THEORY OF MIND AND SOCIAL UNDERSTANDING IN CHILDREN WITH ATTENTION DEFICIT HYPERACTIVITY DISORDER

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ABSTRACT

It is known that children with ADHD have social interaction difficulties (Clark, Cheyne, Cunningham & Seigel, 1988) however little research has been done looking at social understanding of children with ADHD. Recent studies have found that children with ADHD have difficulties similar to those of autistic children in some areas of social processing and some of the social behaviours common to autism have been reported in ADHD children (Clark, Feehan, Tinline & Vostanis, 1999). Autism is associated a specific impairment of 'theory of mind'.

The present study aimed to assess whether children with ADHD have deficits in theory of mind and social understanding.

Forty five children with a diagnosis of ADHD, aged six to twelve years, were tested using 1st and 2nd order theory of mind tasks, a battery of naturalistic stories measuring social reasoning and a response inhibition task. Aspects of social behaviour were measured using a parent-rated questionnaire.

The results were analysed across age groups and compared with published normative data. The results of the study were discussed with reference to theories linking executive functioning and theory of mind. Possible relationships between autism and ADHD were examined. The methodology of the study was criticised and the implications of the findings for further research and clinical practise were outlined.

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CHAPTER 1: INTRODUCTION

This introduction begins with a discussion of the definition of ADHD and recent theories regarding the nature of the disorder. The social functioning of children with ADHD is then reviewed with reference to social motivation, the role of executive functioning in social interaction and the influence of ADHD on social learning. The concept 'theory of mind' is defined and both neurologically based and social learning explanations for theory of mind are discussed. Links between executive functioning in ADHD and autism are examined and the possible relationship of these functions to theory of mind outlined. Finally, the measures used to assess theory of mind are evaluated with particular attention to language, executive functioning and their relationship to everyday functioning.

1.1 Attention Deficit Hyperactivity Disorder (ADHD)

1.1.1 Definition of ADHD

At the beginning of the last century, a group of children were identified by Still (1902) as having difficulties in "moral control" which he believed were due to constitutional or inherited factors not parental or environmental influence (Hinshaw, 1994). Much later, hyperactivity was identified as a major feature of the disorder (Laufer & Denhoff, 1957) and subsequently inattention and impulsivity were included in the definition (Douglas,

1972). The International Classification of Diseases and Related Health Problems (ICD-10) argues that there is not sufficient knowledge of psychological processes of this disorder to include 'attention' in the definition. Therefore ICD-10 refers to this group of children as 'hyperkinetic' describing a lack of persistence in activities as a key characteristic. The Diagnostic and Statistical Manual of Mental Disorders, fourth edition, (DSM-IV) classes hyperactivity and impulsivity together as one impairment with three subtypes, (i) predominantly inattentive, (ii) predominantly hyperactive-impulsive and (iii) combined.

DSM-IV lists nine characteristics of inattention and nine of hyperactivity/ impulsivity that may be exhibited by children with ADHD (Appendix 1). Barkley (1997) criticises the DSM-IV criteria for ADHD as not accounting for the full range of symptoms of the disorder. He suggests that the description of ADHD as comprising of two behavioural deficits (inattention and hyperactivity-impulsivity) is insufficient. Deficits in executive functioning and self-regulation are not accounted for in the DSM-IV definition and, as Barkley (1997) points out, most if not all of the cognitive difficulties found in ADHD can be explained by these categories. Additionally it has been suggested that identifying attention as the primary deficit in ADHD may be misleading as children with ADHD have been found to have consistent inhibitory control deficits on tasks where attentional requirements vary (e.g. Schachar, Tannock and Logan, 1993).

Barkley (1990) has suggested the role of inhibition is a central component of the disorder affecting the ADHD child's executive functioning and ability to self-regulate.

This will now be considered in more detail.

1.1.2 ADHD, Inhibition and Self-Regulation

Executive function is defined by Lezak (1995) as 'those capacities that enable a person to engage successfully in independent, purposive, self-serving behaviour' (p.42). These functions include the ability to formulate intentions or goals, plan actions and execute purposeful and effective behaviour (Lezak, 1995).

Barkley (1997) proposed that four executive functions are influenced by inhibition. These are working memory, self-regulation of affect, motivation and arousal and internalisation of speech and reconstitution (behavioural analysis and synthesis). He suggested that inhibition of response is the first executive function required when confronted with a stimulus and allows a necessary delay so that actions can be considered in the light of information from other executive processes. The four executive functions listed above are dependent on effective inhibition for control of their functioning and contribute critically, to the ability to self-regulate. Barkley (1997) argued that ineffective inhibition, as a central characteristic of ADHD, resulted in poor regulation.

Self-regulation, as defined by Barkley (1997), is any self-directed behaviour, not necessarily observable, which contributes to the likelihood of an individual's response and as a consequence to the outcome of that response. Self-regulation includes self-directed behaviours such as organisation of behaviour across time, the use of internal

speech and consideration of rules and plans. Barkley (1997) highlighted certain kinds of tasks that are likely to require self-regulation skills. These include tasks that involve delays in consequence, resistance to temptation, delayed gratification or require novel responses. Difficulty with self-regulation in children with ADHD presents as a tendency to be influenced by the immediate environment and imminent consequences (Barkley, 1997). Children without ADHD, conversely, are more influenced by internal information including past experience, predictions about the future, plans and rules.

Barkley proposed that the efficiency of these executive functions involved in self-regulation is a result of both neurological and environmental influences including the development of neural networks in the pre-frontal lobes, past experience of consequences from actions, ongoing reinforcement and the social experience of the individual. Thus, Barkley proposed that poor self-regulation in ADHD is a result of a combination of neurological disorder and ongoing experience. That is that children with ADHD develop behavioural responses and strategies that are difficult for the child to modify in the face of limited processing resources (e.g. poor planning, poor use of past experience, restricted ability to make predictions about the future).

Barkley accounts for inattention, traditionally assumed to be a major feature of ADHD, as a result of insufficiencies in goal directed behaviour leading to a lack of persistence with tasks. He describes two types of inattention or persistence, that which is self-regulated and controlled by internal information and that which is motivated externally. The first type is dependant on self-motivation and is required when doing tasks such as

writing an essay or doing a sheet of maths. The second type depends on factors such as novelty of task and timing of reinforcement for persistence to be maintained. Barkley suggested that children with ADHD have difficulty with the first type of inattention. Thus, when rewards and feedback take longer to achieve and more internal regulation is required, the executive functioning deficits described above make it difficult for children with ADHD to persist. Thus children with ADHD may find sitting still and doing homework difficult, but may be able to concentrate for long periods of time on computer games which give regular reinforcement.

The emphasis of the above model on executive functioning as a core deficit suggests that non-executive skills would not be affected by ADHD (Barkley, 1997). Barkley (1997) proposed that the perception of others emotions is likely to remain unaffected for this reason. However studies have found that children with ADHD had difficulty identifying emotional expression and content in speech (Shapiro, Hughes, August & Bloomquist, 1993) and problems recognising facial expression of emotion (Singh, Ellis, Winton, Singh, Leung, & Oswald, 1998). Pennington & Ozonoff (1996) suggest that the skills needed for successful social interaction are similar to those required in executive function tasks. That is, that success in both involves internal representation of concepts, social or otherwise, when deciding on an appropriate response. It seems reasonable to assume that difficulties with self-regulation will affect social interaction as those children will have a tendency to react to the immediate environment and consequences rather than integrating past information and therefore may have difficulty making predictions about the likely behaviour of others involved in the interaction and problems

adhering to internal plans and rules.

1.2 ADHD and Social Interaction

Children with ADHD have been found to have problems with relationships with peers (Clark, Cheyne, Cunningham & Siegel, 1988), teachers and parents (Whalen, Henker & Dotemoto, 1980; Campbell, 1973). They have been found to be less likely to respond to the questions or verbal interactions of their peers (Landau & Milich, 1988) and have been shown to elicit more controlling and directive behaviour from their peers than non-ADHD children (Clark et al., 1988). Studies have shown that children with ADHD have problems with identifying the emotional expression and content in speech (Shapiro et al., 1993), difficulty recognising facial expression of emotion (Singh et al., 1998), deficiencies of social knowledge (Grenell, Glass & Katz, 1987), elicit more aggression and less verbal reciprocity from their peers (Clark et al., 1988) and exhibit differences in judging the acceptability of others behaviour (Whalen & Henker, 1985). Additionally, many of the DSM-IV criteria for ADHD reflect pragmatic communication difficulties e.g. difficulty with turn taking, interrupting others and not listening to what is being said (Giddan, 1991). Thus there is evidence that children with ADHD have social difficulties. However there are a number of possible explanations to account for the origins of these difficulties. Children with ADHD may have different social goals and motivations (Whalen and Henker, 1992) or executive functioning deficits may cause inappropriate response in social situations (Pennington & Ozonoff, 1996). Alternatively having ADHD may influence social learning experience. These three hypotheses are

examined below.

1.2.1 Social Motivation.

Whalen & Henker (1992) suggested that differences in the social interaction of this group may be due to motivation. That is, these children know which behaviours are appropriate and which are not, however, different social goals and agenda mediate their interaction. In support of this, Whalen, Henker & Granger (1990) found that children with ADHD were as able as controls to identify inappropriate behaviours in their peers and those who cause trouble, suggesting good social knowledge. When asked to identify children who were fun to be with, ADHD children proposed significantly more children than their peers and teachers including these children who were labelled as 'troublemakers' (Whalen & Henker, 1985). They interpret this finding as evidence that children with ADHD have a greater tolerance of those with deviant behaviour and may even enjoy difficult behaviours in others and therefore are motivated by different outcomes in interaction. However, the ADHD children in this study may have been accepting these children in attempts to convey acceptance of themselves, who may also have been labelled a 'troublemaker'. Also this suggestion does not account for deficits in social processing of emotional information (Shapiro et al., 1993; Singh et al., 1998) deficits in social knowledge (Grenell et al., 1987) and difficulties in organising conversation (Hamlett, Pelligrini & Conners, 1987) which are found in children with ADHD.

1.2.2 Executive Functioning and Social Interaction.

Many of the social difficulties ADHD children have seem to lend themselves readily to an executive dysfunction explanation. Barkley, Cunningham & Karlsson (1983) found that children with ADHD talk more than their peers. However, when they are required to organise their speech in response to a specific goal they have more difficulty (Hamlett et al., 1987). Barkley (1990) suggested that this is due to deficits in executive functioning which affect the ability to organise and monitor verbal communication.

Studies of peer interaction by Grenell et al. (1987) found ADHD children to be significantly poorer than their peers on measures of social knowledge. Although children with ADHD were able to describe how to initiate interaction, their knowledge about situations involving maintaining relationships was limited. They gave less effective suggestions that showed less impulsive control than those of their peers. Grenell et al. (1987) proposed that more complex problem solving skills are involved in maintaining than initiating a relationship and that this was more challenging for the ADHD than the non-ADHD children. They also suggested that ADHD children had more difficulty considering long-term consequences and were more bound by short-term reward. This explanation is compatible with Barkley's suggestions that ADHD children are more governed by immediate consequences and have difficulty with goal directed behaviour and is consistent with the suggestion that executive functioning may influence these children's social ability when selecting appropriate responses in interaction.

Other deficits, such as difficulties processing emotional information are more difficult to

explain in terms of executive dysfunction. Barkley (1997) predicted that the executive functioning difficulties of ADHD would not influence the perception of emotion in others because of its non-executive nature. However, this type of difficulty has been found in children with ADHD (Shapiro et al., 1993; Singh et al., 1998).

Shapiro et al. (1993) investigated the ability of ADHD children to process emotional stimuli using recordings of speech with varied emotional expression and content and pictures of various facial expressions. Overall they found that the emotional processing skills of ADHD children did not differ from controls. However, significant differences were found between ADHD and non-ADHD children on two of the measures, one requiring the matching of prosody and content in speech and the other matching audio to visual emotional stimuli (Table 1.1). The authors explain this as a difficulty with auditory processing and working memory. However there was no difference between the ADHD and non-ADHD children on working memory tasks. The tasks that the ADHD children performed more poorly on, involved processing conflicting emotion and content of speech or conflicting emotion and facial expression. An alternative explanation for Shapiro et al.'s findings is that ADHD children were able to process emotional information of one type e.g. matching facial expressions, however, difficulties occurred when there was conflicting information requiring two types of processing (auditory and visual processing). These tasks required more internal organisation and therefore placed more demands on executive functioning. This explanation is consistent with the finding that children with ADHD perform more poorly than non-ADHD children on tasks involving processing conflicting information and inhibiting one

response in preference for another, such as the Stroop test (Barkley, Grodzinsky & DuPaul, 1992; Grodzinsky & Diamond, 1992). This explanation for Shapiro's findings is consistent with the hypotheses that executive functioning influences social ability in children with ADHD.

Table 1.1 Emotional Processing in Children with ADHD Compared with Controls in a Study by Shapiro et al. (1993).

Task	ADHD vs Control
Matching inverted faces	Not Significant
Matching faces with different expressions	Not Significant
Matching facial expressions on different faces	Not Significant
Identifying facial expression	Not Significant
Preference for prosody or content in judging affect in speech	Not Significant
Matching speech prosody to speech content	Significant
Matching speech prosody to facial expression	Significant
Facial memory	Not Significant
Object memory	Not Significant

There is some evidence that is difficult to reconcile with the idea that executive functioning deficits influence social processing. Singh et al. (1998) found evidence that children with ADHD have difficulties processing emotional stimuli through investigating perception of facial expression in children with ADHD. They found that when compared to controls, children with ADHD had more difficulty correctly

identifying facial expressions of emotion. These children however did show an ability to discriminate between facial expressions. Thus the children were able to process the information visually, internally manipulate the information to compare faces and then make a judgement about their similarities or differences. This contradicts Shapiro et al.'s interpretation of their findings as indicating difficulties in perceiving stimuli and suggests that children may be able to deal executively with visual information but may not have the social knowledge or understanding to evaluate it. This suggests that the social deficits of ADHD may extend beyond executive functioning.

1.2.3 ADHD and Social Learning.

As discussed above, executive functioning deficits may account for some of the social difficulties experienced by children with ADHD. If deficits in executive functioning affect social ability in the everyday interactions of children with ADHD, then these deficits may have an affect the development of social skills. Camarata & Gibson (1999) presented a theory on how features of ADHD may affect the development of pragmatic communication skills.

Pragmatic communication skills are defined as the aspects of social interaction that are not included in the structural (grammatical) domain, deficits of which significantly disrupt conversation (Giddan, 1991). These deficits include inappropriate eye contact, failure to effectively monitor the conversation, poor turn taking, excessive talking, poor response to shifts of topic, poor assessment of body language and facial cues, frequent interruption and failure to take account of others needs in conversation (Camarata &

Gibson, 1999; Giddan, 1991).

Camarata & Gibson (1999) describe the hypothesis that interactions between mother and child facilitate language development. They applied the transactional model of mother-child interaction to pragmatic aspects of language learning, where the child's language in interaction with their parent instigates certain types of response from their parent. These responses facilitate language advances in the child whose returns then prompt a more advanced response from their parent. The important pragmatics a child needs at this stage of language learning are, the ability to initiate interaction, respond appropriately and maintain attention on the interaction. The exchanges involved in the development of language, Camarata & Gibson (1999) suggest, are likely to be compromised in children with ADHD. The characteristics associated with inattention in ADHD include failure to attend to instructions, difficulty sustaining attention in play, susceptibility to distraction and a tendency to not listen. This may affect parent-child interaction in several areas. A distracted child may disrupt the flow of conversation at the point where a non-ADHD child would be initiating the next parental response. Further more, the child may not attend closely enough to his parent's response and therefore miss the cues which prompt the next advance in language. Additionally, the child's parent may terminate the interaction sooner due to a perception that the child is not interested. Also, due to increased potential of disruption to the interaction, fewer completed conversations may be experienced by the ADHD child resulting in fewer experiences prompting language skills (Camarata & Gibson, 1999).

Additionally, ADHD children may frequently change topic disrupting the course of the interaction, leave the scene before the conversation is complete or interrupt or talk over the parent's attempts to reciprocate. Much of the time spent together may also be spent trying to control the child's behaviour, thus exchanges are more negative and more directive therefore less facilitative to the style of interaction required to encourage language development (Camarata & Gibson, 1999).

Some evidence for these suggestions was found by Clark, Feehan, Tinline & Vostanis (1999). In a study of the prevalence of symptoms commonly associated with autism in children with ADHD, Clark et al. (1999) questioned the parents of 49 children and found that most reported that their ADHD child had a 'lack of awareness of the feelings of others' (85.7%), had 'difficulty forming relationships' (81.6%), a 'difficulty in knowing how to begin or sustain a conversation' (77.5%) and had a 'lack of desire to interact with others' (55.1%). Although these are commonly reported autistic symptoms, Clark et al. (1999) suggested that they would be expected as a result of ADHD. Difficulties waiting in turn taking, interruption of others and being easily distracted are among the symptoms of ADHD that could produce the impression of being unaware of the feelings of others (Clark et al., 1999). Similarly, these symptoms could result in difficulties with relationships and in conversation. Lack of ability to interact may be misconstrued as a lack of willingness to interact and explain the majority of children being rated as having a 'lack of desire to interact with others'.

Parents also reported symptoms that would not be expected as a result of the features of

ADHD. Many of them described their children as having 'stereotyped hand and body movements' (71.4%) or 'odd forms of speech' (75.5%).

Clark et al. (1999) highlighted poor eye contact, failure to greet others and difficulties observing others personal space as commonly reported behaviours that are not easily explained by ADHD. However, these difficulties could be explained if features of ADHD influence development of social functioning, not just those areas which are immediately affected by difficulties such as inhibition. Therefore children with ADHD, because of deficits in executive functioning, may have less opportunity to experience appropriate interaction and learn about social skills and as a result may develop deficits in several areas of social functioning, not just the areas which are directly affected by executive processes. This would also offer an explanation for the results of Singh et al.'s (1998) study, that the ability to assign meaning to facial expression may have been compromised in children with ADHD as a result of impoverished social experience and effective utilisation of feedback about the meaning of facial expressions.

In summary, children with ADHD have been found to have difficulties interacting with other children and adults. Studies with children with ADHD have found problems with processing information relevant to social interactions (Shapiro et al., 1993; Singh et al., 1998), social knowledge (Grenell et al., 1987) and pragmatic skills such as awareness of others feelings and poor eye contact (Clark et al., 1999). Some of these deficits are readily explained by the executive functioning difficulties of children with ADHD,

others may be a result of the influence on social experience that executive functioning deficits have.

Some of the social behaviours mentioned above indicate a lack of regard for others in interaction e.g. inappropriate eye contact, frequent interruptions, difficulties with turn taking, failure to observe personal space. Peterson & Seigal (1995) suggest that social communication deficits are likely to contribute to poorer quality of interactions around mind states. They suggest that it may be less likely for adults to discuss their thoughts and intentions with children with communication problems. As suggested above, ADHD may affect mother child interaction and the development of pragmatic language (Camarata & Gibson, 1999). These assumptions infer that children with ADHD would have reduced opportunities to learn about the feelings and thoughts of others and therefore may face difficulties in social situations which require an understanding of others minds. The ability to understand others minds has been termed 'theory of mind'.

The following section examines the concept of theory of mind and the main research findings relating to this aspect of social understanding before discussing how this might relate to children with ADHD.

1.3 Theory of Mind

1.3.1 Definition of Theory of Mind

The first references to studies of the development of children's ability to distinguish between mental and physical states were by Piaget (1962). He described four stages of cognitive development. In the second stage, which Piaget termed preoperational, he proposed that children aged two to seven years develop the ability to represent things which are not present. This ability to symbolize is apparent in their capability to engage in pretend play. He suggested at this stage that children are 'egocentric', meaning that they do not understand that others have different perspectives and assume that others see, feel and think exactly as they do. Although Piaget's theories are much criticized, not least for the measures on which he based his conclusions (Bernstein, Roy, Srull & Wickens, 1988), they illustrate the first attempt to propose a theory of development of the ability to understand others feelings and thoughts.

The term 'theory of mind' was first used by Premack & Woodruff (1978) in their investigations into the ability of chimpanzees to attribute mental states to others.

Theory of mind has been defined by Tager-Flusberg, Baron-Cohen & Cohen (1993) as:

> the ability of normal children to attribute mind states (such as beliefs, desires, intentions, etc.) to themselves and other people, as a way of making sense of and predicting behaviour (p.3).

Thus theory of mind can be described as the ability to make inferences about a person's expectations and beliefs and to use this information to anticipate and understand their behaviour. For example, if I give my Mum a chocolate box on her birthday and she smiles, I assume that she believes that there are chocolates inside the box. That is, I think that she thinks that the box contains chocolate and this has made her pleased. This ability to form a conception of others' beliefs is termed first order theory of mind. When the assumptions required are more complex and involve others' beliefs about what others are thinking and feeling e.g. my Dad thinks that my Mum thinks that there are chocolates in the box, this is referred to as second order theory of mind.

