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THEORY OF MIND IN CHILDREN WITH AUTISM: IS THERE A NEED FOR BETTER TESTS OF WHAT THEY KNOW?

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PHD

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by

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ABSTRACT

Theory of Mind in Children With Autism:

Is There a Need for Better Tests of What They Know?

by Alex Karen Proto

This research looked at the ability of children with autism to understand theory of mind. This is the ability to attribute mental states (e.g. believing, thinking, knowing etc.) to oneself and to others. The main aim of the study was to provide evidence, contrary to a large body of previous research, that individuals with autism can exhibit a theory of mind, when the standard tests used in the past are simplified for this population. A further aim of the study was to show that language ability is significant in terms of theory of mind task performance. It was hypothesised, because of the nature of the theory of mind tasks, that matching participants in terms of their understanding of grammar, rather than single word understanding (as in past research), would be more appropriate. Three groups took part in the study; autistic, learning disabled and normally developing children. The learning disabled and normally developing participants were selected to match the subjects with autism, in terms of receptive verbal age, on either the British Picture Vocabulary Scale (BPVS) or the Test for Reception of Grammar (TROG) or both. All the participants were given two first order theory of mind tasks; the standard 'Sally-Anne' task, which has been used in past research, and a simplified cartoon version of this task designed by the author. These first order tasks test the ability to consider another person's thoughts about an objective event. Those participants who passed one of the first order tasks were then given three second order theory of mind tasks. These test the ability to consider another person's thoughts about a third person's thoughts regarding an objective event. The second order tasks consisted of the standard 'Ice-Cream Man task' (used in past research), Sullivan, Zaitchik and Tager-Flusberg's (1994) simplified 'Puppy task' and a simplified cartoon version of the task designed by the author. A significant difference in performance was found between the three participant groups (matched on the BPVS) on the standard first order task, but not on the simplified first order task. A significant difference in performance was found between the participant groups on the standard Ice-Cream Man task and the Puppy task, when matched on the BPVS, but not when matched on the TROG. In addition no significant difference in performance was found between the autistic and learning disabled participants on any of the theory of mind tasks. These findings are discussed in relation to other explanations of autism such as the salient object hypothesis and executive function.

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Author's Declaration

At no time during the registration for the degree of Doctor of Clinical Psychology has the author been registered for any other University award.

The contents of this bound volume are identical to the volume submitted for examination in temporary binding except the amendments requested at the examination.

This study was conducted while the author was a Trainee Clinical Psychologist in the South & West Region based in United Bristol Healthcare Trust.

Signed... Alice Pilot.....

Date... 23/7/99.....

Chapter 1: INTRODUCTION

1.1 Definitions

Autism

Autism is a developmental disorder, which affects about four in every 10 000 children, and was first described as a syndrome by Kanner in 1943. DSM-IV defines autism as a severe form of Pervasive Developmental Disorder, and describes the following four main diagnostic criteria: qualitative impairment in reciprocal social interaction; qualitative impairment in verbal and non-verbal communication and in imaginative activity; a markedly restricted repertoire of activities and interests and onset during infancy or childhood.

Asperger's Syndrome

The term Asperger's syndrome was first used by Wing (1981) who listed the following six diagnostic criteria based on Asperger (1944): speech was not delayed, but pedantic, stereotyped and odd in content; poor non-verbal communication in terms of little facial expression, monotone voice and inappropriate gesture; lacking empathy and non-reciprocal in social interactions; resistant to change, enjoying repetitive activities; poor motor co-ordination involving odd gait and posture, clumsy gross movements and sometimes stereotypies; good rote memory and circumscribed special interests.

Theory of Mind

Numerous hypotheses, to account for the specific impairments seen in autism, have been proposed. Baron-Cohen, Leslie and Frith (1995) proposed that a single cognitive deficit could underlie the three diverse features of autism (impairments in socialisation, communication and imagination). Their theory suggests that people within the autistic

spectrum are impaired in their acquisition and use of a 'theory of mind'. The term 'theory of mind' was coined by Premack and Woodruff (1978) and defined as the ability to impute mental states (e.g. believing, thinking, knowing, pretending etc.) to oneself and to others.

1.2 Autism and an Impaired Theory of Mind

It has been argued that many of the impairments observed in autism are explicable in terms of an impaired understanding of mental states. People with autism have been found to have difficulty in comprehending certain facial, bodily and vocal expressions of emotion in others (Hobson, 1986). In addition they themselves tend not to use gestures to express or communicate mental states e.g. pointing to draw someone's attention to an object (Attwood, Frith & Hermelin, 1988; Leslie & Happé, 1989). A striking lack of pretend play is also exhibited by the vast majority of children with autism (Baron-Cohen, 1987) and such play is thought to be a precursor to a theory of mind. More evidence to support the idea that individuals with autism lack a theory of mind comes from studies of their language. It has been found that they tend not to use mental state terms in their spontaneous speech (Tager-Flusberg, 1992) and do not reliably take account of a listener's knowledge when communicating (Perner, Frith, Leslie & Leekam, 1989).

