retrieved. While this will not directly test the predictions of the EO-RSA, because recency plays a significant role within this hypothesis, such testing may still prove informative.

The EO-RSA also suggests testable predictions with regards the categorisation and generalisation abilities of individuals with autism. Recall the comparison made between the prototype study conducted by Molesworth, Bowler and Hampton (in press) and that conducted by Klinger and Dawson (1995). Molesworth et al. (in press) familiarised participants to stimuli by sorting, while Klinger and Dawson (1995) utilised individual presentations. The EO-RSA predicts that if the two different familiarisation techniques are compared, that the technique that utilises sorting will lead to greater prototype formation due to the fact that stimuli are encoded together (and more likely generally) rather than individually and separately.

Finally the EO-RSA predicts, that because of the encoding and retrieval peculiarities of individuals with autism, tests of false belief where cues are provided cued recall tests and tests of rule-based categorisation would be strongly correlated. Tests of false belief where no cues are provided, free recall tests and tests of abstraction-based prototype categorisation are likely to also be correlated if the predictive validity of the EO-RSA holds.

As well as providing theoretical explanation for, and testable predictions concerning autism, the EO-RSA also has practical implications for dealing and working with individuals with autism. These include:

- Benefits of using symbols with children with autism both as a means of communication and of conveying information.
- Importance of generalisation training for individuals with autism.
- Importance of teaching skills to individuals with autism in the environments in which skills naturally occur.
- Necessity when cueing or prompting individuals with autism to use identical cues or prompts that were initially provided when teaching skills.
- Cue or prompt new situations with previously encoded but associated information. For example false belief tasks.
- When teaching individuals with autism reduce distraction both within the teaching environments and within the specific teaching stimuli so as to reduce the likelihood of overselective idiosyncratic encoding.
- The EO-RSA provides insight into why individuals with autism may be hypersensitive to new situations and change, and from this highlights the need for the provision of a 'warning' system and/or advance notice.
- Necessity of some degree of consistency across all environments, stimuli and instructors.
- Importance of pacing exposure rather than flooding or bombarding individuals with new situations or expectations.
- The importance of combining known and unknown, or familiar and unfamiliar stimuli.
- The importance of masking unnecessary elements while emphasising the essential components of any given situation.

Due to the transient and ever-changing nature of the spoken word, individuals with autism, when considering the EO-RSA would find such communication and conveying of information difficult. If individuals with autism at the best encode information only as it is initially presented and at the worst encode information idiosyncratically, it holds that spoken language would prove to be not only difficult but also limiting and severely non-generalisable. That is very rarely is spoken language used in exactly the same way time and time again. However for individuals with autism to understand and eventually use spoken language, this is exactly what would need to happen. From this observation stems the importance of providing individuals with autism with a non-transient, consistent form of communication and conveyance of information. For example if every time the word 'cup' is coupled with a generic outline symbol of a cup or the printed word 'cup', then more meaning would be gained by individuals with autism. Even if many different individuals present the word 'cup', because it is presented with a known, consistent and generic pictorial or textual representation, individuals with autism would be more likely to correctly interpret the intention of the speaker. In addition, because the symbol or the written word is known by the individuals with autism, they would be less likely to idiosyncratically encode unrelated information, for example, unrelated hand movements, the colour of the shirt that the person communicating with them is wearing and so on. The use of symbols and text with individuals with autism is by no means a new suggestion. Rather, the use of symbols (and text) with individuals with autism has been frequently tested and its utility confirmed (Abrahamsen, Romski, & Sevcik, 1989; Angelo & Goldstein, 1990; Lancioni, 1983; Schopler & Olley, 1982).