Thus theory of mind requires the ability to understand that others have minds and mental states e.g. beliefs, hopes, intentions, thoughts and wants, which influence their behaviour. This ability is an essential part of appropriate and effective interaction.

The majority of studies looking at theory of mind have focused on children's ability to understand that another person can hold a belief that differs from their own and from reality, that is, a belief which is false. Wimmer & Perner (1983) were the first to investigate false belief. They used a scenario for young children where the child's own belief was different from that of a character in the scenario and to succeed in the task the child had to recognize that the character can hold a different, and false, belief. This task was adapted by Baron-Cohen, Leslie & Frith (1985) to form the 'Sally Anne Task' which is now commonly used to assess first order theory of mind. In this task, Sally puts her ball in a basket and then her friend, unknown to Sally, removes it and places it

in a box. When Sally returns, the child is asked where she will look for the ball. Giving the correct answer requires the child to understand that Sally holds a belief which is different from his/ her own and is false. That is, the child understands the concept of false belief.

The age of acquisition of this ability is still debated and varies according to the type of task or measure used (Happé, 1999). However, it is agreed that most normal children develop first order theory of mind by the age of four (Wimmer & Perner, 1983; Baron-Cohen et al., 1985).

The origins of theory of mind have been extensively debated recently. Several studies have focused on autistic children, known to have theory of mind deficits and it has been suggested that their theory of mind difficulty has a neurological basis (Frith, 1992). However researchers studying theory of mind in non-autistic populations have suggested a social learning based explanation for theory of mind deficits. These two theories are examined below.

1.3.2 Theory of mind and neurological functioning

Research into theory of mind has consistently involved people with autism. The core symptoms of autism are conceptualised as belonging to a triad of impairments: socialisation, communication and imagination. One of the most prominent symptoms of autism is an impairment of verbal and non-verbal social communication (Baron-Cohen, 1988). This is identified as a core deficit in autism which is manifest as severe

difficulties understanding and reacting appropriately to social stimuli.

Baron-Cohen et al. (1985) assessed the understanding of false belief in autistic children, controlling for intelligence and found that autistic children consistently failed to take account of others beliefs whereas children with Down's Syndrome and normally developing pre-school children consistently considered beliefs when predicting puppets' behaviour. They conclude that this finding is evidence for a specific cognitive impairment which cannot be explained by low intelligence and which can explain the social impairments of autism.

Frith (1992) suggests that theory of mind or 'mentalising' is a single cognitive deficit that can account for the triad of impairments in autism and that this deficit is a direct result of a brain abnormality and therefore, theory of mind deficits have a biological explanation.

Evidence from examining theory of mind in people with brain injury have helped further theories on the role of neurological systems in theory of mind.

The possibility of a specific module in the brain dedicated to theory of mind has been debated (Happé, Brownell, & Winner 1999). They examined theory of mind in people with right hemisphere damage who are commonly found to exhibit social and communication problems that are similar to high functioning people with autism. Happé et al. (1999) reasoned that if a dedicated neurological system for theory of mind existed

in the right hemisphere, those with damage in this area would be expected to have deficits in theory of mind but preservation of other reasoning skills. They found that patients with right hemisphere damage performed significantly worse on theory of mind tasks than those with left hemisphere damage and controls. This supports the suggestion that right hemisphere processes have a key role in theory of mind.

Evidence from functional imaging studies however has revealed mixed results. Activation of the right orbito-frontal regions has been found when participants are asked to identify words associated with the mind, such as 'think' (Baron-Cohen, Ring, Moriarty, Schmitz, Costa & Ell, 1994). However other studies have reported brain activity in the temporal lobes, left superior temporal gyrus and posterior cingulated cortex (Fletcher, Happé, Frith, Baker, Dolan, Frackowiak & Frith, 1995).

Happé et al. (1999) suggest that this may be explained by neural circuitry dysfunction that could affect different sites in the brain. They also point out that their findings support right hemisphere involvement in theory of mind ability in normal adults but do not necessarily imply that the right hemisphere is essential in the development of theory of mind or rule out the possibility that damage to other areas of the brain could affect theory of mind. Their findings importantly suggest that the mechanisms of normal adult theory of mind can be affected separately from other reasoning mechanisms which suggests cognitive specialization in normal adults, for this ability.

Studies of theory of mind in populations that are not autistic have provided evidence

which conflicts with a purely neurological explanation for the development of theory of mind.

1.3.3 Theory of Mind and Social Learning

One of the populations studied by several authors exploring theory of mind, is deaf children (Peterson & Siegal, 1995; Russell, Hosie, Gray, Scott, Hunter, Banks & Macaulay, 1998; Peterson & Siegal, 1998). Peterson & Siegal (1995) argued that the biological hypothesis, does not account for other influences which may affect the development of theory of mind such as sensory, physiological or social handicaps. They suggested that deaf children are of particular interest since their disability severely limits the access they have to information about other's minds. Research has shown that the hearing parents of deaf children rarely attain a competency level in signing which allows them to communicate with their child fluently about their own thoughts and beliefs (Peterson & Peterson, 1990). The conversational interactions between deaf children and their parents tend to be limited to topics of visual reference (Schlesinger & Meadow, 1972) and therefore topics which involve mind states including false beliefs would be seldom discussed. Peterson & Siegal have shown in two separate studies that deaf children performed similarly to autistic children and failed first order theory of mind tasks (Peterson & Siegal, 1995; Peterson & Siegal, 1998). They suggest this contradicts the hypothesis that theory of mind difficulties are specific to autism. Since deaf children do not share the triad of impairments associated with autism, Peterson & Siegal (1995) conclude that deficits in the understanding of false-belief could occur in deaf children for different reasons. Tager-Flusberg (1992), however, found that children with autism

also engage in very few or no conversational exchanges with their mothers on topics involving mind states. This was found to be true even when other topics of conversation were engaged in as fluently as other children of a similar mental age. However, whereas deaf children have a lack of opportunity to discuss mind states due to language barriers, autistic children may miss out on mind state conversations as they are less willing to interact with others. Alternatively or in addition, they may not have the cognitive ability to understand these interactions (Frith, 1989).

Thus autistic children have in common with deaf children, a poverty of exposure to exchanges about mind states. Peterson & Siegal (1998) point out that the reasons for deficits on false belief tasks in autistic and deaf children may be different. The neurological account seems more plausible for children with autism as it is accepted as a neurologically based disorder. In deaf children, neurological deficit seems implausible, however Peterson & Siegal (1999) suggest a neurological basis for the difficulties experienced by deaf children is a possibility since neuro-imaging studies have shown different patterns of activity between hearing and deaf adults (Neville, Coffrey, Lawson, Fischer, Emorey & Bellugi, 1997).

Peterson & Siegal (1998) postulate a link between the two accounts based on the theory that there is a critical period of brain development which is especially important to the development of understanding of mind states (Lenneberg, 1967) and that this is compromised by a lack of conversational exposure to information about others minds in early development. Russell et al. (1998) found evidence contrary to this hypothesis by

studying a wider age range of deaf children. Significantly more of the older children in their study (aged 13-16) passed theory of mind tests than those aged 4-12. They suggested that their findings conflict with an innate hypothesis of theory of mind and conceptualise the difficulties deaf children have with false belief as a developmental delay, which is caused by restricted experience, rather than an enduring deficit.

Studies involving visually impaired children also emphasise the importance of social experience in the development of theory of mind. Visually mediated experience, such as shared visual attention or determining the source of other peoples response, is likely to be compromised in visually impaired children (Hobson, 1990; Minter, Hobson & Bishop 1998). This, suggested Minter et al., may have implications for the ability of severely visually impaired children to develop an appreciation of others minds.

Minter et al. (1998) studied the performance of visually impaired children on theory of mind tasks which were adjusted to give tactile rather than visual information. They found that significantly more visually impaired children failed theory of mind tasks than their sighted peers. As with hearing impaired children, it is possible that the source of the difficulties experienced by these children is a poverty of social experience. Minter et al. (1998) hypothesised that visually impaired children's inability to share visual attention and difficulties understanding the focus of reference in others response may in turn influence others reactions to them, including giving information about their own feelings and intentions, and further reduce their opportunity to process information and learn about mental states. This is consistent with a social learning hypothesis for theory

of mind.

Further evidence supporting the importance of social interaction in developing theory of mind is provided by studies of normal children. Perner, Ruffman & Leekman (1994) suggested that children who have siblings should have an advantage in developing knowledge of others mind states, reasoning that play with siblings gives rich opportunities to learn about mind states and sibling conflicts prompt discussions with parents about feelings and moral issues encouraging consideration of others. In support of this, Perner et al. (1994) found that the number of siblings a child had was positively related to performance on theory of mind tasks. This finding was replicated by Lewis, Freeman, Kyriakidou, Maridaki-Kassotaki & Berridge (1996) although they found that this was only true where the siblings were older. However conflicting findings were discovered by Cutting & Dunn (1999) who found that number of siblings in the family was not related to understanding of emotion or false belief. It may be that it is the quality of interaction that is important not the amount of interaction that affects theory of mind development (Perner at al., 1994). In support of this, Youngblade and Dunn (1995) found that social play with mothers and siblings at 33 months of age was related to social understanding at 40 months of age and Dunn, Brown, Slomkowski, Tesla, & Youngblade (1991) found that mothers conversations about feelings when their child was 33 months old related to understanding of emotion and false belief when they were 40 months old.

Thus evidence supporting a social influence on the development of theory of mind is

substantial. What is not known is whether deficits in theory of mind ability in deaf and blind children have a different cause from the difficulties experienced by autistic children in this area or whether the social experience of children with autism is not given enough emphasis as an influential factor in the development of theory of mind. Alternatively there may be an interaction between neurological capacity and social experience which facilitates development of theory of mind.

Children with autism also have executive functioning deficits and it has been argued that this is linked with deficits in theory of mind. The following section discusses the executive functioning profile of ADHD and autism and the evidence linking executive functioning and theory of mind.

1.4 Executive Functioning

1.4.1 Executive Functioning, Autism and ADHD

As described above, executive functions include the ability to formulate intentions or goals, plan actions and execute purposeful and effective behaviour (Lezak, 1995). Typically those with executive dysfunction (EDF) have problems in all these areas with one or two areas being more affected (Lezak, 1995). Executive functions are primarily associated with the frontal lobes although executive functioning deficits can occur as a result of damage to other areas of the brain including subcortical damage and right hemisphere damage (Lezak, 1995). EDF has been found in children with autism (Ozonoff, Pennington & Rogers, 1991a) and children with ADHD (Seidman,

Biederman, Faraone, Weber & Ouellette, 1997; Grodzinsky & Diamond, 1992)

Pennington & Ozonoff (1996) reviewed the literature concerning executive functioning (EF) and autism, ADHD and Tourettes syndrome. They concluded that the severity and profile of EF deficits in ADHD and autism varies. In their review they found that ADHD children tend to have deficits on EF tasks which require inhibition whereas autistic subjects had more difficulty relative to controls on tasks requiring flexibility. These findings were confirmed by Ozonoff & Jensen (1999) who conducted the first study which directly compared children with autism, ADHD and Tourettes on three EF measures, the Wisconsin Card Sorting Task (WCST), the Tower of Hanoi, (TOH) and the Stroop Color-Word Test. They found that autistic subjects had significantly poorer performance on the WCST and TOH than the ADHD or Tourettes subjects. Thus illustrating difficulties in planning and flexibility. In comparison, the children with ADHD had more difficulty on the Stroop test relative to the other groups but were not impaired on the WCST and TOH. They conclude that although several disorders share EF deficits in common with autism, if the profiles of the EF deficits are examined in more detail they will reveal differences that may account for different behavioural presentation.

Other studies however have found that children with ADHD have difficulty with tasks involving planning and flexibility such as the WCST (Seidman et al., 1997). If deficits usually present across the range of executive functions, as suggested by Lezak (1995), it may be that the different cognitive profiles found in children with ADHD and autism

may be attributable to a different balance of EF deficits. Thus children with ADHD and autism would be expected to have some behavioural similarities but different severities of these behaviours linked to EF.

1.4.2 Executive Functioning and Theory of Mind

Some of the behavioural symptoms common to autistic people are consistent with those expected in executive dysfunction e.g. insistence on sameness, difficulty coping with change, restricted interests. Difficulties with orientation to the future and consideration of long-term consequences as well as problems with self-reflection and self-monitoring are associated with autism and may be explained by EF deficits (Ozonoff et al., 1991a). It has been suggested that EF deficits may be a primary cause of autism and therefore underlie the cognitive and behavioural presentation of the disorder, including impairment of theory of mind (e.g. Russell, Mauthner, Sharpe & Tidswell, 1991). Alternatively poor performance on EF tasks may be a result of other impairments that are primary to autism. For example, difficulties on the WCST could be explained by deficits in skills which are not executive e.g. socially interactive verbal feedback (Pennington & Ozonoff, 1996). Furthermore, EF deficits may be associated with autism but not play a causal role or be a result of, the presence of other cognitive and behavioural symptoms. These three hypotheses are examined below.

Russell et al. (1991) suggests that EF deficits account for theory of mind difficulties as the tasks used to study theory of mind require a child to suppress the more salient knowledge of reality in order to recognise another's false belief requiring executive

control.

However, some studies have failed to find a link between EF and theory of mind. Ozonoff, Rogers & Pennington (1991b) found that a sub-group of their subjects who had Asperger's syndrome had EF deficits but performed well on theory of mind tasks. Griffith, Pennington, Wehner & Rogers (1999) studied children between the ages of 40 and 61 months with autism and found that they performed as well as a control group on eight measures of EF. They reasoned that if no EF deficits were found at this age, when children had been identified by their behaviour as being autistic, then it is unlikely that EDF can account for the behavioural and cognitive symptoms of autism.

Therefore, although there is substantial evidence to support a link between EF and autism, there is evidence which clearly disputes the hypothesis that EDF could account for the behavioural and cognitive symptoms of autism including theory of mind deficits.

The second suggested hypothesis is that EF deficits are secondary to other primary symptoms of autism. Pennington & Ozonoff (1996) suggest that lack of social experience in autism may give reduced opportunity to practise cognitive flexibility that is abundant in social interactions. This hypothesis is also contradicted by the findings of Griffith et al. (1999) that show that the symptoms of autism can exist independently of executive dysfunction, that is, performance on EF tasks can be intact when other deficits are present.

The final hypothesis to be considered is that EF and the other cognitive and behavioural symptoms of autism are present alongside each other, with a potentially related cause. Mitchell (1997) described theory of mind and executive functioning deficits as two separate kinds of cognitive deficiency. He suggests that some of the behaviours in autism can be explained by deficits in theory of mind whereas other behaviours, such as narrow interests and insistence on sameness are explained by impaired EF. The evidence presented above (Griffith et al., 1999; Ozonoff et al., 1991b) suggests that the two deficits although often co-occurring, are not necessarily related in autism. Ozonoff et al. (1991b) discuss the causal role of pre-frontal impairment in EF and theory of mind deficits. They review evidence that the pre-frontal cortex is involved in both EF and social ability (e.g. communication, affect, appreciation for social rules). It has been proposed that the pre-frontal cortex facilitated the use of stored information in mediating behavioural response (Goldman-Rakic, 1987). Based on this assumption, Ozonoff et al. (1991b) suggest that to succeed on a theory of mind task, a subject must be able to internally represent others and their own mind states and act upon this information. Similarly, performance on an EF task involves internal representation of concepts and assumptions about the tasks, which is referred to when organising and choosing a response.

In conclusion, both ADHD and autistic children show EF deficits, however this may vary according to the particular skill required. People with autism tend to have more difficulties on tasks requiring planning and flexibility and ADHD subjects have more difficulty with tasks involving inhibition. Although there is evidence to suggest that

ADHD children also have difficulties in planning and flexibility. Executive functioning deficits have been linked with theory of mind although evidence suggests that this link is not causal and may be no more than symptoms commonly present in autism. It may be that neurological areas responsible for EF and the integration of social information are both affected in autism and therefore deficits in these two areas often co-occur. Therefore, if there is a link between executive functioning and theory of mind, it may be that the EF deficits in children with ADHD are also linked with theory of mind difficulties.

The grounds for investigation of theory of mind in ADHD and the studies of theory of mind that have included children with ADHD are discussed below.

1.5 Theory of Mind and ADHD

There are several reasons for supposing that children with ADHD may have theory of mind difficulties.

The social learning experience of children with ADHD is likely to be affected by the features of ADHD. As discussed above, difficulties with self-regulation and inhibition may interfere with learning of appropriate social interaction skills and may affect others social responses to children with ADHD. Since evidence indicates that quality of social experience influences theory of mind development, this suggests that this group may be disadvantaged when developing an understanding of others mind states.

Children with ADHD have executive functioning deficits, as do children with autism. Evidence suggests that these deficits may not be causally linked with theory of mind in autism. However it is also argued that the processes involved in executive functioning are similar to those required for social processing (Osonoff et al., 1991b). That is, internal representation of concepts, organisation and integration of information and planning responses. Children with ADHD have been found to have social processing deficits in other areas e.g. organising speech (Hamlett et al., 1987), matching prosody and content in speech (Shapiro et al., 1993) which may be explained by executive functioning deficits. These difficulties may extend to other areas of social processing and affect abilities such as theory of mind.

Neurological deficits have been implicated in theory of mind difficulties and in ADHD. Several neurological aetiologies have been proposed to explain ADHD. Theories of biochemical dysfunction have implicated neurotransmitters and norepinephine levels in the right hemisphere (Spreen, Risser & Edgell, 1995). Other theorists have suggested immaturities or late maturation of the frontal lobes (Spreen et al., 1995), or lack of blood flow to the frontal lobes (Lou, Henriksen & Bruhn, 1984). Therefore, although the presence of neurological differences in children with ADHD is generally agreed, there is much debate about the exact nature of these differences.

Given the inconclusive results from neuro-imaging studies of theory of mind, it is not possible to hypothesis a link between areas of brain dysfunction in children with ADHD

and areas responsible for theory of mind. However as discussed by Happé et al. (1999) damage to neural circuitry may implicate several areas of the brain.

Baron-Cohen, Tager-Flusberg & Cohen (1999) highlighted the links between ADHD and executive functioning and ADHD and Social Learning and indicated the lack research examining theory of mind and children with ADHD. There have been no studies that have addressed this population specifically however, two studies examining theory of mind have included children with ADHD.

Buitelaar, Van der Wees, Swaab-Barneveld & Van der Gaag (1999) used ADHD children along with other children in a psychiatric population to compare the performance on theory of mind tasks with children with autism and children with pervasive developmental disorders. The children with ADHD could not be differentiated from autistic children and performed significantly worse than normal controls. Conversely, the others in the psychiatric group, diagnosed with conduct disorder or dysthymia, performed as well as the normal children on theory of mind tasks. Variance in performance on second order theory of mind tasks contributed to most of the differences between the groups. They interpret this finding as in accordance with the findings of Pennington & Ozonoff (1996) that impairment in executive functioning is associated with ADHD (see section 1.4.1). They also describe a case study of a non-autistic 9 year old boy with executive functioning deficits and problems with theory of mind and emotional recognition tasks but good verbal comprehension and reasoning abilities (Buitelaar, Swaab, van der Wees, Wildschut, & van der Gaag, 1996) They

argued that his verbal ability compensated for his executive functioning deficits which they proposed would affect theory of mind ability. They suggest that further research is indicated to investigate whether difficulty with second order theory of mind tasks is associated with neuropsychiatric disorders involving frontal lobe dysfunction.

Conversely, a study by Muris, Steerneman, Meesters, Merckelback, Horsenleberg, Van den Hogen & van Dongen, (1999) used children with ADHD as controls to validate a theory of mind test they had developed. They found that the children with ADHD performed better than those in a groups of pervasive developmental disorder and autism and equally as well as those with anxiety. However their numbers were small (14 children with ADHD) and this may have masked differences between the ADHD and anxiety group. The anxiety group may also have performed below expected levels due to performance anxiety and the absence of a normal control group meant that problems in this group compared with the normal population could have been missed.

Therefore ADHD has several links with associated deficits and hypothesised causes of theory of mind. However theory of mind in this population has not been specifically studied and studies on theory of mind which have included children with ADHD have found mixed results.

1.6 Measuring Theory of Mind

Several tasks have been developed in the attempt to measure theory of mind. In the

following section, the literature on the reliability and validity of theory of mind tasks is examined with particular attention to language and executive functioning, two areas commonly affected in ADHD and which may influence outcome on the tasks.