1.3 Traditional 'Theory of Mind' Tasks

First Order Theory of Mind

It has been argued that it is not until one demonstrates an understanding of false belief (where mental state conflicts with reality) that one can unequivocally attribute a theory of mind to an individual (Dennett, 1978). Wimmer and Perner (1983) were the first to incorporate the idea of testing an understanding of false belief into an empirical test of theory of mind. This was later adapted by Baron-Cohen *et al.* (1985) into the 'Sally-Anne task', and employed with children with autism. The Sally-Anne task tests an understanding

of what is called first order theory of mind, which is the ability to consider another person's thoughts about an objective event, and is normally passed by children at about 4 years of age (Wimmer & Perner, 1983). The task involves a scenario in which Sally's marble is moved, during her absence, and on her return the child is asked to predict where Sally will look for her marble. In order to answer this question correctly, the child must take account of the fact that Sally does not know her marble has been moved, and so must still believe it to be in its original location (i.e. the child must have knowledge of Sally's false belief).

Baron-Cohen *et al.* (1985) found that 80 per cent of their sample of autistic subjects answered the false belief question incorrectly, stating that Sally would look for her marble in its actual location. In contrast, 85 per cent of normally developing 4 year olds and 86 per cent of the group of children with Down syndrome passed this test of false belief. Baron-Cohen *et al.* (1985) argued that this failure of the autistic group could not be attributed to inattention, memory problems, linguistic or motivational factors, since all subjects were able to correctly answer the memory and reality control questions (about the original and current location of the marble). This pattern of results has been replicated on numerous occasions using many different methodological techniques (Baron-Cohen, 1989; Leekam & Perner, 1991; Leslie & Frith, 1988; Reed & Patterson, 1990; Shaw, 1989; Swettenham, 1992).

The majority of subjects with autism have been found to fail first order belief attribution tests, but in each study there is a proportion (between 15 and 90 per cent) who are successful in demonstrating a theory of mind, even if delayed in doing so (Dahlgren & Trillingsgaard, 1996; Reed & Patterson, 1990). This must lead one to question whether a

theory of mind deficit can fully account for the impairments seen in autism, since clearly a lack of understanding of minds is not inevitable in autism.

Second Order Theory of Mind

Baron-Cohen (1989) showed that none of the autistic subjects who passed the Sally-Anne task in the 1985 study could, however, pass a slightly more advanced test known as the 'Ice-Cream Man task'. This tests understanding of second order theory of mind, that is the ability to consider another person's thoughts about a third person's thoughts about an objective event, and is normally passed by children at about 5-7 years of age. Baron-Cohen's (1989) study showed that whilst none of the autistic subjects passed the Ice-Cream Man task, 90 per cent of the normally developing subjects and 60 per cent of the Down Syndrome subjects passed this task. There was no significant difference between the normally developing and Down Syndrome subject groups in their performance on this task.

The Ice-Cream Man task involves a story about two characters, John and Mary, who are informed together about the location of an ice-cream van. John and Mary are then independently told about the ice-cream van's unexpected transfer to a new location. Hence both characters, at the end of the story, know where the van is really located, but Mary does not know that John knows the van has moved. Thus, by asking subjects where Mary thinks *John will go to buy an ice-cream*, one can test understanding of second order belief attribution. It has been stated that it is only when one has the capacity to attribute second order mental states, that one can have a sophisticated understanding of human behaviour (Sullivan, Zaitchik & Tager-Flusberg, 1994).

A number of more recent studies have produced mixed results when comparing the performance of subjects with autism or Asperger's syndrome with controls on second

order theory of mind tasks. Consistent with Baron-Cohen's 1989 study, Ozonoff, Pennington and Rogers (1991) reported that subjects with autism were significantly worse than controls on second-order theory of mind tasks. Other researchers, however, have reported finding no significant difference between subjects on the autistic spectrum and normal or learning disabled controls in their ability to attribute second order beliefs (Bowler, 1992; Ozonoff, Rogers & Pennington, 1991; Tager-Flusberg & Sullivan, 1994a.)

In Bowler's 1992 study it was found that the majority of individuals with Asperger's syndrome were able to pass the theory of mind tasks. It was reported, though, that on the whole they did not use cognitive state terms (i.e. thinking, knowing, believing) in their responses, and none referred explicitly to the beliefs of both characters in the story. These findings, however, were similar for the two control groups in the study. Bowler believed that it was certain features in the story that focused the subject's attention on non-mental explanation's of people's behaviour. Since when he examined the answers given to the justification question in the Ice-Cream Man task (namely 'Why does Mary think that about John'), a large number of subjects stated that the ice-cream man was in the park at the beginning of the story, or that he said he would be there all afternoon. Thus subject's answers centred on the point in the story at which the false belief is set up.