Resulting from their rigid encoding of information and subsequent rigid retrieval of information, individuals with autism have considerable difficulties generalising. This however does not need to remain untreated. Rather this knowledge can be used to better the way that individuals with autism are taught about their worlds. How this can be achieved is by utilising the initial way that information is encoded, perhaps via the use of symbols, and having this information co-exist with new but related pieces of information. If for example a child with autism is taught what a cup is in the presence of a clear plastic cup and the presentation of the word cup and a generic symbol of a cup, then the next time that a cup is needed, purposefully use a different cup whilst still using the word 'cup' and the symbol. This way the child with autism will still have an understanding because of the already encoded information, but at the same time be hearing and seeing that information in the presence of a different stimulus. Another way that the concept of cup could be generalised is by having a different person work with the individual with autism, but again to keep the word and the symbol consistent, therefore generalising across different people. What is being suggested is that individuals with autism are encouraged to generalise but in a way that they are likely to succeed at. The alternative is to consistently use the same words, stimuli, instructors and environments. This would however be of limited utility and certainly would not be best for preparing the individual with autism to more adequately understand their world. Additionally, purposefully constructing the environments of individuals with autism in a rigid and unchanging manner would only be further adding to their reliance on sameness. Another way of potentially assisting the generalisation of skills is to emphasise the essential stimulus components of situations in order to help individuals with autism identify common and salient features, ostensibly providing them with rules that approximate typical categorisation. An example of this would be to highlight the wings of an aeroplane rather than the windows, for all aeroplanes have two wings but not all aeroplanes have equal numbers of windows. In summary it should not be assumed that because individuals with autism are taught a skill once, in one situation, with one instructor that the skill is reliably mastered. On the contrary, as often reported, if left at this stage, children with autism will not generalise, and are likely to fail in the future in what may seem to the observer to be identical situations. The example of psychometric testing provided earlier highlights this. That is, when asked a standardised question the child with autism failed because, as the mother reported, "the question was not asked in the way that he knows". A quote from Taylor (1997) provided in Chapter seven further highlights this:

> It is very clear that children with autism learn to carry out certain skills in specific contexts but when presented with what may seem to an outside observer as a very similar context, are seemingly unable to carry out the task (p.119).

Within the behavioural literature, two common approaches to language instruction for children with autism are highlighted: discrete trial training (Lovaas, 1981; Lovaas, Koegel, Simmons, & Long, 1983; Smith, 1993) where language intervention is conducted in a highly specified and structured manner, usually in a designated situation (often seated at a table) and frequently where high levels of unrelated reinforcement is provided for correct responses; and the natural language paradigm (Koegel, O'Dell, & Koegel, 1987; Laski, Charlop,, & Schreibman, 1988) that focuses on the child's typical daily environment (playground, community, house etc.) rather than structured formal situations. While both forms of instruction have shown to be effective the EO-RSA suggests that teaching skills within the environments they naturally occur is advantageous. That is if children with autism are taught skills within meaningless, unrelated contexts then because of their encoding and retrieval deficiencies and subsequent difficulties with generalisation such skills are unlikely to be immediately useful, requiring elaborate generalisation strategies. Instead if core skills are taught within the contexts and situations that they naturally occur for the children, then because such skills will receive daily attention the likelihood for true and usable skill acquisition is greater. Furthermore, because the environmental contexts of the children are unlikely to change dramatically, the learning environments will remain the same therefore presenting the children with the same cues that were present when the skills were initially taught, resulting in correct retrieval of information. Reducing some distraction within the naturally occurring environments may prove to be effective, however it remains that teaching within situations that skills naturally occur, is preferred, according to the EO-RSA than skills that are not. Additionally it is conceivable that this will reduce the time required in generalisation training as skills are taught where they are to be applied.

Taking into account the EO-RSA, the encoding specificity principle (Tulving & Pearlstone, 1966; Tulving and Osler, 1968) and the findings of Experiments Four and Five, it is important when cueing or prompting individuals with autism, to do so with equivalent cues to those provided at the time of encoding. If different cues or prompts are provided, or indeed if lesser assistance is given then it is likely that prompting will be ineffective as empirically demonstrated in Experiments Four and Five. While it is important to ultimately minimise the use of advertent cues, it nevertheless remains that often cues will be necessary. Unless one is aware of the type of cues that will be effective, successful teaching is unlikely to take place. Utilisation of previously encoded information as cues is also important for the teaching of new skills, for example generalisation. In the example provided previously, if the symbol of a cup and the word 'cup' (previously encoded information) are presented with a new cup as cues, then the cues are likely to be effective. If a different picture (information that has not been previously encoded) of a cup is used as a cue then correct information retrieval is unlikely. Hence the importance of utilising identical cues for the retrieval of previously taught information and indeed for the retrieval of previously taught information that may be useful in different contexts.