Wimmer & Perner (1983) found that 78% of four and five year olds performed correctly on a false belief task which only 15% of three and four year olds managed. Perner, Leeham and Wimmer (1987) tested the hypothesis that the failure of three years olds was not due to memory difficulties, failure to understand the normal expectations that give rise to false belief or pragmatic misrepresentation of the test question. They added memory questions to the original task and found that children were able to answer these accurately. They compared two tasks, one, which made the expectations of the holder of the false belief about the situation explicit, and one that did not and found that this did not influence children's judgement. Finally they manipulated the phrases used to question the children and found that this did not affect results.

The first studies of theory of mind in children with autism were conducted by Baron-Cohen et al. (1985) using the Sally-Anne Task, as described on p.17. This task requires children to understand that others can hold beliefs which are different from your own and false. That is, whether the child understands the concept of false-belief.

The validity of these tasks has been much debated with particular consideration to the effect of language ability, the influence of executive functioning and the relationship of the tasks to social ability in everyday functioning. These three areas are examined

below.

1.6.1 Theory of Mind Tasks and Language Ability.

Siegal and Beattie (1991) examined the role of pragmatic understanding in the questions used in theory of mind tasks. They used an equivalent task to the Sally Anne Task and found that adding the word 'first' and asking the question 'where will Jane look first for the kitten', greatly enhanced the understanding of the children and improved their performance on the task. Therefore, the finding that children don't develop false belief until around the age of four has to be treated with caution as understanding of context and pragmatic language influences performance on these tasks.

Several studies have compared autistic children's understanding of false belief with the understanding of children with language difficulties. Leslie & Frith (1988) used real life scenarios to compare theory of mind abilities in children with difficulties in language comprehension to autistic children and found that the children with language difficulties performed well on false belief tasks suggesting that language problems cannot account for the difficulties experienced by autistic children on these tasks.

Perner, Frith, Leslie & Leekam (1989) also examined autistic and language delayed childrens' false belief understanding. They used the 'Smarties Task' where children are shown a tube of smarties and asked what the tube contains. They are then shown that, contrary to their belief, that it contains pencils. Thus they have experienced holding the false belief themselves. They are then asked what another child would believe was in

the tube. This simple task allows children to experience how a false belief can occur before being asked to acknowledge another's false belief. Perner et al. (1989) used this task with a group of autistic children and a group of language delayed children. Their results were consistent with the findings of Baron-Cohen et al. (1985) and Leslie & Frith (1988) as their autistic children had difficulty with this task and language impaired children did not.

It has been found subsequently that language ability does affect the performance of autistic individuals on theory of mind tasks. Happé (1995) found that autistic children needed better language skills to pass false belief tasks than normally developing children.

Happé (1995) suggests that the autistic subjects were solving the tasks in a different way, their approach may be more logical and conscious, requiring higher verbal ability. In support for this, Happé (1995) found that autistic subjects passing second order theory of mind tasks were able to give justifications for their answers whereas normal and learning disabled children were not. Thus the autistic subjects may have been using more verbal strategies.

Therefore although children with language disorders tend to pass theory of mind tasks suggesting that language difficulties do not affect performance, there is evidence that performance on these tasks may be affected by language skills depending on the approach to the task.

Another area which may affect performance on theory of mind tasks and which ADHD children have been shown to have difficulty is executive functioning

1.6.2 Theory of Mind Tasks and Executive Functioning

Russell et al. (1991) suggested that children failed false belief tasks due to an inability to inhibit responses to a salient object. That is, these tasks require children to inhibit their knowledge of physical reality e.g. 'the ball is in the box' and respond to the situation using mental knowledge 'Sally thinks it is in the basket'. Russell et al. (1991) suggest that the developmental advantage is not knowledge of mind states, but the ability to suppress competing knowledge of physical reality, a skill requiring executive control. An experiment involving theory of mind but not executive functioning by Bartsch & Wellman (1989) gives support to this theory. They found when three year olds watched a puppet search for band-aids in a band-aid box when they knew the band-aids were in an unmarked box, 66% were able to justify correctly that the puppet thought they were in the band-aid box. Thus a much higher percentage than the Sally Anne Task would predict, had an appreciation of the puppets false belief.

However this is an inadequate explanation for the consistent failure of autistic children on false belief tasks for several reasons. Firstly, false belief tasks contain a memory question e.g. 'Where did Sally put the ball first?' If the suggestions of Russell et al. (1991) were correct, children without the required level of executive functioning would be likely to give an incorrect response to the memory question by responding to their

salient physical knowledge. In the Sally Anne Task, giving the response of where the ball is currently. However children who pass the memory question still fail on the false belief question (Perner, et al. 1987) suggesting difficulties with false belief not executive functioning cause failure on the task.

Secondly, further experimental evidence has shown that executive functioning deficits fail to provide the explanation for poor performance on false belief tasks. Leslie & Thaiss (1992) used a task called the False Photo Task to investigate executive functioning hypothesis. This task requires a child to take a photo, with an instamatic camera, of a doll sitting on a mat. While the photo is developing, the experimenter moves the doll onto a box and asks where the doll will be in the photo, which is developing. This involves inhibition of a response guided by the physical cue of the doll being on the box and includes the unexpected transfer of an object present in false-belief tasks but without the requirement of understanding others minds. Zaitchik (1990) found that three-year-olds had difficulty with this task suggesting that they did not have the executive functioning required and this would also cause failure on false-belief tasks. Leslie & Thaiss (1992) found that almost all the children with autism in their study passed the false photo task but failed a false belief task. This strongly suggests that EF deficits cannot account for failure on theory of mind tasks in children with autism or three-year-olds without autism.

1.6.3 Theory of Mind Tasks and Everyday Functioning.

As discussed above, children with autism or Asperger's syndrome often pass theory of

mind tasks and several possible explanations have been given for this. Bowler (1992) suggested that those passing the tasks might be using methods which don't involve affective or emotional sub-domains. This could account for the persisting social handicap of these children despite success on theory of mind tasks (Frith, Happé & Siddons, 1994). In order to address this issue, Happé (1994) developed a series of stories illustrating everyday situations where people say things that they do not literally mean. These stories were designed to present a more naturalistic assessment where participants would be required to consider context and have an understanding of the characters thoughts and/ or feelings to reach a correct answer. They represented situations such as pretending, telling a joke and using sarcasm. Happé (1994) found the performance of those with autism on theory of mind tasks was closely related to performance on the stories, that is those who passed second order tasks performed better than those who passed only first order tasks, who in turn performed better than those who failed both first and second order tasks. She interpreted this as support for the validity of traditional theory of mind tasks. The most able autistic subjects in Happé's study also had significantly more difficulty with the stories than either normal or mentally handicapped controls. She suggested that this indicated that the stories represented a more naturalistic and sensitive way of assessing theory of mind than traditional measures.

Other studies have looked more directly at the relationship of theory of mind tasks and social skills in everyday life. Lalonde & Chandler (1995) found that performance on false belief tasks in three year olds was associated with their teacher's report of

engagement in social activities involving theory of mind e.g. playing co-operatively with four to five children without supervision. In this study, measures of social convention that were thought to be independent of development of theory of mind, e.g. saying please when asking for something, were not correlated with measures of false belief. Frith et al. (1994) found that autistic children who passed theory of mind tasks were reported to have social behaviours in real life situations that required theory of mind. However these children were still socially impaired relative to their age and developmental level. Therefore, there is evidence that relates performance on theory of mind tasks to everyday functioning. However the tasks may lack the sensitivity to highlight those who have more subtle social impairments.

1.7 Summary

Children with ADHD have been found to have social difficulties in several areas including identifying emotional expression and emotional content in speech (Shapiro et al., 1993), recognising facial expression of emotion (Singh et al., 1988), social knowledge (Grenell et al., 1987), social judgement (Whalen & Henker, 1985). They have also been found to have pragmatic communication deficits such as poor eye contact and observation of others' space (Clark et al., 1999). These problems may be explained by the executive functioning deficits of children with ADHD affecting everyday interactions or having an effect on the learning and development of these skills.

Executive functioning deficits are also found in children with autism and it has been

hypothesised that this may account for their social difficulties (Russell et al., 1991). However several studies have found no link between executive functioning and the behavioural and cognitive symptoms of autism, including theory of mind ability.

It has been suggested theory of mind and executive functioning are both linked with the pre-frontal cortex, an area also linked with ADHD, and this may contribute to an explanation of their co-occurrence (Ozonoff et al., 1991b). However both theory of mind and executive functioning have been linked to other areas of the brain (Happé et al., 1999; Lezak, 1995) and there have been several different neurological explanations proposed for ADHD (Spreen et al., 1995). Therefore the neurological evidence is unclear.

It has also been suggested that theory of mind is affected by social learning experience. (Peterson and Siegel, 1995; Russell et al., 1998). Children with ADHD have difficulties in social interaction and therefore their exposure to learning about others mind states is likely to be poorer than normal children.

Theory of mind has not been studied in children with ADHD and studies looking at theory of mind which have included children with ADHD give conflicting results.

1.8 Aims

The main aim of this study was to clarify whether or not children with ADHD had

deficits in theory of mind. The study also aimed to examine the development of this ability in children with ADHD and to relate this to their everyday social behaviour, with particular reference to the behaviours seen in children with Asperger's Syndrome. This study also aimed to examine the relationship of inhibition to performance on theory of mind tasks and everyday social behaviour.

1.9 Hypotheses

Performance on Theory of Mind Tasks

1. More children with ADHD fail 1st and 2nd order theory of mind tasks than children from a normal sample.
2. Children with ADHD are less competent at attributing mental states than children in a normal sample.

Development of Theory of Mind

3. More older children with ADHD pass 1st order and 2nd order theory of mind tasks than younger children with ADHD.
4. Older children with ADHD are more competent at attributing mental states than younger children with ADHD.

Theory of Mind and Verbal Comprehension

5. Failure on theory of mind and social understanding tasks is not associated with verbal comprehension.

Theory of Mind and Inhibition

6. Social understanding is associated with the ability to inhibit habitual responses.

Theory of Mind and Everyday Social Behaviour

7. Children with ADHD are reported by their parents to have a similar pattern of social functioning deficits as children with Asperger's Syndrome.

CHAPTER 2: METHOD

2.1 Design

A cross-sectional design was used to investigate the performance of children with ADHD on theory of mind tasks and parental report of behaviours associated with Asperger's Syndrome.

The participants' scores were compared with data from previous studies and differences on performance were investigated across ages.

Within subjects comparisons were made comparing theory of mind tasks to a measure of verbal comprehension and a measure of inhibition of response.

Descriptive statistics were used to examine the responses in a parent rated questionnaire.

2.2 Participants

All participants were current or past patients of the Department of Child and Family Psychiatry, Royal Aberdeen Children's Hospital (RACH). All children had been given a diagnosis of ADHD by a consultant psychiatrist.

2.2.1 Inclusion Criteria

To be included in the study the children had to meet the following criteria:

1. Between ages of five and twelve years inclusive.
2. A primary diagnosis of ADHD
3. A verbal comprehension age equivalent of five years or more

2.2.2 Exclusion Criteria

Children who had a diagnosis of Asperger's Syndrome or autism were excluded from the study.

2.2.3. Recruitment

Based on the above criteria, suitable participants were identified by consultant psychiatrists from RACH and their parents/ guardians were contacted by letter inviting participation (Appendix 2). They were sent an information sheet (Appendix 3) and a consent form (Appendix 4). Parents were asked to indicate where they would prefer their child to be seen, given the choice of school, home or at the Department of Child Clinical Psychology, RACH. Once consent was received, arrangements were made to see the child.

2.3 Ethical Approval

Ethical Approval was granted by Grampian Research Ethics Committee.

2.4 Materials

Each child was assessed using the following tasks:

1st order theory of mind.

This ability was assessed using two false-belief tasks. The Smarties Task (Perner, Frith, Leslie & Leekam, 1989) involves using a smarties tube and some pencils as visual prompts for questions asked about others beliefs. The Sally Anne Task (Baron-Cohen, 1989) involves the acting out of a scenario using two rag dolls, a basket a box and a ball.

Control Task.

In addition, those who failed the Sally Anne Task were given the False Photo Task (Zaitchik, 1990). This task was used to control for failure on the Sally Anne Task due to difficulty inhibiting salient response. Success on this task requires suppression of a response about the true position of an object but without the involvement of a false belief. A doll, mat, camera and box are used to visually represent the task to the child.

2nd order theory of mind.

The Ice-Cream Van Task (Baron-Cohen, 1989) was used to examine 2nd order theory of mind. In this task a scenario involving toy figures and an ice-cream van is explained to the children as the figures are manipulated to represent the story. The

story takes place in a toy village where there are houses, a church and a park represented by two toy trees.

Social Understanding.

The Strange Stories (Happé, 1994) were used to assess children's understanding of particular social situations. The stories are a collection of scenarios in which characters say things they do not mean literally. To be understood correctly they require understanding that people do not say what is literally true when they lie, tell white lies, joke, pretend, misunderstand another, persuade someone, use a figure of speech, appear to be what they are not, are sarcastic, forget, have contrary emotions or engage in double bluff. Each story describes one of these 12 situations (Appendix 5).

British Picture Vocabulary Scale (Short Form) (Dunn, Dunn & Whetton, 1985).

The British Picture Vocabulary Scale (BPVS) is intended as a measure of receptive vocabulary. It was not intended as a test of general intelligence. The BPVS, short form was standardised on 3334 randomly selected school pupils from the ages of 3 years to 18 years 11 months. The internal consistency of the test was examined by calculating split-half reliability. The median value for split-half reliability was 0.8 with a range of 0.41 to 0.86 (Dunn et al., 1985). The authors do not provide statistical evidence for the validity of the BPVS. They justify content validity by pointing out the selection of words aiming to cover a wide breadth of vocabulary whilst being relevant to children. They also point to the validity of more established tests using hearing vocabulary e.g. Wechsler Intelligence Scale for Children –

Revised (Wechsler, 1974) and the finding that vocabulary correlates highly with full scale IQ (Wechsler, 1974) as evidence that the BPVS measures scholastic aptitude.

This measure was used as a screening task to ensure that the children had sufficient language skills to understand the experimental tasks.

Stroop Neuropsychological Screening Test (SNST) (Trenerry, Crosson, DeBoe & Leber, 1989).

The SNST is one of many versions of the Stroop procedure initiated by Stroop (1935) who discovered that people when asked to name colour names printed in ink of a different colour did so much slower than if they were asked to name colour of square patches of ink (Lezak, 1995). The exact neuropsychological function the Stroop measures is debated however it is most commonly used in neuropsychological assessment as a measure of ability to inhibit response or ability to selectively attend to stimuli (Lezak, 1995).

The test-retest reliability of scores in the colour-word task has been examined over 60 days (Trenerry et al., 1989) and a correlation of 0.9 was found between the 1st and 2nd administration. Trenerry et al. (1989) found that brain injured subjects had significantly poorer scores on the SNST than a normal sample and the scores of the brain injured sample correlated with scores on other neuropsychological tests e.g. Weshler Adult Intelligence Scale – Revised (Weshler, 1981).

The SHST is standardised on adults aged 18 years and over and not on children. However this version was used primarily because it was an available resource and the researcher was unable to obtain other versions given the time constraints. It was also intended only for a between groups measurement therefore did not require normative data for comparison.

Australian Scale for Asperger's Syndrome (Garnett & Attwood, 1995; Attwood, 1998).

This questionnaire was devised for use as a screening questionnaire for Asperger's Syndrome. It was designed to identify children who show more abnormal social and emotional behaviour than would be normally expected. The questionnaire incorporates behaviours of children with Asperger's Syndrome as specified in diagnostic criteria and found in research studies (Garnett & Attwood, 1995). The questionnaire is divided into five sections incorporating impairments in social and emotional functioning, cognitive skills, communication skills, specific interests and motor skills. It contains 24 items questions are rated on a scale of zero to six with zero indicating that the child never engages in the behaviour and six indicated the behaviour is frequently present. The questionnaire has not been standardised on the normal population. Garnett & Attwood (1995) validated the questionnaire by comparing the scores of children referred for assessment of Asperger's Syndrome received a diagnosis with those referred for Asperger's Syndrome who did not receive a diagnosis and a sample of normal children. Significant differences were found between the normal control group and the diagnosed Asperger's Syndrome group on each question. However the questionnaire did not discriminate

significantly over all between the Asperger's Syndrome group and the clinically referred group without subsequent diagnosis. A discriminate analysis of the questions revealed four questions that appeared to distinguish those who went on to be diagnosed as having Asperger's Syndrome. These were a preference of reading information only rather than fiction, a literal interpretation of comments, a fascination with a particular topic and a lack of subtlety in their expression if emotion. Attwood (1998) suggests a score of 2 or more on the majority of questions indicates further assessment for Asperger's Syndrome should be pursued. However this is just a suggested guide and there has been no statistical validation of this suggestion. Thus the authors propose it as a screening tool but warn that it is not sensitive enough to discriminate Asperger's Syndrome from behaviours that present superficially as Asperger's Syndrome in a clinical population.

See Appendix 6 for a copy of the questionnaire.

2.5 Procedure

Place of testing.

The children were tested in a quiet room. The majority of children were seen on their own. One child wished to have a parent present, one parent wished to be present and one teacher wished to be present. Where adults other than the experimenter were present, they did not contribute to the assessment.

The tasks were administered to each child in the order presented below.

Smarties Task (Appendix 7).

The child was shown a tube of smarties and asked 'What do you think is in here?' (the child answers 'Smarties'). The tube was then opened to reveal pencils and the experimenter said 'No, look there are pencils'. The experimenter put the pencils back in the tube and replaced the lid. The child was then asked the reality question 'What's in here?' to ascertain that they know what was really in the box and the memory question 'When I first asked you, what did you say?' to check that they remember their own initial response. The child was then asked what their teacher/ friend or parent would say if they were asked what is in the box (the false belief question). The child was then asked a further reality check question 'Is that what's really in the box?' and another memory question 'When I first asked you what was in this box, what did you say?'

Children were required to answer all questions including the false belief question correctly to pass the test.

Sally Anne Task (Appendix 8).

Children were introduced to two rag dolls 'This is Sally and this is Anne' and their attention draw to a basket and box on the table. The experimenter said 'Sally has a ball. She puts the ball in the basket.' The experimenter manipulated Sally putting the ball in the basket. 'She goes away'. Sally was put out of sight. 'Anne takes the ball and puts it in the box'. The experimenter manipulated Anne putting the ball in the

box. 'Now Sally comes back'. This sequence is illustrated in Figure 2.1. The child was then asked the false belief question, 'Where will Sally look first for the ball?'.

If they answer this question correctly the following two control questions were asked: 'Where is the ball really?' To ensure the child knows the real current location of the ball and 'Where did Sally put the ball first?' To ensure the child remembered the previous location.

Figure 2.1 Sequence of the Sally Anne Task

Sally puts the ball in the basket

Anne takes the ball and puts it in the box.

Sally comes back

To pass the test the child had to answer all three questions correctly. If the child failed the test, the False Photo task was administered to control for failure due to inability to inhibit response.

False Photo Task (Appendix 9).

A doll was placed on a mat beside a box. The child was helped to take a photo of the doll and the experimenter then moved the doll onto the box, as illustrated in Figure 2.2. The child was asked 'In the photo, where will the doll be?'. If the child answers wrongly 'On the box' this suggests that the child is responding to current environmental cues this could account for failure on the Sally Anne task. Answering correctly 'On the mat' indicates the child is able to suppress the impulse to say what they see and failure on the Sally Anne task is likely to be due to inability to appreciate another's false belief.

If the child failed the False Photo task their scores were excluded from analysis on the Sally Anne Task and the Ice-Cream Van Task.

Figure 2.2 Sequence of the False Photo Task

The child takes a photo of the doll on the mat.

The doll is placed on the box

Ice-Cream Van Task.

The story was acted out using model figures which were manipulated by the experimenter as the story was being told. It can be divided into four episodes:

Episode 1: Mary and John see the ice-cream van in the park.

Episode 2: Mary goes home for some money, and meanwhile the ice-cream van man tells John he is going to the church.

Episode 3: Mary unexpectedly sees the ice-cream man who tells her he is going to the church.

Episode 4: John sets out to look for Mary whom, he is told by Mary's Mum, has gone to buy ice-cream.

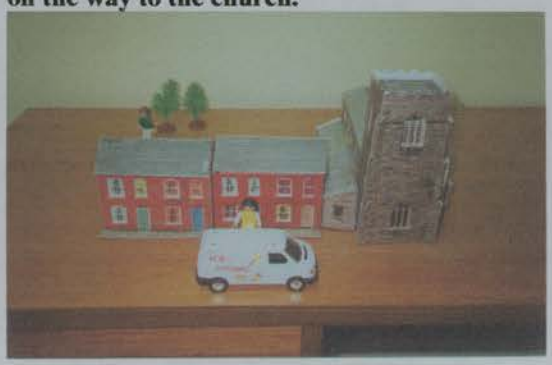
These four episodes are illustrated in Figure 2.3.

Figure 2.3 Sequence of the Ice-Cream Van Task

Mary and John in the park

Mary goes home and the ice-cream man tells John he is going to the church

Mary sees the ice-cream man who says he is on the way to the church.