Dahlgren and Trillingsgaard (1996) employed the Sally-Anne and Ice-Cream Man tasks with three matched groups of subjects: those with autism, those with Asperger's syndrome and normally developing individuals. The results showed that 90 per cent of the subjects with autism, 85 per cent of those with Asperger's syndrome and all of the normally developing control subjects passed the first order theory of mind task. In addition 60 per cent of the subjects with autism and Asperger's syndrome and 90 per cent of the controls

passed the second order theory of mind task. No statistically significant differences were found between the three groups on the theory of mind tasks.

1.4 Criticisms of the Methodology Used in Theory of Mind Tasks

Several criticisms have been made of the methodology of 'theory of mind' false belief tasks as described below:

Salient Object Hypothesis

It has been hypothesised that, in false belief tasks, people with autism may have difficulty overcoming the perceptual salience of the object in the real location. Baron-Cohen's (1989) second order theory of mind task involves the use of a model village to act out a scenario. The test question asks 'Where does Mary think John has gone to buy his ice-cream' and the correct answer, taking account of Mary's false belief about John's belief, is in the park. At the end of the story when the question is asked, however, the ice-cream van is visibly outside the church and therefore likely to be a distraction.

Russell, Mauthner, Sharpe and Tidswell (1991) designed a task called 'the windows task' to test autistic children's ability to deceive, which involves the ability to manipulate another person's thoughts. The windows task requires the subject to compete against the experimenter for chocolate and comprises of two phases. Initially, in the training phase, the subject must point to one of two closed boxes, and if the chosen box contains a chocolate the experimenter gets it, whereas if the box is empty then the subject gains the chocolate. In phase two the boxes have windows facing the subject, so that only s/he knows the true location of the chocolate, and following the same rules as previously the subject must select a box. It is obviously in the subject's best interest to deceive the experimenter and point to the empty box, in order to obtain the chocolate for themselves.

Russell *et al.* (1991) found that the majority of children with autism, and the younger non-autistic children aged less than 4 years old, pointed to the box containing the chocolate for all 20 trials in the second phase. It seems that such perseveration shown by the autistic children on this task is more easily explained as a failure to inhibit reference to the salient object (i.e. a difficulty in drawing one's attention away from where a desired object is present in order to refer to an empty location). If the children with autism had simply not understood the task one might expect more random responding, and it is difficult to see how a deficit in theory of mind could explain why autistic children are so unresponsive to negative feedback.

Hughes and Russell (1993) used a modified version of the windows task with two groups of subjects, children with autism and those with learning difficulties. They found that, in comparison with the non-autistic learning disabled subjects, the autistic subjects had difficulty pointing to the empty box even in a condition with no competitor. This supports the claim that individuals with autism have a problem disengaging from a salient object, since an explanation in terms of lack of a theory of mind does not make sense in a situation where there was no other mind in which to implant a false belief.

Further evidence in support of the salient object hypothesis comes from an earlier study by Wimmer and Perner (1983), showing that young non-autistic children also find it difficult to ignore a salient object. Wimmer and Perner (1983) adapted the original 'Sally-Anne task' into a story about a boy called Maxi and his mother, which is acted out using dolls and other props. In the first version of the story Maxi puts some chocolate away in the blue cupboard and then leaves the house. In his absence his mother bakes a cake, using some of the chocolate and then puts the rest away in the green cupboard. When Maxi returns to the house, the subject is asked where Maxi will look for the chocolate. In another version of

the story, namely the 'disappear' condition, Maxi's mother uses up all of the chocolate in making the cake, so there is none left to transfer to another location. When acted out the chocolate is in fact removed from the scene and placed behind a wall, and on Maxi's return subjects are asked where Maxi will look for the chocolate. There was a group of children who failed this false belief task, and out of this group 85 per cent claimed that Maxi would look behind the wall for the chocolate. In this situation the actual physical location of the chocolate is clearly over-riding either of the other two locations (i.e. the blue and green cupboards) in the task.

Gopnik (1989) also provided evidence for the salience hypothesis, employing normally developing 3 year olds as subjects. It was found that these subjects performed significantly better on a pretence change experiment than a belief change task. In the belief change task the subject is shown a box of smarties and asked what s/he thinks it contains. To the subject's surprise the box is opened and found to contain pencils, and the test question is then asked 'Before I opened the box, what did you think was inside?' The pretence change task involves the child initially being asked to pretend that an object, for example a stick, is a spoon and then later the child is told to pretend it is another object such as a magic wand. When asked the test question 'What were you pretending the object was before?' subjects were more able to answer it correctly than when asked a similar question in the belief change task. Gopnik argued that the pretence change task is easier for subjects, because when asked the test question there was no actual magic wand present (salient object) to distract them.