In order to reduce the idiosyncratic encoding of information by individuals with autism it may be necessary to minimise distraction in the teaching environment and to simplify teaching stimuli. A simple example of this would be when teaching a child with autism in the natural environment what a fork is. Rather than presenting the fork in the context of a cluttered kitchen drawer it would be preferable to remove the bulk of stimuli (other utensils), so that the fork is clearly available for encoding. It may even be necessary to only have the fork present. If this were the case it would be important to eventually reintroduce some of the distraction, as the fork in isolation would neither be practical nor usable. Regardless, in order to initially and usefully encode information that defines what a fork is, it may be necessary to remove some or all distraction. It may even be necessary to teach stimulus components individually, for as suggested by Rincover and Ducharme (1987) stimulus components that are physically separated may be overselectively attended to and encoded. In the example of the fork it may be necessary to have individuals with autism encode the prongs and the handle separately and then to combine them so that both components are encoded as belonging to a fork. This could be achieved by covering the handle when teaching the prongs and vice-versa, so that both components are effectively encoded and hence usable in the future. A related but slightly modified technique was employed by Dube and McIlvane (1999) to reduce stimulus overselectivity in individuals with mental retardation, whereby individuals were taught to observe and discriminate multiple stimulus components. While the effectiveness of the procedure did not have lasting effects, if taught for lengthier periods, maintenance of learnt skills may result. Reducing distraction within teaching environments for children with autism is not a new concept and has been used within classrooms around the world with success. However relating distraction-reduction to fewer possible encoding and retrieval difficulties is new rationale for this established practice.

It is often reported that individuals with autism insist on peculiar routines and resist small, seemingly insignificant changes to their environments (Siegel, 1996). This behaviour demonstrated in some individuals with autism can be explained by the EO-RSA as a result of idiosyncratic cues. Alternatively known cues may not present in new situations and in such cases the individual with autism is marooned without access to available knowledge. A possible way of dealing with this is to provide individuals with autism with similar cues from already known situations so that slightly different situations can be understood. A cue could be the presentation of a generic symbol that has been previously encoded with known environments. For example when taking a child with autism to a new park, they could be shown the symbol that had been previously encoded with the familiar park, therefore giving him/her information as to where they are going. In this sense the symbol can convey the information in order to enable prediction and because this symbol had been previously encoded, it is likely to be effective. In effect the symbol could be a warning system. Similar warning systems have been used in conjunction with visual timetables that are frequently used by those adhering to the TEACCH paradigm (Schopler & Olley, 1982). While the specific example of symbol use has been drawn upon here, the important point deriving from this example, is that previously encoded information can be utilised within unknown situations so that those small (or large) changes will have less of a negative impact on those individuals with autism for whom change presents difficulties.

If children and individuals with autism encode and retrieve information as the EO-RSA paradigm suggests then it may be crucial, especially at the early stages of learning a skill that learning remains consistent across all variables. In practice if instruction does not remain consistent then repeated exposure to specific skills is unlikely. One way of maintaining consistency within language instruction is to utilise symbols. This way the symbol maintains an element of consistency across different stimuli, environments and instructors. Obviously consistency is on a continuum, ranging from very little to total. While it is not recommended to remain totally consistent, as this would impede generalisation, some element of consistency is important so that learning can be continual and so that changes are unlikely to cause frustration or confusion to the individuals with autism as they learn. A further implication of this hypothesis would suggest that a very low level of consistency is also not recommended. For example if one person is teaching what a horse is by utilising a picture of one horse, it is unlikely to be effective to, at an early stage of skill acquisition for another person to teach the same item with a picture of a farm scene, of which one animal in an array of multiple animals is a horse. In the latter scenario the likelihood for the individual with autism to encode the wrong piece of information is great.

The most directly applicable implication from the research presented in this thesis to individuals with autism concerns stimulus overselectivity. Because it has been suggested that individuals with autism encode information overselectively, it is vital that when teaching, testing or interacting with such individuals, that we direct their attention to the most important element or elements of any situation, those elements that are most likely to be present in future encounters involving the object or event. Masking unnecessary elements and highlighting those that are crucial can achieve this. When teaching expressive emotions for example, it would be important to de-emphasise (or completely remove) the non-essential (e.g. hair, ears, nose and body) and highlight the essential (e.g. eyes, mouth) elements of the stimulus, in the case of the majority of emotions, the faces of individuals. This is just one example but one that can be utilised to understand how such strategies may be of assistance in different contexts.