John calls at Mary's and her Mum says she has gone to buy ice-cream

Children were asked the false belief question 'Where does John think Mary has gone to buy ice-cream?'

The children were also asked eight control questions throughout the story to ensure they understand and remember what is happening in the story (see Appendix 10 for full script).

To pass the test, the children had to answer all the control questions and the false belief question correctly. If the child failed the false belief question, they are included in analysis only if they passed all the control questions.

Strange Stories.

Informal observation of the first four subjects indicated that children often began to get agitated around story 10. It was clear that the time taken to read all twenty four stories would require concentration and attention which the subjects may not be able to sustain. Twelve of the twenty-four Strange Stories were used in this study (Appendix 5).

Children were given the stories to follow while the tester read out loud. If the child began to read the story aloud, they were stopped and asked to follow it to themselves. The children had the relevant story in front of them throughout testing and were allowed to refer to it. Before reading the stories the children were informed that they could ask questions about the story or have it re-read if they wished. After each story, the child was asked two (sometimes three) test questions.

1. A comprehension question. This question asked if what the character had said in the story was true. The purpose of this question was to ensure that the child had understood the story. If they responded wrongly to this question the experimenter questioned their answer e.g. 'Is it really a pirate ship?' then relevant parts of the story or the complete story was read again until the child responded correctly or they gave a justification for their wrong answer.

2. The justification question. This question asked why the characters said what they said. Children were given as much time as they wished to respond.

The method of this study differed from Happé's (1994) administration in that the children were prompted if their answers were unclear or appeared incomplete. Only the responses before prompting were included in the data analysis.

The Strange Stories were scored according to the guidelines outlined in Happé (1994). The justifications for the story characters' utterances were rated as correct or incorrect. Responses were incorrect if they were factually incorrect or indicated a misunderstanding of the characters' intentions e.g. In the White Lie story where Peter dislikes his aunt's hat but comments that it is very nice, the response 'he said she looks nice in her old hat' would be factually incorrect and the response 'it was just a joke' would indicate a misunderstanding.

Both correct and incorrect justifications were rated as either involving descriptions of mental or physical states. An justification was classed as mental if it involved

reference to thoughts, feelings, desires, traits and dispositions (Happé, 1994) e.g. like, want, pretend, lie, happy, cross think. Justifications were recorded as physical when they involved physical appearance, action of objects, physical events, outcomes (Happé, 1994) e.g. looks like, because she is (action), to not get (physical outcome).

Scores were given for the best answer. That is, credit would be given for the right answer even if a wrong answer was given too and a mental state justification would be scored if both a physical and mental justification were given.

To increase the accuracy of scoring, the responses to the stories were recorded on tape, providing the child had no objection. The responses, including the researchers prompts, were transcribed verbatim onto response sheets.

The responses were rated independently by two raters, to increase the reliability of scoring. Table 2.1 shows the percentage of concordance between the raters for each story type.

British Picture Vocabulary Scale (Short Form).

The BPVS was administered according to the instructions in the manual (Dunn et al., 1985). The children were asked to point to one of four pictures indicating the word that the experimenter had just said. Testing finished when the child failed on four out of six items in succession or on reaching the final, 32nd item.

Table 2.1 Percentage of concordance on each story type of justifications judged as right/ wrong and physical/ mental.

Story Type	Concordance on Right/ Wrong Justifications (%)	Concordance on Mental/ Physical Justifications (%)
Pretend	97	97
Lie	92	94
White Lie	97	92
Joke	97	94
Misunderstanding	97	100
Figure of Speech	97	97
Sarcasm	86	97
Double Bluff	94	100
Persuasion	97	97
Contrary Emotion	94	100
Appearance/ Reality	100	100
Forget	97	92

Stroop Neuropsychological Screening Test.

This test was administered according to the instructions given in the manual (Trenerry et al., 1989). In the version used, participants were asked to read a list of words in coloured ink different from that described by the word. They are then asked to name the colours on a second sheet of words printed in ink of a different colour. Both tasks were administered although the data from the first task was not used. The authors suggest the first task may have a priming effect and therefore is necessary when comparison with other studies using the same instructions. However since only between group measurements were being assessed in this case, this task

was of little experimental use. It was however an easy task for the children to complete and therefore was used to help introduce the child to the task. It also highlighted children who had difficulty reading the words (e.g. did not recognise the words immediately or needed to spell out the words to read them). The scores of these children were then eliminated from the analysis as their lack of reading comprehension would reduce the inhibitory effect of the words on the second task.

Australian Scale for Asperger's Syndrome.

The parent or guardian of each child was asked to complete the questionnaire. The parents of those children seen in school were sent the questionnaire, to return by post, along with notification of the day and time arranged with the school. Those whose children were seen at home or attended the psychology department were given the questionnaire to complete while the child was seen for the study. Three parents did not return the questionnaire, therefore 42 questionnaires were used in the study.

2.6 Data Analysis

The participating ADHD children were divided into three age groups: 6-8 years, 9-10 years, 11-12 years. This was to allow comparison with other studies using these age groupings when assessing non-ADHD children on 1st and 2nd order theory of mind tasks.

The data were analysed using SPSS Version 10.05 for Windows. Chi-Squared tests were used to compare the nominal data from the 1st and 2nd order theory of mind

tasks. Where assumptions of skewness, kurtosis and homogeneity of variance were met, parametric statistics were used. In one instance, only summary data were available for comparison with a normal group. In this case a separate variance t-test was used to compare standard deviations and means. Otherwise, non-parametric analyses were used to compare independent samples. Since the examination of all associations involved interval data, Pearson correlations were used to investigate relationships between variables.

CHAPTER 3: RESULTS

3.1 Participants

Fifty-One children participated in this study. Following testing, six children were excluded. Two children were excluded because they had an estimated verbal comprehension age of less than five years. A further four children were excluded after subsequent discussion with clinician revealed co-morbid diagnosis of autism or Asperger's Syndrome. Therefore 45 children were included in the analysis for this study.

3.1.1 Age

The age of subjects ranged from 6 years 9 months to 12 years 11 months (m = 10 years 4 months; sd = 1 year 9 months).

For comparison with other studies, the subjects were divided into three age groups as shown in Table 3.1.

Table 3.1 Summary Data of Age Groups of ADHD Children

Age range	mean	sd
6yrs 9mths - 8yrs 9mths	7yrs 9mths	8mths
9yrs 3mths - 10yrs 11mths	10yrs 2 Mths	6mths
11yrs 0mths - 12yrs 11mths	11yrs 11mths	8mths

3.1 Theory of Mind and Children with ADHD

3.1.1 First Order Theory of Mind

All the ADHD children passed the Smarties Task. Two children failed the Sally Anne Task, one of these children also failed the False Photo Task and therefore the data of this child was excluded from the analysis of this task. The data from the Smarties Task and the Sally Anne Task is shown in Table 3.2. The performance of ADHD children on these tasks was compared with the results of Muris et al. (1999). The data from Muris et al. (1999) is presented in Table 3.3.

Table 3.2 First Order Theory of Mind Tasks: ADHD children.

		6-8yrs		9-10yrs		11-12yrs		Total	
		N	%	N	%	N	%	N	%
Smarties	Pass	11	100	15	100	19	100	45	100
n=45	Fail	0	0	0	0	0	0	0	0
SallyAnne	Pass	11	100	14	93	19	100	44	98
n=44	Fail	0	0	1	7	0	0	1	2

Table 3.3 First Order Theory of Mind Tasks: Non-ADHD children (Muris et al., 1999).

		7-8yrs		9-10yrs		11-12yrs		Total	
		N	%	N	%	N	%	N	%
Smarties	Pass	19	95	20	100	10	100	49	98
n=50	Fail	1	5	0	0	0	0	1	0
SallyAnne	Pass	14	70	19	95	8	80	41	82
n=50	Fail	6	30	1	5	2	20	9	18

There was no significant difference between the number of ADHD children and non-ADHD children (Muris et al., 1999) passing the Smarties Task (χ^2 (1) = 0.10, NS).

Significantly more children with ADHD passed the Sally Anne Task than the children in Muris et al.'s normal sample (χ^2 (1) = 8.76, $p<.01$).

Muris et al. (1999) had a higher percentage of children in their younger age group, 40% compared with 23% in the ADHD sample. The difference between the ADHD and non-ADHD children was not attributable to differences in age groups numbers. (χ^2 (4) = 6.98, NS.).

3.2.2 Second Order Theory of Mind

75% of the children with ADHD passed the Ice-Cream Van Task. 30% of 7-8yr olds failed the Ice-Cream Van Task, as did 31% of 9-10yr olds and 21% of 11-12yr olds (Table 3.4).

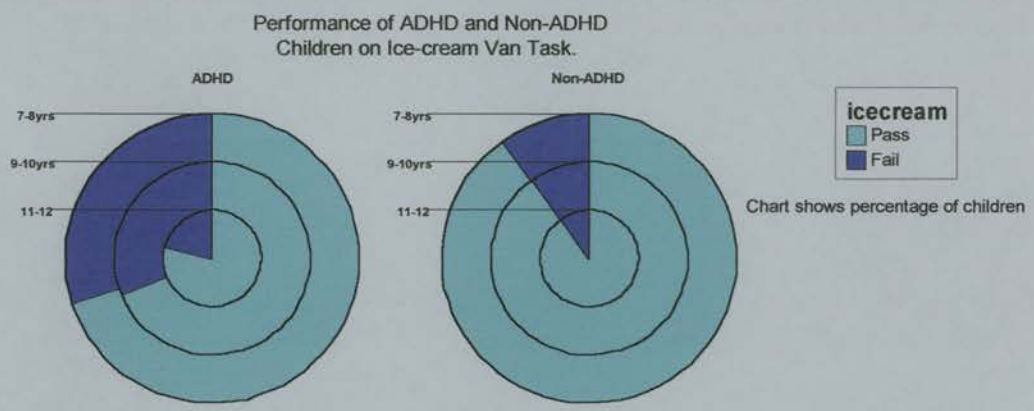
Table 3.4 Ice-cream Van Task: ADHD and Non-ADHD Children

Data for non-ADHD children taken from Muris et al. (1999).

		7-8yrs		9-10yrs		11-12yrs		Total	
		N	%	N	%	N	%	N	%
ADHD	Pass	7	70	11	69	15	79	33	75
n=44	Fail	3	30	5	31	3	21	11	25
Non-ADHD	Pass	18	90	18	90	9	90	45	90
n=50	Fail	2	10	2	10	1	10	5	10

A significant difference was found between ADHD and non-ADHD children (χ^2 (1) = 4.48, $p<.05$). The performance of children on the Ice-Cream Van task is illustrated in Figure 3.1. More children with ADHD, than non-ADHD children, failed the Ice-Cream Van Task in each age group.

Figure 3.1 Pie Chart of ADHD and Non-ADHD Children Passing and Failing the Ice-Cream Van Task



3.2.3 Strange Stories

The scores of the child excluded from analysis of the Sally-Anne Task and the Ice-Cream Van Task, due to failure of the False Photo Task, were included in this analysis.

The box plot in Figure 3.2 indicates the spread of scores, out of 12, on the Strange Stories. Two of the children made only one correct justification to the stories and one child made only three correct justifications. The results profile of these children is detailed at the end of the results section.

The current study used 12 stories instead of 24 for reasons explained in the method section. The scores of the children with ADHD were doubled to allow comparison with data from Happé (1994) (Table 3.5)

Figure 3.2 Box Plot of ADHD Children's Scores on the Strange Stories

Table 3.5 Strange Stories Summary Data: ADHD and Non-ADHD children

Data for non-ADHD children from Happé (1994).

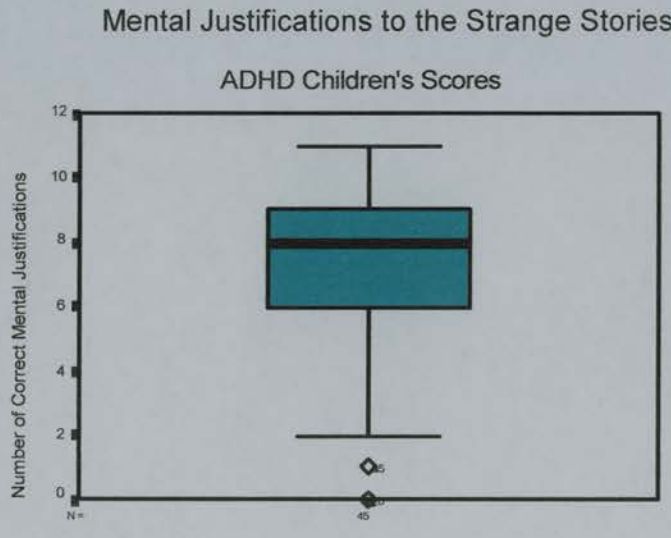
	Total Score		Correct Justifications	
	(max. = 24)		Mental	Physical
ADHD	Mean	18.8	14.2	4.62
n=45	SD	5.3	5.31	3.56
	Range	2-24	0-22	0-18
Non-ADHD	Mean	21.0	16.7	4.4
n=26	SD	3.0	3.1	1.9
	Range	11-24	10-22	1-9

The mean and standard deviation of the number of correct justifications made by children with ADHD was compared with that of Happé's sample of normal children and found to be significantly different ($t = 2.23$; $df = 69$; $p < .05$). The mean number of correct justifications of the children with ADHD was less than that of Happé's normal sample of children.

Mental Justifications

The mean and standard deviation of the number of correct mental justifications made by the children with ADHD were compared to those in the normal sample of children of Happé (1994) and a significant difference found ($t = 2.5$; $df = 69$; $p < .05$). The mean number of correct mental justifications of children with ADHD was less than that of Happé's sample.

Figure 3.3 Box Plot of ADHD Children's Correct Mental Justifications



The box plot in Figure 3.3 indicates the spread of correct mental justifications (maximum = 12) given by the ADHD children. One of the children made only one correct justification and one child did not make any

correct justifications.

Profile of questions answered incorrectly on the Strange Stories

Table 3.6 shows the number and percentage of ADHD children giving incorrect responses for each of Strange Stories. The three stories that elicited the most incorrect justifications were Double Bluff (38%), Contrary Emotion (27%) and Figure of Speech (24%). The stories that elicited the least incorrect responses were Lie (2%) and Forgetting (2%).

Table 3.6 Incorrect responses of ADHD children to the Strange Stories

Story Type	**Incorrect Mental Justifications**		**Incorrect Physical Justifications**		**Total Incorrect Justifications**	
	n	**%**	**n**	**%**	**n**	**%**
Pretend	3	7	2	4	5	11
Lie	1	2	0	0	1	2
White Lie	3	7	2	4	5	11
Joke	2	4	2	4	4	9
Misunderstanding	6	13	1	2	7	16
Figure of Speech	6	13	5	11	11	24
Sarcasm	6	13	3	7	9	20
Double Bluff	14	31	3	7	17	38
Persuasion	3	7	0	0	3	7
Contrary Emotion	10	22	2	4	12	27
Appearance/ reality	1	2	3	7	4	9
Forgetting	1	2	0	0	1	2

Prompts on the Strange Stories

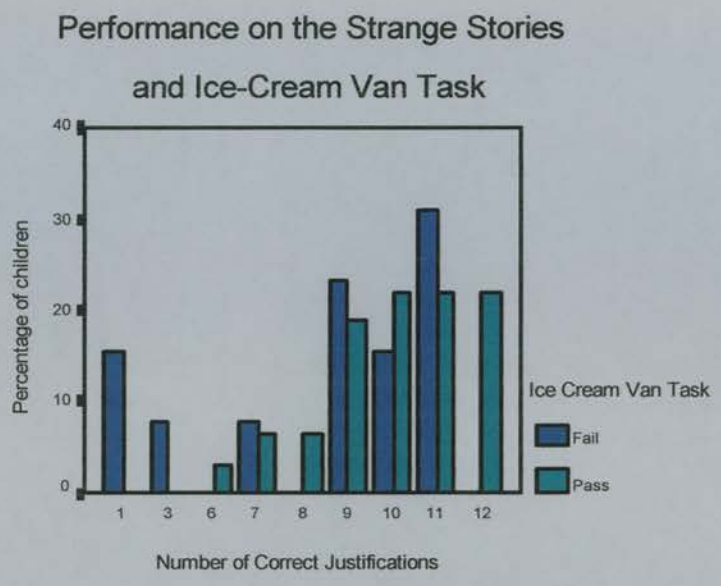
In Happé's study, prompting was not used and therefore the performance of the ADHD children was scored before prompting, to allow comparison with her findings. However prompting was used in the current study. Since standard prompts were not decided before testing, there was not sufficient control over this variable to interpret the responses after prompts meaningfully. However, it is noted that 12 (27%) of the children gave answers following the prompts which would have increased their score on the Strange Stories by one or more.

3.2.4 Ice-Cream Van Task and Strange Stories

ADHD children were separated into two groups on the basis of their performance on the Ice-Cream Van Task: those who passed and those who failed this task. The number of correct justifications made by the children in these two groups were compared using a Mann-Whitney test. No significant association between performance on Ice-Cream Van Task and correct answers on Strange Stories ($z = 1.707$, NS). The percentage of children for each score on the Strange Stories, grouped according to those who passed and those who failed the Ice-Cream Van Task, is illustrated in Figure 3.4.

The number of mental state justifications in response to the Strange Stories given by the children who failed the Ice-Cream Van task was compared to the mental state justifications given by those who passed.

Figure 3.4 Bar Chart of Scores on the Strange Stories of Children who Passed or Failed the Ice-Cream Van Task



A significant difference was found between the number of correct mental justifications given by those who passed and the number given by those who failed. ($z = 2.80$, $p<.01$). Those who passed gave more correct mental state justifications.

Figure 3.5 Bar chart of the Number of Correct Mental Justifications Given by Children who Passed or Failed the Ice-Cream Van Task

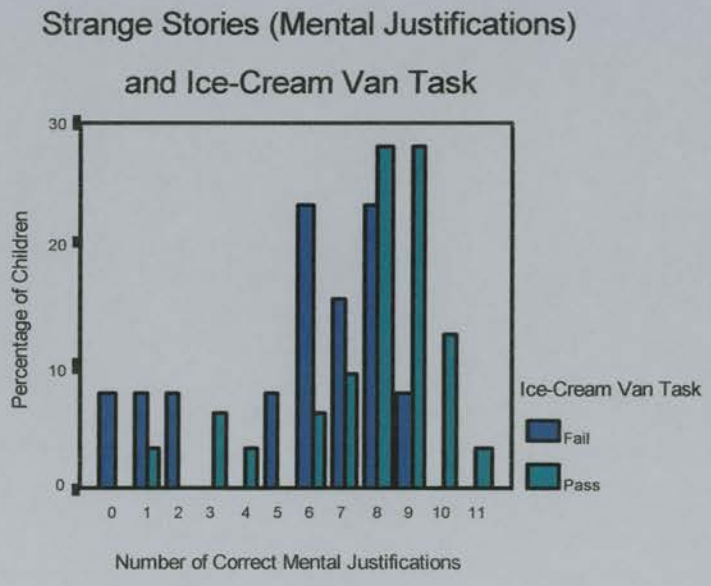


Figure 3.5 shows the percentage of children for each number of correct mental justifications given, grouped according to those who passed and those who failed the Ice-

Cream Van task.

3.3 Development of theory of mind in children with ADHD.

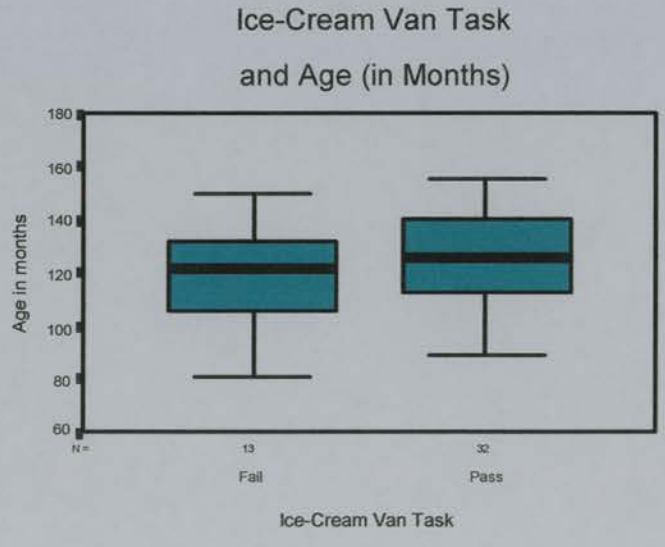
3.3.1 Ice Cream Van Task

Figure 3.6 shows the spread of ages of those who passed and those who failed the Ice-Cream Van Task. No significant differences were found between the two groups (t=0.68, df=43, NS).

3.3.2 Strange Stories

Age was not associated with number of correct justifications made on the Strange Stories (r=0.29, n=45, NS) or number of correct mental justifications (r=0.13, n=45, NS).