In this piece of research the Sally-Anne and Ice-Cream Man tasks have been adapted, by using cartoon drawings to tell the story rather than acting the scenarios out with a model and puppets. The use of drawings means that the true physical location of the salient object

will be less distracting, since it will not be visible. Therefore subjects will not have to give a response to a question such as, 'Where does Mary think John has gone to buy an ice-cream?' which directly contradicts the visible evidence.

Information Processing Load

It has also been argued that individuals with autism may fail at false belief tasks because of an inability to process all the information, rather than due to a deficit in theory of mind. Various researchers have shown that by modifying (simplifying) both the standard first and second order theory of mind tasks more subjects, or individuals of a younger age, can be shown to possess a theory of mind. Such results raise the question of whether the difficulty people with autism have with theory of mind tasks represent a task artefact rather than a genuine deficit in theory of mind.

Eisenmajer and Prior (1991) tested children with autism on the Sally-Anne task, and those who failed were given an additional trial in which the word 'first' was included in the false belief question: 'Where will Sally *first* look for the marble?' It was found that half the subjects who had initially failed the false belief task were able to pass when this alteration was made. It has been argued that since the order of trials was not counterbalanced in this study, practice effects could cause the results. Tager-Flusberg and Sullivan (1994b) tested out this possibility by counterbalancing the order of presentation of tasks, and found no evidence of practice effects. Similarly Sullivan *et al.* (1994) found no practice effects in their study.

Other studies have modified the standard second order theory of mind task. Sullivan *et al.* (1994) aimed to explain the developmental lag between understanding first order and second order beliefs, such understanding normally occurs at about 4 years and 6-7 years

respectively. One hypothesis that they proposed was that younger children may not have the language skills necessary to understand the second order false belief question, which contains a double embedded proposition 'Where does Mary think John has gone...?' Alternatively they suggested that children younger than 6 or 7 years may lack the information processing resources necessary to solve second order theory of mind tasks, or that a conceptual breakthrough is made around 6 years of age.

In order to test these hypotheses Sullivan *et al.* (1994) gave normally developing 4-8 year olds four stories involving second order belief attribution. Two stories were based on Perner and Wimmer's (1985) Ice-Cream Man task, but these were slightly shorter than the original scenario and prompt questions and a memory aid question were added to ensure the child was attending to the story. The other two stories were newly designed and also included a memory aid and prompt questions. In addition the latter stories were made simpler than the original task by employing fewer characters, episodes and scenes and by including a deceptive context. A linguistic control question, containing a double embedding, was also added to each scenario: 'Does John know that the ice-cream man told Mary he was going to the school?'

The main findings of this study were that significantly more subjects passed the new stories than the standard stories, and that 40 per cent of the under 5 year olds were able to attribute second order false beliefs. These findings show that children of a younger age than previously demonstrated can exhibit second order belief attribution. Perner and Wimmer (1985) found children were unable to attribute second order beliefs until 6 or 7 years old, and in a much earlier study Barenboim (1978) found no child under the age of 11 was able to make second order belief attributions. In conclusion the modifications made in this study to Perner and Wimmer's (1985) Ice-Cream Man task significantly improved

children's performance, thus supporting the hypothesis that younger children lack the information processing resources to solve second order theory of mind tasks.

Leekam and Prior (1994) tested a group of autistic subjects and a control group of normally developing children on a version of the Ice-Cream Man task, and also on several stories to assess understanding of the distinction between joking and deceitful lies. Surprisingly, they found that there was no difference between the autistic and normally developing children's performance on the test questions. In addition Leekam and Prior found that the majority of normally developing subjects, by the age of 5 years, were able to demonstrate an understanding of second order beliefs and intentions. These results again support the idea that if the theory of mind task is made simpler (i.e. the information-processing load is reduced) then children of a younger age and more subjects with autism can pass. In this study a series of illustrations was used alongside each story being told by the experimenter, and when the test question was asked, subjects had to point to one of two pictures to answer. This meant that not only was there no salient object to disengage from, just two pictures to compare, but also in the final picture in the Ice-Cream Man task, the ice-cream van was positioned halfway between the park and church. Leekam and Prior (1994) argued that in terms of the salient object hypothesis this change in methodology could also have been beneficial to subjects.