Clearly the majority of the implications and suggestions just presented are neither new nor revolutionary. However the EO-RSA provides empirical support for these practices. Similarly the implications provided here are by no means exhaustive.

In conclusion, it is necessary to return the discussion to one of false belief, for this is the central concern of this thesis. The results reported from the collection of studies here provide evidence to suggest that children with autism fail tests of false belief not because they lack a theory of mind, but rather as a consequence of specific difficulties with the encoding and retrieval of information. According to the EO-RSA individuals with autism encode information in an overselective manner and this in turn restricts the retrieval of information. These findings and consequently the EO-RSA cast serious doubt on the theory of mind-deficit account of autism as well as providing explanation for both the triadic and non-triadic impairments that are associated with the psychopathology of autism. Furthermore stemming from the research conducted here that set out to provide alternative explanations for false belief failure in autism, is support for the numerous practical implications previously listed. While many of these implications have a well-established history, the results of the false belief research conducted for this thesis confirms their probity and supports their continued use. The results presented within this thesis therefore not only have considerable importance for our understanding of false belief performance in autism, but also for other difficulties encountered by this population.

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Appendix 1: An example of a consent letter

Dear Parent,

My name is Paul Holland. I work with children who have been identified as having Autism Spectrum Disorder. At present I am conducting PhD research into this area in general and the field of false belief in particular. This research is registered with City University and is supported and supervised by the Head of Psychology, Dr. Dermot Bowler. The research involves comparing children with autism with typically developing children on false belief tasks. I have contacted (name of school) and indeed have spoken to (name of Head Teacher), who gives this research their full support. I am now writing to yourself in order to seek permission to include your child within this research.

The research will involve brief psychometric testing followed by an experiment focusing on the area of false belief, where the children will have to predict the location of various objects.

The research will involve two visits. The first visit will be the psychometric testing which will require approximately 15 minutes. The test used in this case will be the Test for the Reception Of Grammar (TROG). The other visit will take approximately 30-40 minutes and will involve the actual experiment.

As stated previously I have discussed all of the details with the Head Teacher and they give this research their full support. I would be very grateful if you would give permission for your child to take part in this research as it will have invaluable input into the clinical field of autism and indeed have practical application to special needs education.

If you would like more information or have any questions please feel free to contact me on (home phone number) or on my mobile (mobile phone number). Alternatively you may contact me by post at the above address (City University address) or indeed my office, which is at (home address).

Yours sincerely,

Paul Holland.

I DO / DO NOT (delete as appropriate) wish my child to be included within this research.

Childs' name:

Parents Signature:

Date:

Appendix 2: Latin squares for experiment one

A = Sally-Anne

B = Landing Pad Light Condition

C = Central Light Condition

D = Sound Condition

Participant	Conditions			
1	A	B	C	D
2	B	C	D	A
3	C	D	A	B
4	D	A	B	C
5	A	B	C	D
6	B	C	D	A
7	C	D	A	B
8	D	A	B	C
9	A	B	C	D
10	B	C	D	A
11	C	D	A	B
12	D	A	B	C
13	A	B	C	D
14	B	C	D	A
15	C	D	A	B
16	D	A	B	C
17	A	B	C	D
18	B	C	D	A
19	C	D	A	B
20	D	A	B	C
21	A	B	C	D
22	B	C	D	A
23	C	D	A	B
24	D	A	B	C

Appendix 3: Condition instructions for experiment one

Light signal conditions

The train collects things from the plane.

If the plane lands on the yellow landing pad, the yellow light goes on which tells the train to go to the yellow landing pad.

If the plane lands on the blue landing pad, the blue light goes on which tells the train to go to the blue landing pad.

The train has **NO** driver it is **ONLY** controlled by the light.

Only the light tells the train where to go.

Sound signal condition

The train collects things from the plane.

If the plane lands on the yellow landing pad, a high-pitched noise sounds which tells the train to go to the yellow landing pad.