Figure 3.6 Box plot of Ages of Children who Passed and Failed the Ice-Cream Van Task



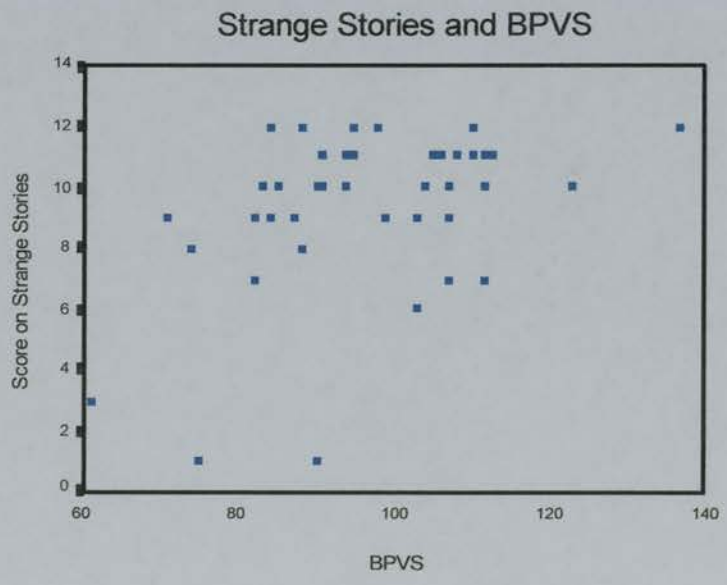
3.4 BPVS and Theory of Mind

The children with ADHD had a mean estimated verbal comprehension score on the BPVS of 95.9, a standard deviation of 14.33 and a range of 61 to 137. The standardised mean for the BPVS is 100 with a standard deviation of 15.

3.4.1. Performance of ADHD children on Strange Stories and BPVS

Pearson's correlation revealed an association between verbal comprehension and performance on the Strange Stories ($r = 0.41$, $n=45$, $p< .01$, two-tailed)). This is illustrated in Figure 3.7. An association was also found between scores on the BPVS and number of correct mental justifications given to the Strange Stories ($r=0.45$, $n=45$, $p<.01$, two-tailed)

Figure 3.7 Scatter Plot of Scores on the Strange Stories and Scores on the BPVS



3.4.2 Performance of ADHD children on Ice-Cream Van Task and BPVS

Those children who failed the Ice-Cream Van Task did not have significantly different verbal comprehension scores than those who passed (t=1.56, df=43, NS).

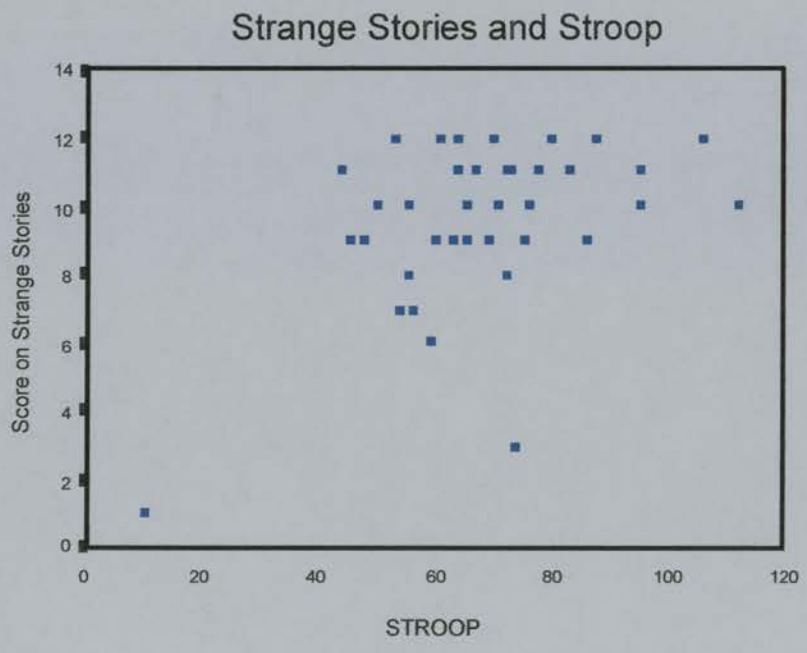
3.5 Stroop and Theory of Mind

The score on the Stroop represents the number of correct responses given in two minutes. Thus, the higher the score the better the performance.

3.5.1 Performance of ADHD children on the Stroop and Strange Stories

The performance of the ADHD children on the Strange Stories was compared with their performance on the Stroop (Figure 3.8).

Figure 3.8 Scatter Plot of Scores on the Strange Stories and Scores on the Stroop



Pearson's correlation revealed positive association between performance on the Stroop and number of correct justifications on the Strange Stories (r = 0.45, n=41,

p<.01, two tailed) and a positive association between performance on the Stroop and number of correct mental justifications (r=0.36, n=41, p<.05, two tailed).

3.5.2 Performance of ADHD children on Ice-Cream Van Task and Stroop

There was not a significant difference in performance on the Stroop between those who failed and those who passed the Ice-Cream Van Task (t=1.67, df=39, NS).

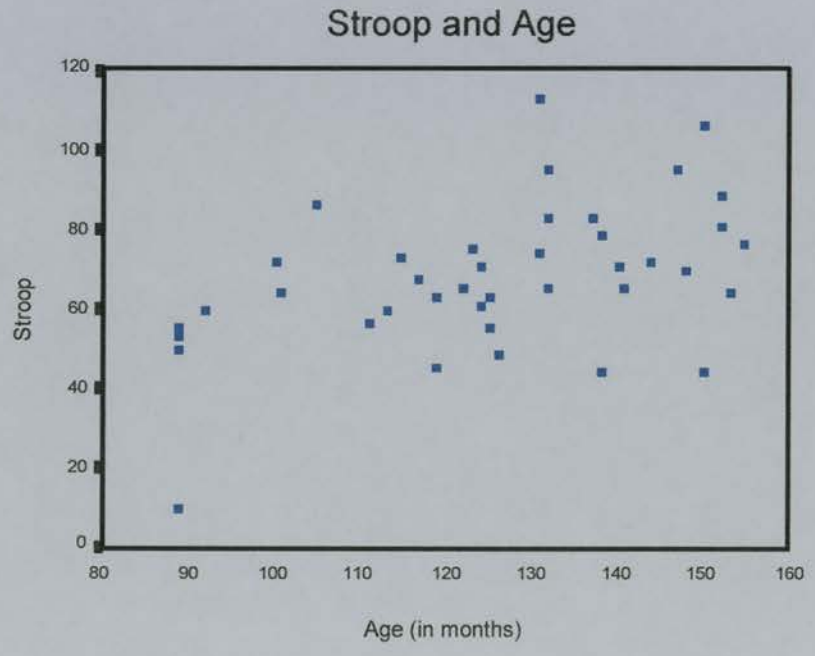
3.5.3 Performance on the Stroop and BPVS

Performance on the Stroop was not associated with verbal comprehension (r=0.12, n=41, NS).

3.5.4 Performance on the Stroop and Age

An association was found between performance on the Stroop and Age (r=0.48, n=41, p<.01, two tailed). This is illustrated in Figure 3.9.

Figure 3.9 Scatter Plot of Scores on the Stroop and Age



3.6 Behaviours associated with Asperger's Syndrome in children with ADHD

3.6.1. Parent ratings of children with ADHD on the Australian Scale for Asperger's Syndrome

Table 3.7 shows the percentage of children who were rated as showing the behaviours described in each question as 'frequently', that is scores of 4-6. See Appendix 6 for questions.

Table 3.7 Percentage of Parents Giving a Rating of 'Frequently' for Each Question.

Question	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
%	45	7	60	50	43	64	69	52	29	21	33	14
Question	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
%	50	50	12	48	26	45	19	31	40	17	26	14

Seven of the behaviours in the questionnaire were rated as 'frequent' by 50% or more of the parents. These are illustrated in Table 3.8.

All of the questions had a rating of 'frequent' by three or more parents (7%).

Table 3.8 Questions Rated as 'Frequent' by Over 50% of Parents

Social and Emotional Communication	Frequency (%)
Does the child lack subtlety in their expression of emotion?	69
Does the child need excessive amount of reassurance, especially if things are changed or go wrong?	64
Does the child appear unaware of social conventions or codes of conduct and make inappropriate actions and comments?	60
Does the child lack precision in their expression of emotion?	52
Does the child lack empathy, i.e. the intuitive understanding of another person's feelings?	50
Communication Skills	
When talking to the child does he or she appear uninterested in your side of the conversation?	50
When in a conversation, does the child tend to use less eye contact than you would expect?	50

As outlined in the method, Attwood (1998) suggests further investigation of the possibility of Asperger's Syndrome if the majority of questions are scored two or more. The stem and leaf plot in Figure 3.10 looks at the frequency of questions scored two or over Australian Scale for Asperger's Syndrome. The stem (central column) gives the leading digits (tens) of the number of questions rated 2-6 and the leaf gives the units of the number of questions scored 2-6.

Figure 3.10 Stem and Leaf Plot of Number of Children Given Ratings of Two or More on the Majority of Questions of the Australian Scale for Asperger's Syndrome

```
Frequency     Stem &  Leaf

     4.00       0 .  0023
     3.00       0 .  899
     9.00       1 .  001112334
    13.00       1 .  5555566778899
    13.00       2 .  0012223334444

 Stem width:     10.00

 Each leaf:       1 case(s)
```

Of the 42 out of 45 questionnaires that were returned, 29 of the parents (69%) rated the majority of answers (over 12 questions) between two and six. Only two of the children did not have ratings of 2 or more on any of the behaviours in the questionnaire.

3.6.2 Australian Scale for Asperger's Syndrome and Age

Age and score on Australian Scale for Aspergers' were positively correlated ($r=0.38$, $n=42$, NS). This is illustrated in Figure 3.11. When the association of age with the sections of the questionnaire were examined, age was found to correlate with positively with Social and Emotional Behaviour ($r=0.34$, $n=42$, $p<.05$) and positively

with Interests (r=0.38, n=42, p<.05) but did not correlate with Communication (r=0.28, n=42, NS) or Cognitive Skills (r=0.21, n=42, NS).

Figure 3.11 Scatter Plot of Scores on the Australian Scale for Asperger's Syndrome and Age

3.6.3 Australian Scale for Asperger's Syndrome and performance on Strange Stories

Using Pearsons correlation, no significant associations were found between the Australian Scale for Asperger's Syndrome and the children's overall performance on the Strange Stories (r = 0.03, n = 42, NS) or the number of correct mental justifications given by the children (r = -0.13, n = 42, NS).

3.6.4 Australian Scale for Asperger's Syndrome and Stroop

There was no association between total score on the questionnaire and score on the Stroop (r = 0.20, n = 41, NS).

3.7 Outliers on the Strange Stories

Two of the children made only one correct justification to the stories and one child made only three justifications. The results profile of these children and additional information is examined below.

3.7.1 Case 1

Age: 7 years and 5 months *Sex:* Female

Theory of Mind. This child passed the 1st order theory of mind tasks but failed the Ice-Cream Van Task.

Strange Stories. This child scored a total of one correct justification. She attended to the stories with prompting but frequently missed the main point of the story. For example, in the story illustrating misunderstanding (Appendix 5), she answered 'No' to the question 'Was the policeman surprised by what the burglar did?' and justified this by saying 'Because his hands were cold'. Thus not attending to or understanding the content of the story and/ or the thoughts of the characters.

Use of Mental Justifications. This child gave one correct mental justification but used a total of seven mental justifications (six were incorrect). Of the six incorrect justifications, five of these were justified in terms of what the characters 'wanted' e.g. 'He didn't want to get into trouble', 'She wants to go out on the picnic'.

Verbal Ability. This child had a verbal comprehension score of 90.

Attention and Inhibition. Throughout testing this child needed prompting to stay on task and was frequently distracted by other items in the room (e.g. papers, felt pens). She obtained a score of 10 on the Stroop which is more than three standard deviations below the sample mean (m = 67.5; sd = 18.3). She had difficulty retaining the aim of the task, reverting to saying the word instead of the colour after the 10th item.

Unfortunately the parental questionnaire was not returned for this child and therefore there is no information about her everyday social behaviour. The head teacher of her school commented that she had difficulties interacting with both children and adults.

3.7.2 Case 2

Age: 10 years and 11 months *Sex*: Male

Theory of Mind. This child passed the Smarties Task but failed the Sally Anne Task and the False Photo Task. He also failed the Ice-Cream Van Task but gave correct responses to the control questions.

Strange Stories. This child gave one correct justification. He needed prompting to help clarify his understanding of the stories. He frequently repeated the content of the

story as a strategy for answering the question e.g. in the first story, Pretend (Appendix 5), he gave the justification 'because he's paddling along'.

Use of Mental Justifications. This child gave four mental justifications, one of which was correct. Again, these justifications were taken from the text of the stories e.g. in the story involving contrary emotion, he gave the justification 'because she said to her Mum she was sad she didn't win'.

Verbal Ability. This child had a verbal comprehension score of 74 this is more than one standard deviation below the standardised norm (m = 100, sd = 15). His BPVS score estimated his verbal ability at an age equivalent of 7 years and 9 months, 2 years and 2 months below his chronological age.

Attention and Inhibition. This child concentrated well on all the tasks. Unfortunately due to experimenter error, the responses to the Stroop were lost in this case.

The parental questionnaire for this child was not returned.

3.7.3 Case 3

Age: 10 years 11 months *Sex:* Male

Theory of Mind. This child passed the Smarties Task, failed the Sally Anne Task, passed the False Photo Task and failed the Ice-Cream Van Task.

Strange Stories. This child gave three correct justifications, two of them mental. He had a distinctive and repetitive pattern of answering. He responded 'No, it's false' to each of the comprehension questions and needed prompting to ensure comprehension of the stories. He gave responses which indicated a literal interpretation of the stories e.g. In the story illustrating figure of speech, he asserted 'That's not right, the frog's not in her throat' and in the story involving sarcasm, he responded' 'It's not sunny, it's false' (that Sarah says it's a nice day).

Use of Mental Justifications. He gave four mental justifications for the stories, two of which were correct. Two of these answers were taken from the content of the story e.g. in the story about contrary emotion, he responded 'she was sad'.

Verbal Ability. This child had a verbal comprehension score of 61, which is over two standard deviations below the norm (m = 100, sd = 15). This estimates his ability at an age equivalent of 6yrs and 3mths, 4yrs and 10mths below his chronological age.

Attention and Inhibition. This child attended well to the tasks. He had a score of 74 on the Stroop which was within one standard deviation from the sample mean (m = 67.5 s.d. = 18.3).

Australian Scale for Asperger's Syndrome. This child was rated as 'frequently' showing 15 of the 24 behaviours listed which are associated with Asperger's Syndrome. Six of the 'other characteristics' were indicated including unusual fear or distress due to ordinary sounds or noisy, crowded places.

The profile of results for Cases 1,2 and 3 is summarised in Table 3.9.

Table 3.9 Summary of Results of Outliers on the Strange Stories

Task	Case 1	Case 2	Case 3
Smarties	Pass	Pass	Pass
Sally Anne	Pass	Fail	Fail
False Photo	N/A	Fail	Pass
Ice-Cream Van	Fail	Fail	Fail
Strange Stories Correct Justifications	1	1	3
Correct Mental Justifications	1	1	2
BPVS	90	74	61
Stroop	10	Not recorded	74
Australian Scales for Asperger's Syndrome Number of questions rated 2-6	Not returned	Not returned	15

CHAPTER 4: DISCUSSION

This study aimed to examine theory of mind in children with ADHD. The children were assessed using 1st and 2nd order theory of mind tasks and a battery of stories requiring understanding of character's mind states. The children's verbal comprehension was measured using the BPVS and their ability to inhibit habitual response was assessed using the Stroop. The children's parents were asked to complete a questionnaire of behaviours commonly seen in Asperger's Syndrome.

4.1 Summary of Findings

The main findings of this study were:

i. Children with ADHD performed equally well on one 1st order theory of mind task and significantly better on another than a normal sample.

ii. Significantly more children with ADHD failed a 2nd order theory of mind task than a normal sample.

iii. When justifying characters utterances in the Strange Stories, children with ADHD gave significantly fewer correct justifications and used significantly fewer correct mental state justifications than children in a normal sample.

iv. There was no association between the age of the children with ADHD and their performance on 1st order or 2nd order theory of mind tasks or on the Strange Stories.

v. ADHD children's performance on the Strange Stories was positively associated with their performance on the BPVS. The number of correct mental state justifications given was also positively associated with the children's score on the BPVS.

vi. There was a significant association between ADHD children's performance on the Stroop and their performance on the Strange Stories. Those who had lower scores on the Stroop gave fewer correct justifications to the stories and fewer correct mental justifications. There was no significant difference on performance on the Stroop between those who passed or those who failed the Ice-Cream Van Task. Performance on the Stroop improved with age.

vii. On a questionnaire of behaviours commonly found in children with Asperger's Syndrome, seven of the behaviours were rated as frequently observed in their child by 50% or more of the parents of children with ADHD. Overall score on the questionnaire was not associated with performance on the Strange Stories and there was no association between any of the sub-sections of the questionnaire and performance on the Strange Stories. There was an association between over all score on the questionnaire and age, with older children being given higher ratings. This association was

mainly accounted for in the correlation between the Social and Emotional Behaviour section and age and the Interests section and age.

The above findings are now discussed in relation to the hypotheses proposed in the introduction. The theoretical and clinical implications of the findings are then considered. Finally, the methodology of this study and indications for further research are reviewed.

4.2 Discussion of Hypotheses

The hypotheses are numbered as they are in the introduction.

1. More children with ADHD fail 1st order and 2nd order theory of mind tasks than children from a normal sample.

1st order tasks.

The children with ADHD in this sample performed equally well to the comparison study (Muris et al., 1999) on the Smarties task and significantly better on the Sally Anne Task. One possible explanation for this difference is disparity in the methodology of the two studies . Comparison with children used in a separate study meant that there was no control over methodological differences. One methodological disparity was that the children in Muris et al.'s study (1999) were not given a control task to eliminate the possibility that the reason for failure was due to

a response to environmental cues. Although, it is unlikely that children in a control group would have inhibition problems that would interfere with the task, given that in the ADHD group only one child failed the Sally Anne task for this reason. The current study also controlled for language ability and it is possible that the children included in the Muris et al. (1999) study may have failed the task due to language comprehension difficulties. Again, this would not be expected in a normal population. There was also not sufficient information in the Muris et al. (1999) study to allow control in this study for differences in task administration. Differences such as interest in presentation may have affected the child's motivation to attend.

The number of children failing the Sally Anne task in the Muris et al. study is surprisingly high. 70% of their 7-8 year olds failed whereas Baron-Cohen et al. (1985) found that 85% of children aged 3-5 years in their sample passed the Sally Anne Task. Therefore the finding that children with ADHD performed significantly better than the normal children in Muris et al.'s sample, is not likely to be indicative that more children with ADHD have 1st order theory of mind than the normal population. The purpose of this study was to investigate the performance for ADHD children and in this case there is no indication that children with ADHD have difficulty with 1st order theory of mind tasks.

Passing 1st order theory of mind tasks does not indicate that children have good social abilities. Autistic children often pass 1st order theory of mind tasks and are still reported to have difficulties (Frith et al., 1994). Therefore it cannot be

concluded that children with ADHD have good theory of mind on the basis of these findings.

2nd Order tasks

Significantly more children with ADHD failed the Ice-Cream Van Task than children in Muris et al. (1999) normal sample. This finding is consistent with the chance finding of Buitlaar et al. (1999) more children with ADHD had failed 2nd order theory of mind tasks than children in a normal control group.

If the ADHD children in this sample passed the Sally Anne task (which they all did) it was assumed that they had the ability to inhibit responding to salient environmental cues in these tasks. It is possible that the added complexity of the 2nd order task increased the inhibitory control needed. Alternatively, inhibitory control could have been more difficult on the Ice-Cream Van Task due to the visibility of the response requiring suppression. That is, the child had to inhibit the response that Mary was at the church when they knew and could see that she was there. Whereas in the Sally Anne Task they could not see the ball and therefore only had to inhibit a response based on their knowledge, not a visual cue. However the control questions designed to check the understanding of the story and the memory of the details also required responses which were incongruent to the visual cues and each child responded correctly to these. Additionally, it would be expected that those who had more difficulty inhibiting responses on the Stroop would be more likely to fail the Ice-Cream Van Task due to inhibition. However, this was not the case as no differences

were found in Stroop performance between the children who failed and the children who passed the Ice-Cream Van Task.

Therefore the children with ADHD had more difficulty with a 2nd order theory of mind task than the children in normal sample and there is not sufficient evidence to conclude that this is due to difficulties inhibiting response.