Tager-Flusberg and Sullivan (1994a) also hypothesised that second order theory of mind tasks pose a difficulty for autistic, learning disabled and young normally developing children because of the added information processing load. They tested this hypothesis by employing a 'simpler' second order theory of mind task, with matched groups of autistic and learning disabled subjects. This 'simpler' task will be referred to as the 'Puppy' task, and was designed by Sullivan *et al.* (1994). The results of this study showed that the

majority of subjects in both groups passed the new task, and there were no significant differences in performance between the autistic and learning disabled subjects on this task. It might be, however, that careful matching of subjects on their understanding of grammar and sentences, rather than matching simply on the basis of single word vocabulary as used in past research, eliminated any potential group differences.

In this study it is proposed that representing the theory of mind tasks as cartoon pictures, with the story written underneath the drawings, will ease the information-processing load for children with autism. There will be fewer distractions with the cartoons, as subjects will not have to follow a story presented verbally whilst watching a number of puppets and objects move around. Boucher and Lewis (1989) found that when children with autism are following instructions, they make significantly more errors when such instructions are presented either verbally or visually demonstrated, than when they are written down.

A number of past researchers have already shown that by reducing the information processing load more children with autism can be shown to pass theory of mind tasks. It is not until one compares performance on these 'simpler' theory of mind tasks with performance on the traditional tasks employing the same group of subjects, however, that one can unequivocally know the role information processing plays in these tasks. Since it could be claimed that studies demonstrating a higher percentage of passers might have used particularly able groups of autistic subjects.

The Role of Verbal Ability in Theory of Mind Tasks

Several researchers have suggested that verbal ability may be linked to an autistic individual's performance on theory of mind tasks, but the results are equivocal. Many studies have shown a relationship between verbal mental age and false belief task

performance (Baron-Cohen, 1989; Charman & Baron-Cohen, 1992; Eisenmajer & Prior, 1991; Frith, Happé & Siddons, 1994; Happé, 1993; Leekam & Perner, 1991; Prior, Dahlstrom & Squires, 1990; Sparrevohn & Howie, 1995) whilst others have found no evidence for such a link (Baron-Cohen, 1989; Baron-Cohen *et al.*, 1985; Leslie & Frith, 1988; Perner *et al.*, 1989.) Prior *et al.* (1990) stated that a certain level of verbal ability is necessary, but not sufficient, for task success. Happé (1995) found, however, that not only is some minimal verbal mental age necessary for success on theory of mind tasks, but that there is also a higher verbal mental age (11 years 7 months) above which all subjects pass these tasks.

The majority of studies examining the relationship between theory of mind and verbal age have used relatively small sample sizes, which may account for the inconsistent results that have been found. Happé (1995) collated data on age, verbal mental age, verbal IQ and theory of mind test performance for 70 individuals with autism, of widely varying ages and ability levels. She found a strong and significant relationship between theory of mind task success and verbal ability.

If there is a certain verbal mental age above which all subjects with autism can pass theory of mind tasks, why is it so much higher than that required by normally developing children? It may be that some other factor can account for better verbal ability and theory of mind task performance e.g. motivation or teaching. Bowler (1992) suggested that individuals with Asperger's syndrome might be passing theory of mind tasks in a verbally mediated fashion. Bowler stated that 'although people with Asperger's syndrome can compute correct solutions to problems requiring a theory of mind, they do so by routes that are slow and cumbersome, disrupting the timing of their responses and making them appear odd in everyday social interactions'.

A criticism of the methodology of theory of mind tasks is that predominantly in past research subjects have been matched on the basis of vocabulary comprehension, using either the Peabody Picture Vocabulary Test (Dunn & Dunn, 1981) or, the later version, the British Picture Vocabulary Scale (Dunn, Dunn, Whetton & Pintilie, 1982), yet most tasks require understanding of complex grammatical sentences. It would therefore seem more appropriate to assess understanding of sentences, since development of grammatical competence may be slower than vocabulary. Indeed many autistic children who develop language can acquire large vocabularies, of the concrete kind, which are assessed in picture vocabulary tests (Frith, 1989a). Whilst subjects with autism are able to answer correctly control questions in theory of mind tasks, it may be that the test question is pragmatically or grammatically more difficult to answer.

Tager-Flusberg and Sullivan (1994b) assessed the performance of three matched groups of subjects (autistic, learning disabled and older normally developing children) on first order theory of mind tasks based on Wimmer and Perner's (1983) Sally-Anne task. They aimed to explore the relationship between grammatical comprehension and theory of mind task performance, by matching subjects not only on the British Picture Vocabulary Scale (BPVS) but also on a test of syntax, using the Sentence Structure subtest of the Clinical Evaluation of Language Fundamentals (CELF; Semel, Wiig & Secord, 1987). It was found that 90 per cent of the subjects with autism passed the false belief task, and no significant difference in performance was found between the autistic and learning disabled groups. In addition it was reported that for autistic subjects there was a strong relationship between performance on the theory of mind tasks and performance on the CELF. Scores on the BPVS were not related to theory of mind task performance for either group of subjects.