If the plane lands on the blue landing pad, a low-pitched noise sounds which tells the train to go to the blue landing pad.

The train has **NO** driver it is ONLY controlled by the sound.

Only the sound tells the train where to go. A high sound tells the train to go to the yellow landing pad and a low sound tells the train to go to the blue landing pad. ***(Give examples of the sounds)***

Sally-Anne condition

This is Sally with the red hair. This is Anne with the hat on.

[Make sure the children know which is which]

Sally has a marble. She puts her marble in the box/cup and leaves the room.

Anne moves the marble from the box/cup to the box/cup.

Sally comes back. Sally wasn't there when Anne moved her marble.

Appendix 4: ***Latin squares for experiment two***

A = Sally-Anne

B = High/Low Condition

C = Multiple/Continuous Condition

D = Voice Signal condition

Participant	Conditions			
1	A	B	C	D
2	B	C	D	A
3	C	D	A	B
4	D	A	B	C
5	A	B	C	D
6	B	C	D	A
7	C	D	A	B
8	D	A	B	C
9	A	B	C	D
10	B	C	D	A
11	C	D	A	B
12	D	A	B	C
13	A	B	C	D
14	B	C	D	A
15	C	D	A	B
16	D	A	B	C
17	A	B	C	D
18	B	C	D	A
19	C	D	A	B
20	D	A	B	C

Appendix 5: Condition instructions for experiment two

High/Low Condition

The train takes things to the plane.

If the plane lands on the yellow pad, a high-pitched noise sounds which tells the train to go to the yellow pad.

If the plane lands on the blue pad, a low-pitched noise sounds which tells the train to go to the blue pad.

The train has **NO** driver. It is **ONLY** controlled by the sound.

Only the sound tells the train where to go. A high sound tells the train to go to the yellow pad and a low sound tells the train to go to the blue pad. ***(Give examples of the sounds)***

Multiple/Continuous Condition

The train takes things to the plane.

If the plane lands on the yellow pad, a bleeping noise sounds which tells the train to go to the yellow pad.

If the plane lands on the blue pad, a continuous noise sounds which tells the train to go to the blue pad.

The train has **NO** driver. It is **ONLY** controlled by the sound.

Only the sound tells the train where to go. A bleeping sound like this tells the train to go to the yellow pad and a continuous sound like this tells the train to go to the blue pad. ***(Give examples of the sounds)***

Voice Signal Condition

The train takes things to the plane.

If the plane lands on the yellow pad, a voice tells the train to go to the yellow pad.

If the plane lands on the blue pad, a voice tells the train to go to the blue pad.

The train has **NO** driver. It is **ONLY** controlled by the voice.

Only the voice tells the train where to go. A voice saying "yellow pad" like this tells the train to go to the yellow pad and a voice saying "blue pad" like this tells the train to go to the blue pad. ***(Give examples of the sounds)***

Sally-Anne condition

This is Sally with the red hair. This is Anne with the hat on.

[Make sure the children know which is which]

Sally has a marble. She puts her marble in the box/cup and leaves the room.

Anne moves the marble from the box/cup to the box/cup.

Sally comes back. Sally wasn't there when Anne moved her marble.

Appendix 6: Latin squares for experiment three

SA = Sally-Anne **TN = Tigger Near** **TM = Tigger Middle** **TF = Tigger Far**
WN = Wizards Near **WM = Wizards Middle** **WF = Wizards Far**

Participant	Conditions						
1	SA	TN	TM	TF	WN	WM	WF
2	TN	TM	TF	WN	WM	WF	SA
3	TM	TF	WN	WM	WF	SA	TN
4	TF	WN	WM	WF	SA	TN	TM
5	WN	WM	WF	SA	TN	TM	TF
6	WM	WF	SA	TN	TM	TF	WN
7	WF	SA	TN	TM	TF	WN	WM
8	SA	TN	TM	TF	WN	WM	WF
9	TN	TM	TF	WN	WM	WF	SA
10	TM	TF	WN	WM	WF	SA	TN
11	TF	WN	WM	WF	SA	TN	TM
12	WN	WM	WF	SA	TN	TM	TF
13	WM	WF	SA	TN	TM	TF	WN
14	WF	SA	TN	TM	TF	WN	WM

Appendix 7: Condition instructions for experiment four

Sally-Anne condition

This is Sally with the red hair. This is Anne with the hat on.