2. Children with ADHD are less competent at attributing mental states than children in a normal sample.

The Strange Stories were used as a measure to test this hypothesis. Children with ADHD gave significantly fewer correct justifications to the stories and used significantly less correct mental justifications than children in a normal sample which offers support for the hypothesis. As discussed later when the methodology is reviewed, this finding is inconclusive due to difficulties with the statistical analysis. However the summary data indicates that the range for the ADHD children was much larger (2-24) than that of the normal sample (11-24) and therefore some children in the ADHD sample performed more poorly than any of the children in the normal sample. Although, this finding may have been affected by the scores from the outliers, which are discussed more in detail later in this section.

The evidence for the finding is strengthened, however, when the ages of the children are taken into account. Happé's sample ranged from 6 years 7 months to 9 years 8 months with a mean of 8 years 7 months. In comparison the ADHD sample ranged

from 6 years 9 months to 12 years 11 months with a mean of 10 years 4 months. Therefore, it would be expected that the older ADHD population would have an advantage, assuming that ability to understand others mind states improves with age.

Therefore although this finding would have to be confirmed using a matched control group, there is provisional evidence to suggest that the children with ADHD had more difficulty attributing mind states to the characters in the stories than normal children.

3. More older children with ADHD pass 1st order and 2nd order theory of mind tasks than younger children with ADHD.

No evidence was found to suggest that more older children with ADHD passed 1st or 2nd order theory of mind tasks than younger children. Therefore there was no evidence to support the hypothesis that there is a developmental progression of ability found on these tasks between the ages of six and twelve years.

4. Older children with ADHD are more competent at attributing mental states than younger children with ADHD.

Performance on the Strange Stories was not associated with age within the range of this sample. Therefore there was not a developmental progression, apparent in this sample, of the children's ability to give correct justifications or correct mental justifications to stories requiring social understanding.

5. Failure on theory of mind and social understanding tasks is not associated with verbal comprehension.

Relationship of Verbal Comprehension to Strange Stories

An positive association was found between the children's verbal ability and performance on the Strange Stories. However, there are several reasons why the ADHD children's poor performance on the Strange Stories may not be wholly attributable to difficulties with verbal comprehension.

Firstly, the BPVS was used primarily as a measure to exclude these children who had a verbal comprehension age equivalent of below five years, which was taken as the minimum verbal comprehension age needed for understanding the tasks. It was not intended to be used to explore the relationship between language ability and performance on the Strange Stories. This would require more rigorous assessment of language skills. Therefore although an interaction between performance on the stories and language ability is indicated this measure does not give sufficient evidence on which to draw this conclusion.

Secondly, the majority of the children scored within the normal range of performance on the BPVS. That is, 75% of the children scored within 1 standard deviation from normal population, only one child scored below 2 standard deviations from the population mean. If most of ADHD children's estimated verbal comprehension is

within the normal range then poor performance on Strange Stories would not be expected as a result of poor language skills.

Thirdly, the comprehension question in the Strange Stories allowed exploration of the children's verbal comprehension of the stories and hence helped to highlight and give additional assistance to those not understanding the content of the story. Although the comprehension question was not a good screen for those not understanding the story as the choice of response is dichotomous ('yes' or 'no') and therefore children could get the result correct by chance.

Fourthly, other research has found that verbal comprehension difficulties cannot account for poor performance on the Strange Stories. Happé (1994) studied people with autism who failed all theory of mind tasks, passed only 1st order tasks and those who passed both 1st and 2nd order tasks and found a significant difference between the groups on both verbal comprehension and performance on the Strange Stories. She argued that the success of the 2nd order theory of mind group could not be attributed to verbal comprehension differences as one of her control groups, the learning disabled control, had lower verbal comprehension scores than the autistic participants who failed all the theory of mind tasks. Despite this, the learning disabled control performed better on the Strange Stories than the autistic subjects. Her control group of learning disabled adults had a mean verbal comprehension score (as estimated by the BPVS) of 56.9 and a range of 40-89. The children in the ADHD sample of this study had a mean of 95.9 and a range of 61-137. If verbal comprehension was a significant factor it would be expected that the learning

disabled population would perform more poorly than the children with ADHD. Since their results were very similar to the normal child sample (mean score of 21.4 and range of 17-24) it is likely that the learning disabled sample performed better on the Strange Stories than the ADHD sample. This argument would have to be substantiated by further research, however it illustrates that the relationship between verbal comprehension and performance on the Strange Stories is not as direct as may first appear and the finding that the two variables are associated in children with ADHD does not necessarily suggest a causal relationship.

6. Social understanding is associated with the ability to inhibit habitual responses.

A significant positive correlation was found between performance on the Strange Stories and performance on the Stroop giving evidence to support this hypothesis. It may be argued that familiarity with words was a confounding factor on the Stroop. However, if this were the case then as children get older and have more experience of words, they would be likely to have more difficulty inhibiting the response of saying the word rather than the colour and would be expected to have slower times. Conversely, in this study, increase in age was associated with better performance on the Stroop. This is consistent with other studies using the Stroop and children with ADHD (Grodzinsky and Diamond, 1992; Seidman et al., 1997) and suggests that increased word experience is not associated with poorer performance on the Stroop in children with ADHD. Therefore if there is a confounding effect with word

experience and the Stroop, it was not apparent in this sample. Further more, there was no relationship found between scores in the Stroop and scores on the BPVS, therefore those with a higher estimated verbal comprehension performed no differently than those with a lower verbal comprehension. Thus an association was found between performance on the Strange Stories and the Stroop which cannot be accounted for by familiarity with words.

Conclusions drawn from this data should be cautionary however, as the association found was not a particularly strong relationship. As can be seen in Figure 3.8 (p.72), some of the children scoring poorly on the Stroop, in comparison to the rest of the sample, obtained scores of 10,11 or 12 on the Strange Stories. Therefore although this finding indicates that executive functioning may have influenced performance on the Strange Stories, it is not conclusive.

7. Children with ADHD are reported by their parents to have a similar pattern of social functioning deficits as children with Asperger's Syndrome.

Australian Scale for Asperger's Syndrome

All of the questions in this assessment were rated as 'frequent' by at least 7% of the parents asked. Using Attwood's (1998) criteria, 69% of the children had scores which indicated further assessment of Asperger's Syndrome. Thus more than half of the children in the sample were reported to have a score of two or more on 15 or more of the items on the questionnaire. Only two children in the sample did not have

any ratings of two or more on any of the questions. Thus the majority of the children in the sample were reported by their parents to have some behaviours similar to those seen in children with Asperger's Syndrome.

A significant correlation was found between the Australian Scale for Asperger's Syndrome and age. Children who were older had higher scores than children who were younger. Age was correlated with two sections of the questionnaire, social and emotional behaviours and interests. This result is unexpected as it would be assumed that as children grow older they learn more about social behaviours and the emotions of themselves and others. It may be reflective of the expectations of parents. That is, as children get older parents may be less forgiving of social and emotional immaturities or unusual behaviours.

Another unexpected finding was that the performance of children on the Strange Stories was not associated with the ratings given by parents on the Australian Scale for Asperger's Syndrome. It may be that the measure was not valid enough to reflect true behaviour, this is discussed further when reviewing the methodology. Many of the children in the study were likely to be in the early stages of puberty when social behaviour towards parents can be very varied and this could have affected the ratings. Ratings are also likely to have varied across parents, some may be more accepting than others of different social behaviours and some parents may have more strict ideas about what their child should be able to do. Variables such as intervention from professionals, biochemical treatment were also not controlled for. Therefore there are several factors which could have influenced this questionnaire and which

were not controlled for in this study and this could explain the lack of association between the Strange Stories and the Australian Scale for Asperger's Syndrome.

4.3 Discussion of outlying cases

These three cases were highlighted due to their particularly poor score on the Strange Stories. All three of the cases failed the 2nd order theory of mind task and two, of the three, also failed the 1st order theory of mind task, Sally Anne. This is consistent with the findings of Happé (1994) that poor performance on 1st and 2nd order theory of mind tasks is associated with poor performance on the Strange Stories.

Two of the cases (Case 2 and Case 3) have similar profiles on the rest of the tasks. Case 1 has a markedly different presentation.

Strange Stories

Case 1 gave more mental state justifications than Case 2 and Case 3. This child was also the only one of the three to pass the Sally Anne Task. Interestingly, Happé (1994) found that the use of mental state justifications by autistic subjects did not differ from adult and child controls although their use of *correct* mental justifications did. Thus they had an understanding that mental state terms were required but were unable to select the appropriate term. In the same way, perhaps the use of mental state terms in this case example suggests she knew that the situations required these kind of justifications but was not skilled in selecting the appropriate term. The other two cases highlighted also made some wrong mental state justifications suggesting

they were aware of mental state involvement in the stories but did not use appropriate terms.

None of the participants in Happé's sample, including the autistic participants, performed as poorly as Case 1 or Case 2 since the minimum correct justifications given by her poorest scoring group (autistic participants that failed both 1st and 2nd order theory of mind tasks) was six out of 24, the equivalent of three correct justifications out of twelve.

Verbal Ability

Both Case 2 and Case 3 had estimated verbal ability that was below that of the normal population. It is possible that poor understanding influenced the scores of these children especially since both children consistently answered no to the comprehension question and needed prompting to try and clarify understanding. The role of verbal ability is considered in more detail earlier in this chapter (p. 90).

In contrast to case two and case three, case one had an estimated verbal ability that was within one standard deviation from the normal population. Therefore, her performance is more likely explained by difficulties attending to the story or understanding the concepts in the story rather than language comprehension problems.

Inhibition

Most striking in Case 1 was her poor score on the Stroop. This was due to her inability to retain the purpose of the task resulting in her reading the words instead of saying the colours after item 10. This can be explained by an inability to suppress what the environmental cues were indicating i.e. to say the words she saw despite the instructions to say the colour of the word. In contrast, Case 3 had a Stroop score that did not deviate from the norm of the sample and attended well to the tasks.

Case 3 did not have a diagnosis of autism however his responses were repetitive and his interpretations often literal. Therefore it is possible he had unidentified autism. The issue of unidentified co-morbidity as an explanation for the results is discussed later in this section.

Conclusions about a population cannot be drawn from one or two individuals however the extremely poor performance on a measure of verbal ability in Case 2 and Case 3, the autistic like presentation of Case 3 and the very poor inhibitory control of Case 1 illustrates three factors which may influence performance on theory of mind tasks and the Strange Stories. That is, very poor verbal comprehension, poor ability to inhibit response and unidentified co-morbidity with autistic spectrum disorders.

4.4 Theoretical Implications

The findings of this study will now be discussed with relation to the theories and studies reviewed in the introduction.

4.4.1 Theory of mind and ADHD

The finding that more children with ADHD fail 2nd order theory of mind tasks than a normal sample confirmed the findings of Buitelaar et al. (1999). This finding is also extended as results suggest that children with ADHD performed more poorly than a normal sample when asked to attribute mind states to story characters. Children with ADHD were also rated highly on many questions describing social difficulty by their parents.

There are several explanations which may account for these findings. Executive dysfunction (EDF) in children with ADHD may influence social ability. Or social learning experiences may be affected by ADHD and these children may have a reduced opportunity to learn about mind states. Alternatively the neurological areas which are affected by ADHD may be associated with theory of mind deficits. It may be that children with ADHD share this trait with children with autism and Asperger's Syndrome due to similarities between the disorders or co-morbidity. These hypotheses are examined below.

Executive Functioning Deficits

As discussed in the introduction, people with autism or Asperger's Syndrome who have executive functioning deficits may not show deficits on theory of mind tasks (Osonoff et al., 1991b) and children with autism aged from three to five years have been found to have no executive functioning deficits despite behavioural symptoms of autism. Mitchell (1997) suggests that theory of mind and EDF are two separate cognitive deficiencies present in autism and Osonoff et al. (1991b) proposed that similar neurological processes are involved with both abilities i.e. the ability to internally represent information and act on it effectively. Therefore, evidence suggests that EDF is not the cause of theory of mind deficits in people with autism or Asperger's Syndrome but that there is a relationship.

Children with ADHD have executive functioning deficits that are similar to those found in children with autism (Grodzinsky and Diamond, 1992). It may be that even though EDF and theory of mind do not seem to be causally linked in children with autism, EDF may influence social understanding in ADHD. Alternatively, as is hypothesised for autism, EDF may co-occur with theory of mind difficulties for neurological reasons. These two suggestions are now examined.

Some of the responses given by the ADHD children to the Strange Stories could be explained in terms of Barkley's (1997) theory of self-regulation as a central deficit in ADHD children. Thus self-regulation problems mean that these children have difficulty planning, considering rules, utilising past experience and making predictions about the future on which to base their responses. They tend to respond

to immediate environmental cues and immediately available consequences (Barkley, 1997). It may be that when considering the responses of the characters in the stories, the ADHD children based their judgements on short-term consequences and failed to consider the details of the story. For example, in the story that children most frequently failed to justify correctly, the double bluff story, the responses of the ADHD children indicated that they tended to focus on the imminent consequence for the soldier (i.e. possible torture or death) and therefore they gave responses such as 'he didn't want to die' or 'he thought he was saving his army but he probably forgot they were in the mountains'. They did not consider that the soldier may have alternative motives for telling the truth i.e. he thinks that they think that he will lie to them. The story involving contrary emotion, to which 27% of the ADHD children gave an incorrect justification, is more difficult to explain in terms of self-regulation. These incorrect responses were primarily due to a failure to recognise that the child in the story was feeling two emotions at the same time for different reasons. Several of these children gave a justification for the character experiencing one emotion for two reasons e.g. 'because she wants to make her friend happy and maybe she'll get a prize', 'She's sad because her friend won and sad because she didn't win' or changed the facts of the story to fit in with their interpretation e.g. 'because it was her best friend that won but she didn't want her to win'. Possibly the children were focusing on one aspect of the story, that Sarah lost the competition, and found it difficult to consider other factors in the story that would make Sarah feel differently. In both these stories, children seemed to have difficulty dealing with conflicting social information and instead of considering several reasons for the characters utterances, they adjusted the story to fit their interpretation.

The responses on the Strange Stories indicate that the children with ADHD had difficulty dealing with apparently conflicting information. This is consistent with an executive dysfunction explanation as difficulties organising and dealing flexibly with information would influence ability to deal with information in these stories. This suggestion is consistent with the findings of Shapiro et al. (1993), described in the introduction (section 1.2.2), that children with ADHD had difficulties processing conflicting information about emotion and content of speech or facial expression.

Thus the poor performance of the children with ADHD on the Strange Stories could be accounted for by poor strategies in the organising and utilisation of the information in the stories. Therefore, children with ADHD may have the ability to understand others minds but have difficulties using this information effectively when making and acting on social judgements.

This lack of cognitive flexibility in dealing with information would be consistent with the finding that poor performance on the Stroop is related to poor performance of the Strange Stories. It may be that the children who had more difficulties inhibiting response were inclined to be impulsive with their answers. That is, they had difficulty inhibiting the first response to occur to them and therefore failed to consider several aspects of the stories.

If the executive functioning difficulties of children with ADHD affect their response to social situations then it may be that their learning experience about social interaction has been affected in the long term by these deficits.

Social Learning

Camarata and Gibson (1999) suggested that pragmatic difficulties in children with ADHD can be explained by the features of ADHD (failure to attend to instructions, difficulty sustaining attention in play, susceptibility to distraction and a tendency to not listen) interfering with mother child interaction. Peterson and Seigal (1995) propose that social communication deficits are likely to instigate poorer social interaction and reduce conversations relating to thoughts and intentions between adults and children.

Theory of mind difficulties have been found in populations with disabilities which affect social interaction, e.g. deaf children (Peterson & Siegal, 1995; Russell et al., 1998), blind children (Minter et al., 1998). It has been hypothesised that exposure to conversations about mind states is a facilitating factor in the development of theory of mind. Further support for this has been found in studies of children without disabilities. Youngblade and Dunn (1995) found that social play with mothers and siblings at 33 months was related to social understanding at 40 months and Dunn et al. (1991) found that mothers' conversations about feelings at 33 months related to understanding of emotion and false belief at 40 months.

Therefore the reduced quality of interaction that children with ADHD have as a result of the behavioural presentation of ADHD may hinder their development of theory of mind. If this were the case however, it would be expected that children with ADHD would have a delayed theory of mind and their understanding of mind states would develop as they accumulated more experience of conversations and social situations concerning mind states. Thus it would be expected that development of theory of mind would have been evident in this study, however older children performed no better on the tasks than younger children. It may be that children with ADHD have enduring social difficulties and fail to fully develop theory of mind, possibly due to their continuing EF deficits. It may also be that the delay in theory of mind extends beyond the age group of the sample. Russell et al. (1998) found evidence for a delayed development of theory of mind in deaf children finding that children aged 13-16 years performed significantly better than those aged 4-12 years. Therefore if older children had been included in the ADHD sample more of a developmental pattern might have emerged.

If the symptoms of ADHD affected social experience and learning about others mind states, it would be expected that all children with ADHD would be affected. However, not all the children in the sample had difficulties with the theory of mind tasks. 75% of the ADHD children passed the Ice-Cream Van Task, 20% of these children made 12 correct justifications on the Strange Stories. It could be argued that, as with Asperger's Syndrome, some children can perform well on the tasks but when faced with real social situations often have difficulty (Frith et al., 1994). Therefore the ADHD children who illustrated good performance on the tasks may

not have good skills in everyday social situations. The parent rated questionnaire used in this study gives some evidence for this as 60% of the ADHD children were rated as appearing unaware of social conventions and making inappropriate actions and comments and 50% as appearing uninterested in another's side of conversations. Since the questionnaire did not relate to performance on theory of mind tasks, it is possible that some of the children who performed well on the tasks were rated as having social difficulties by their parents.

Neurological Functioning

An alternative explanation for the findings is that the neurological areas responsible for social functioning are affected in ADHD. This is a difficult hypothesis to explore as many areas of the brain have been associated with theory of mind and many areas have been associated with ADHD. It is also possible that several areas of the brain are involved in theory of mind and in ADHD as problems with neural pathways have been implicated in both (Happé et al. 1999; Spreen et al.,1995).

As discussed in the introduction, people with right hemisphere damage have been found to have theory of mind problems (Happé et al. 1999) and right hemisphere structural differences have been found in children with ADHD (Hynd, Semrud-Clikeman, Lorys, Novey, Eliopulos & Lyytinen, 1991). Happé et al.'s (1999) study involved people who had suffered damage to a previously intact cognitive system. Therefore the ability to attribute mind states was already developed in these individuals. Different areas may be implicated in the process of developing theory of mind and these areas may be affected by ADHD.

It has been suggested that children with ADHD have immaturities in their frontal lobes (Spreen et al., 1995) or lack of blood flow to the frontal lobes (Lou, Henriksen & Bruhn, 1984). Grodzinsky and Diamond (1992) found that children with ADHD performed more poorly than controls on several tasks associated with frontal lobe functioning. Ozonoff et al. (1991b) suggests that both executive functioning and theory of mind may be functions associated with the pre-frontal cortex which has been implicated in the storing of information about behavioural response. They suggest that both theory of mind and executive functioning involve the ability to internally represent, organise and act on information. Therefore the two abilities are linked by the neurological areas they depend on however are independent of each other. If this is true for both autism and ADHD, this highlights another possible hypothesis. That ADHD and autism share EDF and theory of mind difficulties because the disorders are closely linked, perhaps even the same disorder but with different severities of behavioural presentation. Alternatively, it may be that neurological similarities cause high co-morbidity and many children with ADHD have autism or Aspreger's Syndrome which has not been identified. These hypotheses are examined below

ADHD and Autism/ Asperger's Syndrome

Children with ADHD in this study were rated by their parents as having many of the behaviours associated with Asperger's Syndrome. This finding was consistent with the findings of Clark et al. (1999) that children with ADHD scored highly on a questionnaire of autistic behaviours. Some of the behaviours in the Australian Scale

for Asperger's Syndrome which were rated as common in children with ADHD can be explained in terms of behavioural features of ADHD.

The behaviour rated as frequent by the highest percentage of parents was a lack of subtlety in expression of emotion (69%). Barkley (1997) suggests that emotions, once elicited, are moderated by the self-regulatory function of executive processes. He points to research linking the development of inhibition and self-regulation to emotional responses in pre-school children as evidence for this association (Barkley, 1997). This assumption would also explain the report of 52% of ADHD children in this study lacking precision in their expression of emotion.

However, some of the other highly rated questions in this study are more difficult to explain in terms of self-regulation. The second highest rated characteristic, 'needs an excessive amount of reassurance, especially if things are changed or go wrong', is not easily explained by the deficits described by Barkley (1997). One possible explanation is that if children with ADHD find it more difficult to consider future consequences and integrate plans and rules, then changes instigated by other people may be difficult to understand, provoke anxiety and require reassurance. This question is also very ambiguous, as discussed further in the methodological considerations (p. 115) and if more emphasis was put on the description 'if things go wrong' by the rater, the tendency of children with ADHD to get into trouble may explain the need for excessive reassurance if things go wrong which are not their fault and they are concerned they will get the blame.