1.5 Shortcomings of the 'Theory of Mind' Explanation of Autism

The 'Talented Minority'

Research has suggested that the core impairments seen in autism can be explained in terms of a single cognitive deficit, namely a lack of 'theory of mind', however, this theory has been challenged, on a number of accounts. Firstly, as mentioned previously, by the finding that in every study a proportion of subjects with autism have been found to possess a theory of mind, when tested on standard tasks, and yet they remain socially impaired.

Frith, Morton and Leslie (1991) suggest that those autistic individuals who are able to pass false belief tasks have achieved this by 'hacking out' a solution, using general problem solving skills and not a theory of mind. Such a strategy may be inflexible, and whilst allowing success on relatively simple and artificial tests, it would not be as useful in real life situations. One such problem solving strategy, would be to associate the person with the object and place in the story, e.g. in the Sally Anne task to link Sally-marble-basket. Such a strategy would allow an individual to pass the Sally Anne task, without an understanding of minds, but would not generalise to real life 'mentalising' skills such as keeping secrets (Happé, 1994a.)

Baron-Cohen (1989) has proposed a developmental argument, that although some children with autism develop a theory of mind, they do so much later than other children. He stated that no autistic child has yet been found to pass theory of mind tests at the normal mental age. It has been suggested, therefore, that even those individuals who develop a theory of mind will have abnormalities in using it, even if only subtle ones (e.g. in social interactions and communication), because of developing the skills later than normal.

Failure on Theory of Mind Tasks is Not specific to Autism

The majority of research examining theory of mind performance in individuals with autism has included a control group of learning disabled subjects. In each of these studies a number of learning disabled individuals have failed to show that they possess a theory of mind. In Baron-Cohen *et al.'s* 1985 study, 14 per cent of the group with Down Syndrome failed to solve the first order theory of mind task, suggesting that the deficit may not be specific to autism.

In addition three studies have found no significant difference between learning disabled and autistic children on a number of standard theory of mind tasks (Oswald & Ollendick, 1989; Tager-Flusberg & Sullivan, 1994b; Yirmiya & Shulman, 1996.) This was despite the fact that these studies used children with a lower average IQ score than those participating in Baron-Cohen *et al.'s* (1985) study, who found that there was a significant difference between these groups. It could not be argued, therefore, that the former findings were a result of a selective bias towards more able autistic individuals.

Several studies have also compared the performance of individuals with learning disabilities (but not autism) with normally developing individuals, on both first and second order theory of mind tasks. Sodian and Frith (1992), Benson, Addeduto, Short, Nuccio and Maas (1993) and Zelazo, Burack, Benedetto and Frye (1996) all found that subjects with a learning disability performed worse than matched normally developing controls on theory of mind tasks.

The above mentioned studies have shown that children with learning difficulties have problems with theory of mind. Research has also indicated problems in this ability in

children with other communication difficulties e.g. deaf children (Peterson & Siegal, 1995; Russell, Hosie, Gray, Scott, Hunter, Banks & Macaulay, 1998).

The Theory of Mind Hypothesis Cannot Explain All Features of Autism

The 'theory of mind' account does seem to offer an explanation for the triad of impairments in social interaction, communication and play seen in autism. There is more to autism, however, than the classic triad of impairments. People with autism frequently present with a strikingly uneven profile of abilities, with islets of ability as well as impairments needing an explanation. Happé (1994b) summarised the findings from 10 studies examining the profile, of subjects with autism, across the subtests of the Wechsler Intelligence Scales (Weschler; 1974, 1981). These studies all showed a peak in performance on the Block Design subtest and a trough on the Comprehension subtest. This pattern of results has been found in both high and low functioning individuals with autism (Shah & Frith, 1993), in children and adults with autism (Freeman, Lucas, Forness & Ritvo, 1985; Rumsey & Hamburger, 1988) and those with Asperger's syndrome (Bowler, 1992). Such islets of ability cannot easily be explained by a lack of a theory of mind, nor can a number of other aspects of autism such as a restricted repertoire of interests, obsessive desire for sameness, excellent rote memory and preoccupation with parts of objects (Frith & Happé, 1994).

To conclude, it would seem that a deficit in theory of mind is not specific to autism, nor can this theory account for all people with autism or all features of autism.

1.6 Alternative Theories

There have been two other main theories proposed to account for autism, other than the theory of mind explanation. These other theories are that of central coherence and

executive function, each of which shall be described in turn. Whilst this study does not attempt to address either of these other theories, it may be that they will need to be given further consideration if an impairment of theory of mind in autism is shown to be a test artefact, and/or not specific to this population.