[Make sure the children know which is which]

Sally/Anne has a marble. She puts her marble in the box/cup and leaves the room.

Anne/Sally moves the marble from the box/cup to the box/cup.

Sally/Anne comes back. Sally/Anne was not there when Anne/Sally moved her marble.

Where will Sally/Anne look for her marble?

Winnie-Tigger condition

This is Winnie and this is Tigger.

[Make sure the children know which is which]

Winnie/Tigger has a sharpener. He puts his sharpener in the plastic/tin pencil case and leaves the room.

Tigger/Winnie moves the sharpener from the plastic/tin pencil case to the plastic/tin pencil case.

Winnie/Tigger comes back. Winnie/Tigger was not there when Tigger/Winnie moved the sharpener.

"Hmmm, I left my sharpener in the plastic/tin pencil case" exclaims Winnie/Tigger.

Where will Winnie/Tigger look for his sharpener?

Blackbeard-Redbeard condition

This is Blackbeard and this is Redbeard.

[Make sure the children know which is which]

Blackbeard/Redbeard has a wand. He puts his wand in the pouch/cylinder and leaves the room.

Blackbeard/Redbeard moves the wand from the pouch/cylinder to the pouch/cylinder.

Blackbeard/Redbeard comes back. Blackbeard/Redbeard was not there when Blackbeard/Redbeard moved the wand.

"Hmmm, I left my wand in the pouch/cylinder" exclaims Blackbeard/Redbeard.

Where will Blackbeard/Redbeard look for his wand?

Appendix 8: Latin squares for experiment five

A = Standard Sally-Anne **B = Light Cued Sally-Anne**

C = Sound Cued Sally-Anne **D = Light and Sound Cued Sally-Anne**

Participant	Conditions			
1	A	B	C	D
2	B	C	D	A
3	C	D	A	B
4	D	A	B	C
5	A	B	C	D
6	B	C	D	A
7	C	D	A	B
8	D	A	B	C
9	A	B	C	D
10	B	C	D	A
11	C	D	A	B
12	D	A	B	C
13	A	B	C	D
14	B	C	D	A
15	C	D	A	B
16	D	A	B	C
17	A	B	C	D
18	B	C	D	A
19	C	D	A	B
20	D	A	B	C

Appendix 9: Condition instructions for experiment five

Standard Sally-Anne

This is Sally with the red hair. This is Anne with the hat on.

[Make sure the children know which is which]

Sally has a marble. She puts her marble under the yellow/blue cup and leaves the room.

Anne moves the marble from the yellow/blue cup to the yellow/blue cup.

Sally comes back. Sally was not there when Anne moved her marble.

Where will Sally look for her marble?

Light Cued Sally-Anne

This is Sally with the red hair. This is Anne with the hat on.

[Make sure the children know which is which]

Sally has a marble. She puts her marble under the yellow/blue cup and leaves the room. A light will come on to remind Sally where to look for her marble when she comes back into the room.

Anne moves the marble from the yellow/blue cup to the yellow/blue cup.

Sally comes back. Sally was not there when Anne moved her marble.

Where will Sally look for her marble?

Sound Cued Sally-Anne

This is Sally with the red hair. This is Anne with the hat on.

[Make sure the children know which is which]

Sally has a marble. She puts her marble under the yellow/blue cup and leaves the room. A voice will remind Sally where to look for her marble when she comes back into the room.

Anne moves the marble from the yellow/blue cup to the yellow/blue cup.

Sally comes back. Sally was not there when Anne moved her marble.

Where will Sally look for her marble?

Light and Sound Cued Sally-Anne

This is Sally with the red hair. This is Anne with the hat on.

[Make sure the children know which is which]

Sally has a marble. She puts her marble under the yellow/blue cup and leaves the room. A light and a voice will remind Sally where to look for her marble when she comes back into the room.

Anne moves the marble from the yellow/blue cup to the yellow/blue cup.

Sally comes back. Sally was not there when Anne moved her marble.

Where will Sally look for her marble?