In the current study, 50% of parents rated their children as using less eye contact than would be expected. Poor eye contact was listed by Clark et al. (1999) as included in their category of 'problems in non-verbal communication' reported by 71.4% of the parent's of their ADHD sample. However 'less eye contact than would be expected' can be explained in terms of children with ADHD being more likely to be distracted in conversation and having difficulties sustaining visual attention in interactions. Thus, the reports of behaviours associated with Asperger's Syndrome in children with ADHD can be explained by features of ADHD.

However, although an association was found between inhibition and performance on social understanding tasks, performance on the Stroop was not associated with the parent rated questionnaire. However, as commented before, only one measure of executive functioning was used and therefore an association between everyday social functioning and executive functioning may be found in these children if more extensive measurement was used. It would be interesting to examine the severity of ADHD symptoms compared with the difficulties reported in the questionnaires. Unfortunately, Clark et al. (1999) did not provide this information in their data and a measure of symptoms of ADHD was not included in this study.

Although children with ADHD share many of the same behavioural symptoms with Asperger's Syndrome it is likely to be for different reasons. That is children with Asperger's Syndrome may have a lack of interest in interaction as well as a lack of ability whereas children with ADHD may be interested but are lacking in the skills. It could also be that Asperger's Syndrome children have a more fundamental deficit

in social ability whereas children with ADHD have difficulty as a result of EF deficits. Alternatively, the report of several Asperger's behaviours in children with ADHD may also be explained by co-morbidity.

Co-morbidity

Another explanation for these findings is that of co-morbidity in the sample. Although children who had a dual diagnosis of autism or Asperger's Syndrome were eliminated from the study, it is possible that there were some children in the sample whose primary diagnosis of ADHD masked symptoms which would usually lead a clinician to considering autism. Clark et al. (1999) explain their finding, that children with ADHD have many autistic symptoms, by suggesting that the long standing behavioural problems of these children and hyperactivity mean that additional diagnoses are not routinely considered. That is, if a child is identified as having ADHD, then behaviours indicative of autism or Asperger's Syndrome, might be explained by the symptoms of ADHD or longstanding behavioural problems and make further investigation less likely. Case 3, described in the results and above (p. 97) may be such a case. His rigid presentation of answers and frequent literal interpretation was suggestive of autism or Asperger's Syndrome. It is likely that, since screening for the study could not be completely rigorous, some children were included who may have had a co-morbid diagnosis of autism or Asperger's, if further assessment was conducted. This is a criticism of the study but also raises the point that many of these children may have an unidentified co-morbid diagnosis which is exacerbating their difficulties. The pattern of results of the study however do not appear to differentiate the children into two groups as would be expected if there was

a group of children with autism and Asperger's in addition to ADHD who accounted for the poor scores on the theory of mind tasks.

A possible explanation for this, is a group of children who have been identified by several researchers (e.g. Gillberg, Rasmussen, Carlström, Svenson & Waldenström, 1982) as having disorders of attention, motor control and perception. This group of children have been termed 'DAMP', although this is not an official diagnostic criteria in ICD-10 or DSM-IV. Gillberg (1992) reviewed his previous studies on children with DAMP and concluded that the children with severe DAMP often show social impairments, semantic pragmatic problems and repetitive obsessive behaviours, although to a lesser extent than is observed in autism. He also highlighted that about one third of the population studied had hyperkinetic syndrome, some of which showed autistic features, some did not. He suggested that there were no clear boundaries between the disorders. Therefore perhaps amongst the sample for this study, there were children who would have satisfied the criteria for DAMP and had additional social impairments but to a lesser extent than would be expected in autism and therefore did not differentiate substantially from the others.

Although it is possible that co-morbidity influenced the results, it seems more plausible that some of the children in the sample may have met the criteria for DAMP. In their ratings on the Australian Scale for Asperger's Syndrome, 26% of parents gave a rating of 'frequently' to the question 'does the child have poor motor co-ordination?' although the relationship of those scoring highly on this question to

their scores on the theory of mind tasks was not studied since one question rated by parents is not indicative of diagnostic motor problems.

In conclusion there are arguments to suggest that executive functioning deficits, social learning experience, neurological differences and co-morbidity may be implicated in the theory of mind ability of children with ADHD. These explanations are not mutually exclusive. It is especially likely that a neurological explanation is linked with executive functioning deficits. The ability to learn about social experience is also likely to be affected by neurological and executive functioning deficits or co-morbidity. Therefore each of the above hypothesised influences may affect theory of mind ability and there may also be an interaction between two or more factors.

4.4.2 Executive Functioning and Theory of Mind Tasks

The findings of this study also contribute to the discussion of the effect of executive functioning on theory of mind tasks outlined in the introduction. It would be expected that children with ADHD would be particularly susceptible to failure on these tasks due to executive functioning. The finding that 43 out of the 45 ADHD children assessed, passed the Sally Anne Task suggests that executive functioning difficulties are not likely to influence this task extensively and therefore contradicts the claims of Russell et al. (1991) that this tasks measures executive functioning and not theory of mind.

4.5 Clinical Implications

Social deficits are fundamental in children with autism and therefore are a focus for assessment and intervention. However this is rarely the emphasis for children with ADHD as focus tends to be on issues such as reducing disruptive behaviour or increasing attention and concentration on school-work. If these children lack the social ability or understanding to participate in appropriate social interaction they will need assistance to learn about and experience positive appropriate interaction.

If children with ADHD have difficulties taking account of others' thoughts and feelings in social interaction, and if the reason for this difficulty is not because they do not possess the ability to appreciate others' minds but that they do not use this information effectively, then this has implications for the intervention. Children with autism and Asperger's Syndrome may have a deficit in the ability to understand others' minds whereas children with ADHD may lack the skills to organise and apply social information. Therefore intervention aimed at teaching children to stop and consider the other person's thoughts and intentions before responding may be beneficial. Additionally if the features of ADHD have disadvantaged the social learning process of these children, they may also need explicit teaching about and increased experience of others' minds.

The findings also raise the possibility of unidentified co-morbidity with autism or Asperger's Syndrome in this group. This indicates that the consideration of dual diagnosis when assessing and treating these children is important. The presence of

co-morbidity would also impact on intervention as deficits in these children may be more difficult to overcome if the mechanisms for social understanding are dysfunctional, as they are in autistic spectrum disorders.

4.6 Methodological Considerations

4.6.1 Measures

Theory of Mind Tasks.

Some of the issues debated in theory of mind tasks were examined in the introduction. Critics have suggested that executive functioning rather than theory of mind is being measured by these tasks (Russell et al., 1991). Although the false photo tasks was included to control for the possibility of failure on the Sally Anne task for this reason, no control task was used for the Ice-Cream Van Task which may have been more susceptible to difficulties inhibiting salient environmental cues due to the visibility of the position of the ice-cream van. However no significant differences on performance of the Stroop were found between those failing and those passing the tasks which suggests that those who failed the tasks did not show any more difficulties inhibiting response than those who passed.

As suggested by Mayes, Klin, Tercyak, Cinchetti & Cohen (1996), basing decisions about whether a child does or does not have theory of mind on one question does not seem a valid way to draw conclusions. Many autistic children who pass theory of mind tasks still show difficulties with social interaction (Happé et al., 1999), therefore the tasks are not sensitive enough on which to base judgements about social

functioning. However, the use of the Strange Stories, found to be a more sensitive measure of children's understanding of mind states (Happé, 1994), gives a more valid indication of theory of mind ability in this study. In support of the validity of the measures, the finding that those children who failed the Ice-Cream Van Task made significantly less correct mental justifications to the stories suggests the assessments may be measuring common factors.

Strange Stories.

The stories used a comprehension question as an indication of the understanding of the child. However only a 'yes' or 'no' response is required. Therefore there is a 50% chance that the child could give the correct answer to this question even if they didn't understand the content of the story. Thus the comprehension question was not an accurate indication of whether or not the child understood the story.

Only 12 of the 24 stories were used and therefore the scores were doubled to allow comparison with the data from Happé (1994). Doubling the scores of the children assumes that they would have performed equally on a story about the same mind state. This could have falsely raised the score of children with ADHD by giving them credit for a response they may not have given or may falsely reduce their score by assuming if they got one of the stories incorrect they would get another illustrating a similar scenario also incorrect. However use of all 24 stories would have been more time consuming and also required more concentration and maintenance of on-task behaviour which may have led to less compliance and more varied results from the ADHD children.

The judgement of a correct/ incorrect justification and a justification involving mental states is somewhat subjective as it is decided by the experimenter using the criteria suggested by Happé (1994) as a guide. An attempt was made to reduce these biases by using two raters, between which good compliance was found (see Table 2.1, p.58).

Prompting

The scoring criteria of Happé (1994) was used which stipulated that the score on the stories was taken from the response given before prompting. Prompts were used with the ADHD sample however scores were taken before prompting. Twelve of the ADHD children gave a better response on one or more of the stories following prompting. Thus when these children were given external regulation, that is prompted to consider the story longer, they reached a better social understanding of the story. It could also be argued however that the use of prompting with children with ADHD primed the children into thinking more carefully and considering the character's mind states in subsequent stories. If this were true this would give the children with ADHD an advantage over the children in Happé's sample, and despite this they still performed more poorly. However, the protocol for prompting was not agreed before testing and therefore it was not done in a consistent manner. Where children's scores did improve following prompting, this was often only in one question and therefore may not have improved the children's scores sufficiently to make a difference to the overall performance. Therefore, conclusions cannot be

drawn about whether prompting improved the ADHD children's overall scores or not.

Measures of Verbal Comprehension.

The BPVS is only a screening measure and therefore cannot be used to draw definite conclusions about the children's verbal ability. There was also no measure of other verbal abilities such as language expression. Children with ADHD have problems in this area in several areas of language (Westby & Cutler, 1994) and this may have affected their ability to express their knowledge of mind states.

Australian Scale for Asperger's Syndrome.

Many of questions in this assessment are open to interpretation. For example, the question 'needs an excessive amount of reassurance, especially if things are changed or go wrong' refers to two distinct types of situation. If 'things are changed' this is likely to be an externally controlled source, such as parent or teacher and could be a minor incident such as moving an ornament or a piece of furniture or a major incident such as moving house. The second situation 'if things go wrong' could refer to major or minor incidents or incidents that are internally controlled by the child e.g. getting into trouble, accidentally breaking a toy or which are externally controlled e.g. the house is flooded. The response of the child is likely to vary given the amount of control and responsibility they feel for the situation and therefore the rating given to this question is very much dependant on the parents interpretation of what it is asking about. Also, many of the questions included terms such as 'excessive' or 'less than expected' which rely on the judgement of the parent as to

what levels of behaviour are defined by these terms. Again, ratings may be affected by differences in individual's interpretation. Additionally, some parents may be more inclined to rate their children higher due to difficulties with them at the time e.g. frustrations with behaviour at home, trouble with school or lower if they do not want to convey the extent of their child's difficulties.

Parents were either sent the questionnaire or completed it while the child was being assessed. They were not guided through the assessment by a clinician and did not have an opportunity to ask questions during completion of the questionnaire. Therefore, misunderstanding may have affected the accuracy of report in the questionnaire.

Therefore there are several factors which may have influenced the scores on this questionnaire other than the presence of the behaviours in the children and so, conclusions drawn from this questionnaire should be treated with caution.

Measures of Executive Functioning.

The Stroop was chosen as a measure of inhibition guided by the literature using this assessment with children with ADHD (Grodinsky & Diamond, 1992; Everett, Thomas, Cote, Levesque & Michaud, 1991) and the emphasis on inhibition given by the most recent theories of ADHD (Barkley, 1997). The Stroop has been used in the assessment of several neuropsychological functions, most prominently response inhibition or selective attention (Lezak, 1995). Therefore although it is widely regarded as a measure of inhibition, it may also be affected by deficits in other

neuropsychological functions. This has to be considered when interpreting the results.

Additionally there was not the time nor the resources to be selective about the version of the Stroop which was used, and the only one available within the time constraints, does not have norms for children. However the primary use of this assessment was to make within subjects comparisons with attainment on other tasks and therefore, although findings should be treated with caution, it was seen as applicable to the purpose.

The Stroop was the only executive functioning task used. The cause of problems with theory of mind is still much debated and although evidence has shown that theory of mind and executive functioning are unrelated in children with autism, this may not be the case in ADHD. It would have been useful to have additional measures of executive functioning, such as the Wisconsin Card Sorting Test and the Tower of Hanoi to allow more conclusions to be draw about the influence of these abilities on theory of mind and children with ADHD. However, the main purpose of this study was to investigate the performance of children with ADHD on theory of mind tasks. Relating this to executive functioning remains to be investigated in future studies.

4.6.2 Control group

One of the major short comings of this study was the lack of control group. A control group was not used due to the time constraints involved in the study and the

availability of matched controls. Also, several studies give data on the performance of theory of mind tasks in normal children and data was available to compare performance with a normal sample on the Strange Stories.

However on reflection a control group would have allowed more meaningful comparisons of data to be made, would have reduced the influence of methodological differences between this study and those used to compare data and would also have allowed more qualitative comparison between the types of responses given by children with ADHD and those given by children without ADHD.

4.6.2 Data Analysis of the Strange Stories

Efforts were made to obtain the raw data of the normal sample group used for comparison on the Strange Stories by contacting the author. However, this data was not made available and therefore comparison had to be made with the summary data of Happé's (1994) normal sample stated in the published paper. Information on the shape of the data was not obtainable and therefore the assumptions for using a t-test could not be fully tested. However, the use of parametric statistics for this analysis was the only option given the data available. Therefore, the findings of this analysis must be treated with caution.

4.6.4 Stimulant Medication

A criticism of this study is that there was no control over the levels of stimulant medication that were being taken by the children. All children in the study were taking methylphenidate and it was requested that they take it at their usual time.

Since children were seen at different times of day, there was no control over the time elapsed since their last methylphenidate tablet. However, all the children who were included attended sufficiently well to the tasks for the assessments to be completed. This has implications for the use of the Stroop in assessment of these children which may be affected by medication. Although, Everett et al. (1991) found that ADHD children who were given stimulant medication for a year improved scores on the Wisconsin Card Sorting Test but not on the Stroop and concluded that this test was more resistant to the effects of stimulant medication. However this does not inform about the effect of medication on performance on the other tasks, in particular, the Strange Stories which may have varied if medication affected the children's ability to attend to aspects of the stories.

No measures were taken of the age at which children started taking methylphenidate or the length of time that they were on medication. Therefore, a more long term effect on social ability of stimulant medication was not considered. If, as is suggested by several theorists social learning is affected by ADHD (Peterson & Seigal, 1995; Camarata & Gibson, 1999), then the age that a child began taking methylphenidate and the amount of time the child has been taking methylphenidate may affect their social ability. Further investigation would be needed to explore this suggestion however, it is possible that the children performing well in this study may have an advantage for this reason.

4.7 Further research

Before drawing conclusions about theory of mind in children with ADHD, the findings in this study would have to be substantiated by linking the children's performance on these tasks to social ability in real life situations. Although the questionnaire attempted to do this to a certain extent, the lack of association between formal assessment and parental report questions the validity of the measures. The influence of executive functioning and theory of mind in this population merits further investigation. Assessment using several measures of executive functioning alongside the theory of mind, social understanding and assessment of everyday social interaction would be needed to inform on the role of executive functioning in the social difficulties of this group. Thus in order to draw sound conclusions about the nature of theory of mind in children with ADHD and the possible links to EDF, there would have to be closer examination of these children's social ability in everyday life and more rigorous assessment of their executive functioning.

This study would also need to be replicated using more controlled comparison group to confirm the results. Comparing children with ADHD on these measures to normal controls, children with learning disabilities and children with autism or Asperger's Syndrome would inform on the level and quality of theory of mind of children with ADHD.

4.8 Conclusions

There is some evidence to suggest that children with ADHD have more difficulty with 2nd order theory of mind tasks and understanding mind states than normal children. There is also evidence to suggest that children with ADHD have many of the social behaviours associated with Asperger's Syndrome. The children's performance on the tasks and the behaviours highlighted can be explained in terms of an executive dysfunction hypothesis. Social learning may also be a factor influencing the development of theory of mind in children with ADHD although the findings of this study do not extend to evidence for or against this hypothesis. Further understanding of neurological areas affected by ADHD and involved in theory of mind ability is needed before conclusions can be draw about neurological links between theory of mind and ADHD. It is also possible that there is a higher level of co-morbidity between ADHD and autistic spectrum disorders than is currently recognised which could account for theory of mind difficulties in some of the children in the study.

There are many methodological difficulties with this study. These include lack of a control group, lack of controls over levels and duration of prescription of stimulant medication and lack of comprehensive language assessment. Further investigation with controls for these variables would be needed to substantiate the findings of this study on theory of mind and ADHD.

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APPENDIX 1:

DSM-IV Criteria for Attention Deficit Hyperactivity Disorder

DSM-IV Diagnositic Criteria for Attention-Deficit/ Hyperactivity Disorder.

A. Either (1) or (2)

(1) Six (or more) of the following symptoms of inattention have persisted for at least 6
months to a degree that is maladaptive and inconsistent with developmental level.

Inattention

a) Often fails to give close attention to details or makes careless mistakes in schoolwork, work or other activites.

b) Often has difficulty sustaining attention in tasks or play activities.

c) Often does not seem to listen when spoken to directly.

d) Often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behaviour or failure to understand instructions).

e) Often has difficulty organising tasks and activities.

f) Often avoids, dislikes or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework).

g) Often loses things necessary for tasks or activities (e.g. toys, school assignments, pencils, books or tools).

h) Is often easily distracted by extraneous stimuli.

i) Is often forgetful in daily activities.

(2) Six (or more) of the following symptoms of hyperactivity-impulsivity have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level.

Hyperactivity

a) Often fidgets with hands or feet or squirms in seat.

b) Leaves seat in classroom or in other situations in which remaining seated is expected.

c) Often runs about or climbs excessively in situations which it is inappropriate (in adolescents or adults, may be limited to restlessness).

d) Often has difficulty playing or engaging in leisure activities quietly.

e) Is often 'on the go' or often acts as if driven by a motor.

f) Often talks excessively.

Impulsivity

g) Often blurts out answers before questions have been completed.

h) Often has difficulty awaiting turn.

i) Often interrupts or intrudes on others (e.g. butts into conversations or games).

B. Some hyperactive-impulsive or inattentive symptoms that cause impairment were present before age 7.

C. Some impairment from the symptoms is present in two or more settings (e.g. at School [or work] and at home).

D. There must be clear evidence of clinically significant impairment in social, Academic or occupational functioning.

E. The symptoms do not occur exclusively during the course of a Pervasive Developmental Disorder, Schizophrenia or other Psychotic Disorder and are not better accounted for by another mental disorder (e.g. Mood Disorder, Anxiety Disorder, Dissociative Disorder or Personality Disorder).

APPENDIX 2:

Letter of invitation to participate in the study

Grampian University Hospitals
ROYAL ABERDEEN CHILDREN'S HOSPITAL
CORNHILL ROAD, ABERDEEN AB25 2ZG

TEL: 01224 681818 EXT: 52706
FAX: 01224 840938

DEPARTMENT OF CHILD AND FAMILY PSYCHIATRY

Mr and Mrs Smith
Aberdeen

date

Dear Mr and Mrs Smith

The child psychology department are doing a research project looking at the social skills of children with ADHD.

I wondered if you would like John to participate in the project.

I have enclosed some information to help you decide whether or not you would like John to take part.

If you decide to participate, please sign the enclosed consent form and you will then be contacted by Maggie Whyte from the psychology department who will arrange to see John.

If you do not wish your child to participate your treatment will not be affected in any way.

Please do not hesitate to contact myself or Maggie if you have any questions.

yours sincerely

Clinician

APPENDIX 3:

Letter of information about the study.

Grampian University Hospitals
Department of Clinical Psychology
Royal Aberdeen Children's Hospital
Cornhill Road
Aberdeen AB25 2ZG

Development of Theory of Mind in children with ADHD

Information for Parents/ Guardians

Dear Parent/ Guardian,

The department of Child Clinical Psychology is doing a study about children with ADHD and their understanding of how other people think and behave.

We are writing to invite your child to take part.

Aim. The aim of the project is to find out whether children with ADHD have difficulties in this area.

What does the project involve? Children taking part in the study will be asked to talk about the thoughts and behaviour of characters in various stories. They will also be asked to name objects in some pictures to look at their vocabulary skills. Parents/ guardians will be sent a questionnaire to fill in about their child's social behaviour.

How long will it take? To complete all the tasks takes about 45 minutes.

Where would my child be seen? You will choose whether your child is seen in school, at home or at the child psychology department.

Will I find out how it went? You will be sent information about the results of the project. Further queries can be discussed with your psychiatrist/ psychologist.