Central Coherence

Frith (1989b) proposed an alternative theory to try to explain both the strengths and impairments found in autism. A characteristic of normal information processing seems to be the tendency to consolidate different pieces of information, in order to derive higher-level meaning in context, for example the gist of a story is easily recalled whilst the exact details are usually not. Frith termed this natural inclination to form connections over as wide a range of stimuli as possible, and to generalise over as wide a range of contexts as possible 'central coherence'. She proposed that this was disturbed in autism, leading to a specific impairment in extracting meaning in context, and a preference for processing local rather than global information. Frith predicted, therefore, that autistic subjects would be relatively good at tasks where fragmented processing is advantageous, but poor at tasks requiring the recognition of global meaning.

An impairment in central coherence could account for the superior performance of subjects with autism for their mental age, reported by Shah and Frith (1983), on the Embedded Figures test, which involves finding a small target shape in a drawing of a larger meaningful shape made up of confusing lines. Similarly the Block Design subtest of the WAIS-R, which people with autism have been found to excel at, requires subjects to break down a geometric shape into smaller shapes, in order to copy the design using small building blocks. Shah and Frith (1993) found that modifying the Block Design stimuli by pre-segmenting the designs, had little effect on the performance of children with autism,

but in contrast greatly improved the performance of learning disabled and normally developing children. Further, more anecdotal evidence for a disturbance in central coherence comes from a single case study by Mottron and Belleville (1993) of an autistic man with exceptional artistic ability. They noted that the subject began his pictures by drawing one small detail and then continued by adding adjoining parts of the picture, whereas a professional draughtsman who acted as a control started by drawing an overall outline of the whole picture and then added the various parts.

The central coherence theory does seem to account for some of the unusual strengths shown by people with autism, but it also needs to explain their impairments. Frith and Snowling (1983) gave children with autism a number of sentences containing homographs (words with the same spelling as another but with a different meaning) to read. In order to pronounce the words correctly, one must process the homograph as part of the whole sentence meaning e.g. 'He had a pink *bow*' and 'He made a deep *bow*'. They found that compared to a group of dyslexic children and those without a learning disability of the same reading age, the autistic children read fewer words correctly and tended to give the more frequent pronunciation regardless of the sentence context. There are a number of other experimental findings, which cannot be accounted for by the theory of mind explanation of autism, but can be explained by a lack of central coherence. Frith and Hermelin (1969), for example, found that autistic subjects had an unusual strength for completing jigsaw puzzles by shape, but an unusual weakness for completing them by picture. It has also been found that children with autism can sort faces better by accessories than by emotion (Weeks & Hobson, 1987.) Similarly Tager-Flusberg (1991) found that autistics have an unusual strength in terms of remembering unrelated items, but an unusual weakness in memory for related items.

Central coherence may be useful in explaining some of the real-life features of autism, as well as making sense of a number of experimental findings that cannot be accounted for by a theory of mind deficit. Several researchers have explored the links between central coherence and theory of mind. Happé (1991) found that a group of autistic subjects performed poorly on Snowling and Frith's (1986) homograph reading test irrespective of level of theory of mind understanding. Even those subjects who consistently passed all the theory of mind tasks did not use the sentence context to aid pronunciation of the homographs. Happé (1994b) looked at the WISC-R and WAIS profiles of a group of individuals with autism, in comparison with their performance on a standard first order theory of mind task. She found that subjects' good performance on the non-verbal tasks, which benefit from weak central coherence (e.g. Block Design), was independent from theory of mind task success. In contrast, social reasoning deficits (e.g. poor performance on the Comprehension subtest) were striking only in those subjects who failed the theory of mind tasks. Frith and Happé (1994) have suggested that the central coherence hypothesis might be useful in supplementing the theory of mind account of autism, in terms of explaining the persisting social impairments of the talented minority. It may be that a theory of mind, which is not fed by rich and integrated contextual information, is of little use in everyday life.

Executive Function

Damasio and Maurer (1978) were the first to highlight the similarities between the effects of frontal lobe damage and autism. Specifically 'executive functions', which are associated with the frontal lobes, have been thought to be impaired in autism. Executive function is defined as the ability to maintain an appropriate problem-solving set for attainment of a future goal; it includes behaviours such as planning, impulse control, inhibition of prepotent but irrelevant responses, set maintenance, organised search and flexibility of

thought and action. Ozonoff, Pennington and Rogers (1991) noted that some features of autism are reminiscent of executive function deficits. Autistic children are rigid and inflexible and may become distressed at change. Their repetitive and stereotyped actions may be likened to the response perseveration seen in frontal lobe patients. Autistic individuals do not plan or anticipate long-term consequences, and appear not to reflect or self monitor. They frequently appear impulsive and unable to inhibit prepotent but irrelevant responses.