Confidentiality. All the information collected in the study is confidential. Copies of the tasks completed in the study will be kept in your child's psychology/ psychiatry file unless you have an objection to this.

If you have no objections to your child's participation in this project, please sign the attached consent form and return it in the SAE provided.

If you do agree to participate you can change your mind at any time and withdraw your child from the study. You are under no obligation to take part.

Thank you for considering taking part in this study. If you have any questions or wish to discuss any aspects of the study, please do not hesitate to contact us.

yours faithfully

Maggie Whyte
Psychologist in Clinical Training
Department of Child Psychology
Royal Aberdeen Children's Hospital

ext. 54110

Supervised by:

Lindsay Stewart
Clinical Psychologist
Department of Child Psychology
RACH

ext. 53268

Messages can be left with the secretaries. ext. 52234

APPENDIX 4:

Consent Form

Grampian University Hospitals

CONSENT FORM

CONSENT BY PARENT/ GUARDIAN FOR THEIR CHILD TO PARTICIPATE IN:

A Study of Theory of Mind in Children with Attention Deficit Hyperactivity Disorder (ADHD)

Name of Child:	John Smith
Name of Parent/ Guardian:	Mr and Mrs Smith
Name of Study:	The development of theory of mind and children with ADHD.
Principal Investigator:	Maggie Whyte, Psychologist in Clinical Training

I have read the patient/volunteer information sheet on the above study and have had the
opportunity to contact, Maggie Whyte, Psychologist to discuss the details.

I have agreed to my child taking part in the study as it is has been outlined to me, but I understand that I am completely free to withdraw my child from the study or any part of the study at any time I wish and that this will not affect my child's continuing treatment in any way.

I understand that these trials are part of a research project designed to promote medical knowledge, which has been approved by the Grampian Research Ethics Committee, and may be of no benefit to me personally. The Grampian Research Ethics Committee may wish to inspect the data collected at any time as part of its monitoring activities.

I hereby fully and freely consent for my child to participate in the study which is outlined on the enclosed information sheet.

Signature of Parent/ Guardian: .....

Date: .....

Child's School: .....

Please indicate where you would like your child to be seen

Home	☐
School	☐
Child Psychology (Royal Aberdeen Children's Hospital)	☐

I confirm that I have provided the above parent/ guardian with information about the nature and purpose of the study to be undertaken and have given them the opportunity to discuss this further with myself or my supervisor.

Signature of Investigator:.....

Date: .....

Please note: This form must be kept in Section A of the patients notes.

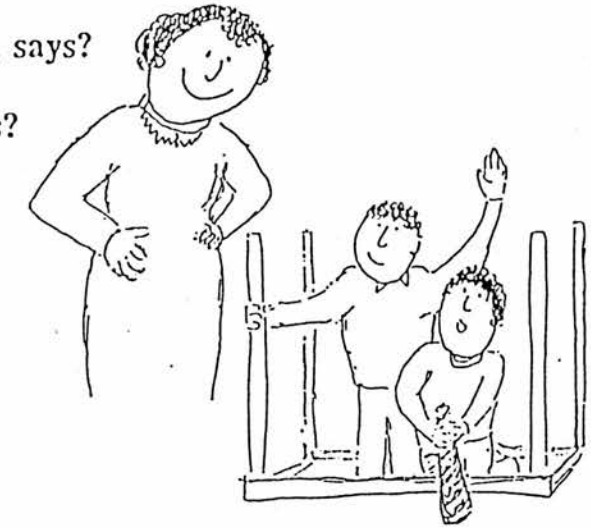
APPENDIX 5:

Strange Stories

Mark and Adam are having great fun! They have turned the kitchen table upside down and they are sitting in it, paddling along with rolled up newspapers. When their mother comes in she laughs. "Whatever are you two doing?", she asks. "This table is a pirate ship", says Adam, "And you had better get in too before you sink - because you are standing in the sea!"

Is it true what Adam says?

Why does he say this?



One day, while she is playing in the house, Anna accidentally knocks over and breaks her mother's favourite crystal vase. Oh dear, when mother finds out she will be very cross! So when Anna's mother comes home and sees the broken vase and asks Anna what happened, Anna says, "The dog knocked it over, it wasn't my fault!"

Was it true, what Anna told her mother?

Why did she say this?

White Lie

One day Aunt Jane came to visit Peter. Now Peter loves his aunt very much, but today she is wearing a new hat; a new hat which Peter thinks is very ugly indeed. Peter thinks his aunt looks silly in it, and much nicer in her old hat. But when Aunt Jane asks Peter, "How do you like my new hat?", Peter says, "Oh, its very nice".

Was it true what Peter said?

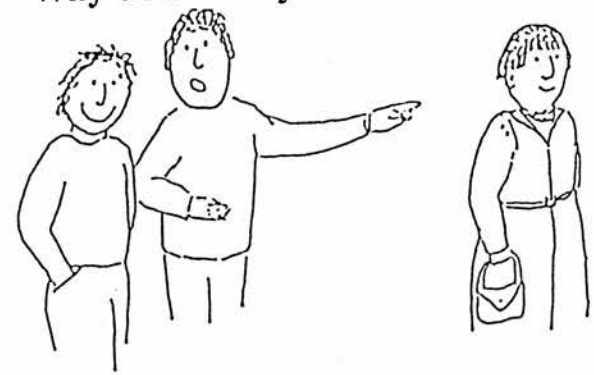
Why did he say it?

Joke

Daniel and Ian see Mrs.Thompson coming out of the hairdresser's one day. She looks a bit funny because the hairdresser has cut her hair much too short. Daniel says to Ian, "She must have been in a fight with a lawnmower!"

Is it true, what Daniel says?

Why does he say this?



A burglar who has just robbed a shop is making his getaway. As he is running home, a policeman on his beat sees him drop his glove. He doesn't know the man is a burglar, he just wants to tell him he dropped his glove. But when the policeman shouts out to the burglar, "Hey, you! Stop!", the burglar turns round, sees the policeman and gives himself up. He puts his hands up and admits that he did the break-in at the local shop.

Was the policeman surprised by what the burglar did?

Why did the burglar do this, when the policeman just wanted to give him back his glove?

Emma has a cough. All through lunch she coughs and coughs and coughs. Father says, "Poor Emma, you must have a frog in your throat!"

Is it true, what Father says to Emma?

Why does he say that?

Sarcasm

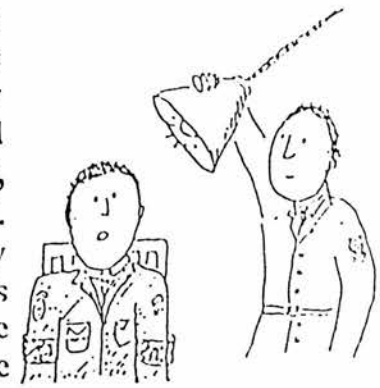
Sarah and Tom are going on a picnic. It is Tom's idea, he says it is going to be a lovely sunny day for a picnic. But just as they are unpacking the food, it starts to rain, and soon they are both soaked to the skin. Sarah is cross. She says, "Oh yes, a lovely day for a picnic alright!"

Is it true, what Sarah says?

Why does she say this?

Double Bluff

During the war, the Red army capture a member of the Blue army. They want him to tell them where his army's tanks are; they know they are either by the sea or in the mountains. They know that the prisoner will not want to tell them, he will want to save his army, and so he will certainly lie to them. The prisoner is very brave and very clever, he will not let them find his tanks. The tanks are really in the mountains. Now when the other side ask him where his tanks are, he says, "They are in the mountains".



Is it true what the prisoner said?

Where will the other army look for his tanks?

Why did the prisoner say what he said?

Brian is always hungry. Today at school it is his favourite meal - sausages and beans. He is a very greedy boy, and he would like to have more sausages than anybody else, even though his mother will have made him a lovely tea when he gets home! But everyone is allowed two sausages and no more. When it is Brian's turn to be served, he says, "Oh, please can I have four sausages, because I won't be having any tea when I get home!"

Is it true, what Brian says?

Why does he say that?

Jane and Sarah are best friends. they both entered the same painting competition. Now Jane wanted to win this competition very much indeed, but when the results were announced it was her best friend Sarah who won, not her. Jane was very sad she had not won, but she was happy for her friend, who got the prize. Jane said to Sarah, "Well done, I'm so happy you won!" Jane said to her mother, "I am sad I did not win that competition!"

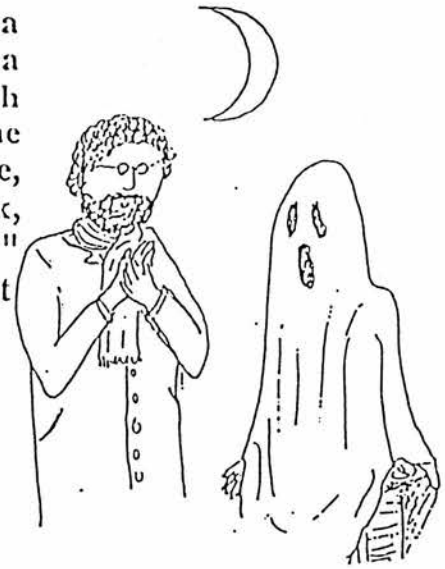
Is it true what Jane said to Sarah?

Is it true what Jane said to her mother?

Why does Jane say she is happy and sad at the same time?

Appearance/ Reality

It is Halloween, and Chris is going to a fancy-dress party. He is going as a ghost. He wears a big white sheet with eyes cut out to see through. As he walks to the party in his ghost costume, he bumps into Mr.Brown. It is dark, and Mr.Brown says, "Oh! Who is it?" Chris answers, "I'm a ghost Mr.Brown!"

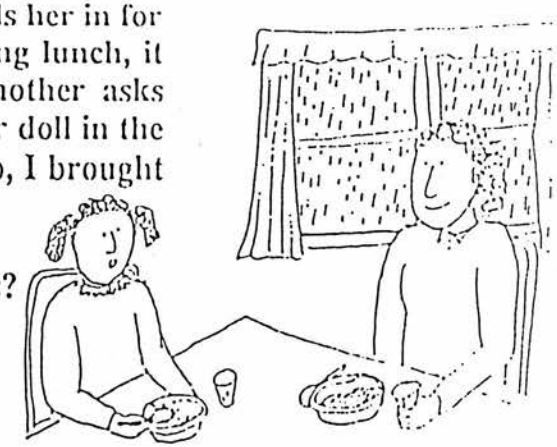


Is it true, what Chris says?

Why does Chris say this?

Forgetting

Yvonne is playing in the garden with her doll. She leaves her doll in the garden when her mother calls her in for lunch. While they are having lunch, it starts to rain. Yvonne's mother asks Yvonne, "Did you leave your doll in the garden?" Yvonne says, "No, I brought her in with me, Mummy".



Is it true, what Yvonne says?

Why does Yvonne say this?

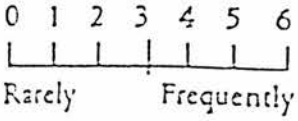
APPENDIX 6:

Australian Scale for Asperger's Syndrome

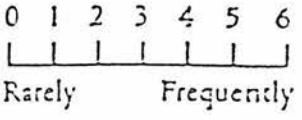
Please complete the following by circling the appropriate number on the scale beside each of the questions. Also, please note, a score of *zero* would be the usual level expected of a child of that age.

A. SOCIAL AND EMOTIONAL ABILITIES

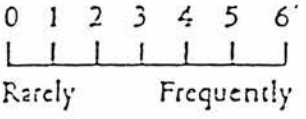
1. Does the child lack an understanding of how to play with other children? For example, unaware of the unwritten rules of social play.



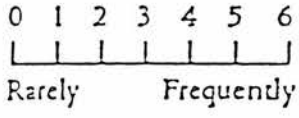
2. When free to play with other children, such as school lunchtime, does the child avoid social contact with them? For example, finds a secluded place or goes to the library.



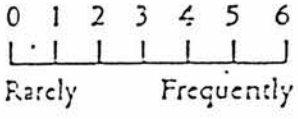
3. Does the child appear unaware of social conventions or codes of conduct and make inappropriate actions and comments? For example, making a personal comment to someone but the child seems unaware how the comment could offend.



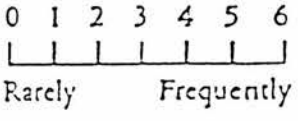
4. Does the child lack empathy, ie. the intuitive understanding of another person's feelings? For example, not realising an apology would help the other person feel better.



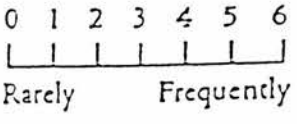
5. Does the child seem to expect other people to know their thoughts, experiences and opinions? For example, not realising you could not know about something because you were not with the child at the time.



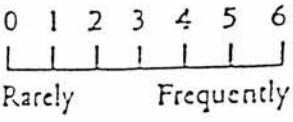
6. Does the child need an excessive amount of reassurance, especially if things are changed or go wrong?



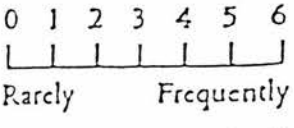
7. Does the child lack subtlety in their expression of emotion? For example, the child shows distress or affection out of proportion to the situation.



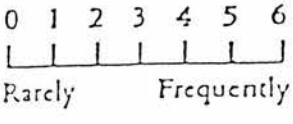
8. Does the child lack precision in their expression of emotion? For example, not understanding the levels of emotional expression appropriate for different people.



9. Is the child not interested in participating in competitive sports, games and activities.

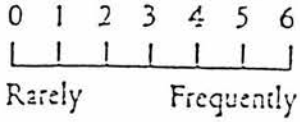


10. Is the child *indifferent* to peer pressure? For example, does *not* follow the latest craze in toys or clothes.

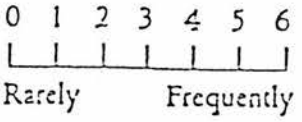


B COMMUNICATION SKILLS

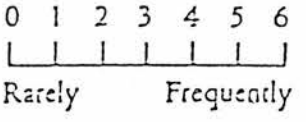
11. Does the child take a literal interpretation of comments? For example, is confused by phrases such as 'pull your socks up', 'looks can kill' or 'hop on the scales'.



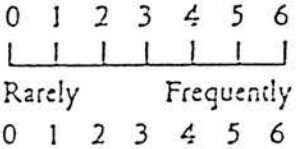
12. Does the child have an unusual tone of voice? For example, the child seems to have a 'foreign' accent or monotone that lacks emphasis on key words.



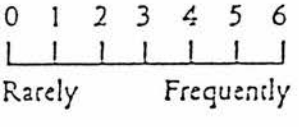
13. When talking to the child does he or she appear uninterested in your side of the conversation? For example, not asking about or commenting on your thoughts or opinions on the topic.



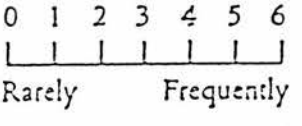
14. When in a conversation, does the child tend to use less eye contact than you would expect?



15. Is the child's speech over-precise or pedantic? For example, talks in a formal way or like a walking dictionary.

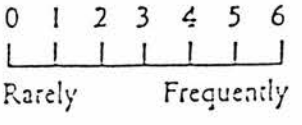


16. Does the child have problems repairing a conversation? For example, when the child is confused, he or she does not ask for clarification but simply switches to a familiar topic, or takes ages to think of a reply.

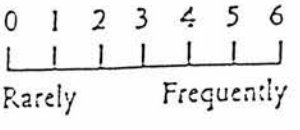


C. COGNITIVE SKILLS

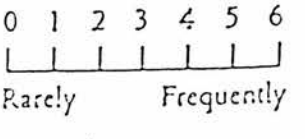
17. Does the child read books primarily for information, not seeming to be interested in fictional works? For example, being an avid reader of encyclopaedias and science books but not keen on adventure stories.



18. Does the child have an exceptional long-term memory for events and facts? For example, remembering the neighbour's car registration of several years ago, or clearly recalling scenes that happened many years ago.

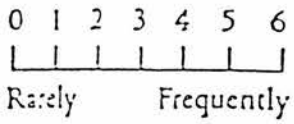


19. Does the child lack social imaginative play? For example, other children are not included in the child's imaginary games or the child is confused by the pretend games of other children.

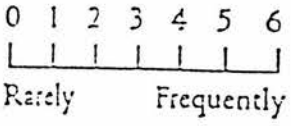


D. SPECIFIC INTERESTS

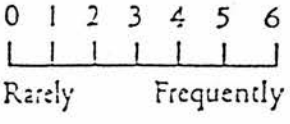
20. Is the child fascinated by a particular topic and avidly collects information or statistics on that interest? For example, the child becomes a walking encyclopaedia of knowledge on vehicles, maps or league tables.



21. Does the child become unduly upset by changes in routine or expectation? For example, is distressed by going to school by a different route.

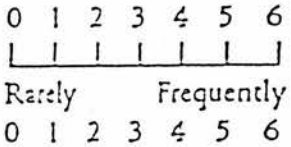


22. Does the child develop elaborate routines or rituals that must be completed? For example, lining up toys before going to bed.

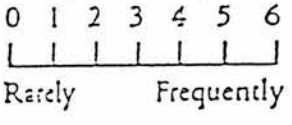


E. MOVEMENT SKILLS

23. Does the child have poor motor coordination? For example, is not skilled at catching a ball.



24. Does the child have an odd gait when running?



F. OTHER CHARACTERISTICS

For this section, tick whether the child has shown any of the following characteristics:

(a) Unusual fear or distress due to:

- ordinary sounds, e.g. electrical appliances ☐
- light touch on skin or scalp ☐
- wearing particular items of clothing ☐
- unexpected noises ☐
- seeing certain objects ☐
- noisy, crowded places, e.g. supermarkets ☐

(b) A tendency to flap or rock when excited or distressed ☐

(c) A lack of sensitivity to low levels of pain ☐

(d) Late in acquiring speech ☐

(e) Unusual facial grimaces or tics ☐

Any other comments:

APPENDIX 7:

Instructions for the Smarties Task

Smarties task

Ask the child to name another child in their class (e.g. who do you sit next to in class).

Show child tube of smarties and rattle the tube.

What do you think is in here? (child answers 'smarties')

Open the tube to show pencils

No, look there are pencils.

Put pencils back in tube and close.

What's in here? reality question

When I first asked you, what did you say? memory question

(Other child) **hasn't seen this box. If I showed him/ her this box, just like this and asked, what's in here, what would** *(other child)* **say?'**
false belief question

Is that what's really in the box? reality question

Do you remember, when I took the box out of my bag and asked you what was in it, what did you say? memory question

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APPENDIX 8:

Instructions for the Sally Anne Task

Sally-Anne Task

This is Sally and this is Anne. *Show two puppets*

There is a basket and a box on the table. *Point to the basket and box.*

Sally and Anne both present

Sally has a ball. She puts the ball in the basket. *Manipulate Sally to put the ball in the basket*

She goes away

Sally leaves, Anne remains.

Anne takes the ball and puts it in the box. *Manipulate Anne to put the ball in the box.*

She goes away.

Anne leaves

Now, Sally comes back

Question

Where will Sally look first for the ball? False belief question

---

If answer = 'basket' then
Where is the ball really? Reality question

Where did Sally put the ball first? Memory question

APPENDIX 9:

Instructions for the False Photo Task

False Photo task

Position the doll on the mat.

Help the child take a photo of the doll on the mat.

Move the doll onto the box.

In the photo, where will the doll be? _____

APPENDIX 10:

Instructions for the Ice-Cream Van Task

Ice-cream van task

This is John and this is Mary. They live in this village.

Which is John/ which is Mary? Naming question

Here they are in the park. Along comes the ice-cream man. John would like to buy an ice-cream but he has left his money at home. He s very sad. 'Don't worry' says the ice-cream man. 'You can go home and get your money and buy some ice-cream later. I'll be in the park all afternoon' 'Oh good' says John 'I'll be back in the afternoon to buy an ice-cream'.

Where did the ice-cream man say to John he would be all afternoon?
Memory question _____

So, John goes home. He lives in this house. Now, the ice-cream man says, 'I'm going to drive my van to the church to see if I can sell my ice-creams outside there'

Where did the ice-cream man say he was going? _____
Memory question

Did John hear that? _____
Reality question

The ice-cream man drives over to the church. On his way he passes John's house. John sees him and says 'Where are you going?'. The ice-cream man says 'I'm going to sell some ice-cream outside the church'. So, off he drives to the church.

Where did the ice-cream man tell John he was going? _____
Memory question

Does Mary know that the ice-cream man has talked to John? _____
Reality question

So, John goes to the church to buy ice-cream.

Now, Mary goes home. She lives in this house. Then she goes to John's house. She knocks on the door and says 'Is John in?'. 'No' says his mother, 'he's gone out to buy ice cream'.

Where does Mary think John has gone to buy an ice-cream? _____
False belief question

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

Where was the ice-cream man in the beginning? _____
Memory question