Ozonoff, Pennington and Rogers (1991) compared a group of high-functioning autistic children with a group of control children on a number of tasks: namely theory of mind, executive function, emotion perception, memory and spatial tasks. They used the Wisconsin Card Sorting Test (WCST) and the Tower of Hanoi task to assess executive function. The WCST requires the subject to deduce a rule, which is periodically changed, for sorting cards either by colour, shape or number, using feedback from the assessor about the correctness of each sort. In the Tower of Hanoi task the subject must reproduce a configuration of discs on three pegs, keeping to certain rules which in effect require moves to be planned in advance. The two most widely spread deficits in the autistic group were in executive function and second order theory of mind. In general, however, executive function was the best discriminator between the two groups. Other researchers have also found that autistic subjects and those with Asperger's syndrome perform poorly on standard tests of executive function (Ozonoff, Rogers & Pennington, 1991; Prior & Hoffmann, 1990; Rumsey, 1985; Rumsey & Hamburger, 1988, 1990; Steel, Gorman & Flexman, 1984.)

Goodman (1989) has suggested that it may be misguided to look for one primary impairment that can account for all symptoms of autism. Ozonoff, Rogers and Pennington

(1991) found that whilst subjects with a diagnosis of Asperger's syndrome were not impaired on theory of mind tests, they showed executive function deficits like the other autistic subjects in their study. They therefore argued that executive function deficit was more likely, than a theory of mind deficit, to be the primary impairment in autism. They did discuss, however, possible links between the two deficit theories and hypothesised that executive function deficits may be the result of a lack of theory of mind, or vice versa, or that both may result from a third factor.

1.7 The Aims of the Study

The main aim of this research is to provide further evidence to support the idea that people with autism do possess a theory of mind. It will be argued that the theory of mind tests traditionally used in past research, however, need to be modified to allow this ability to be exhibited.

A number of researchers have shown that by simplifying the theory of mind tasks in some manner, allows more individuals or younger subjects to pass (e.g. Leekam & Prior, 1994; Sullivan *et al.*, 1994; Tager-Flusberg & Sullivan, 1994a.) None of these studies, however, compared performance on the traditional theory of mind task with that on the modified version, using the same groups of subjects. Thus it could be argued that it was possible for them to have selected particularly able participants in their studies.

This study therefore aims to compare the performance of subjects on the traditional 'Sally-Anne task' (first order theory of mind test) with performance on a simplified version of the task, designed by the author. In order to do this, three matched groups of subjects will be employed: individuals with autism, learning-disabled (but non-autistic) individuals and normally developing individuals. It is hoped that using cartoon drawings, to tell the stories

used in the theory of mind tasks, will aid autistic subjects to focus on only the salient features of the story (rather than being distracted by puppets, a marble etc). Also by representing the story in pictures it means that the actual location of the salient object (e.g. Sally's marble) will not be visibly off-putting.

Those participants passing the first order theory of mind will also be given three different second order theory of mind tasks. The study also aims to compare performance on the traditional 'Ice-Cream Man task' with performance on a simplified cartoon version, designed by the author, and the simplified 'Puppy' task used by Tager-Flusberg and Sullivan (1994a).

Finally, the study aims to compare the use of matching subjects according to either vocabulary or grammar, on their performance on theory of mind tests. If matching subjects on grammatical competence proves more appropriate than on the basis of single word vocabulary, then it is predicted that this will remove any significant differences in performance, between the groups, on the standard theory of mind tasks as well as on the simplified versions of the tasks.

1.8 The Hypotheses

Relating to First Order Theory of Mind Tasks

1. There will be a significant difference in performance between the autistic, learning disabled and normally developing groups (matched on the BPVS) on the 'standard' first order theory of mind task (namely Sally-Anne task).

2. There will be **no** significant difference in performance between the autistic, learning disabled and normally developing groups (matched on the BPVS) on the **'simplified'** first order theory of mind task (namely Ben's Toy Car task).

3. Significantly more autistic subjects will pass the simplified first order theory of mind task than the traditional Sally-Anne task.

Relating to Second Order Theory of Mind Tasks

4. There will be a significant difference in performance between the autistic, learning disabled and normally developing groups (matched on the BPVS) on the 'standard' second order theory of mind task (namely Ice-Cream Man task).

5a. There will be **no** significant difference in performance between the autistic, learning disabled and normally developing groups (matched on the BPVS) on the **'simplified'** Puppy task.

5b. There will be **no** significant difference in performance between the autistic, learning disabled and normally developing groups (matched on the BPVS) on the **'simplified'** Classroom task.

6. Significantly more autistic subjects will pass the simplified Classroom and Puppy tasks than the traditional Ice-Cream Man task.

Relating to Matching Participants on the BPVS or the TROG

7. Matching subjects on the basis of the TROG will remove any significant differences, in performance on a theory of mind task, found between the three participant groups matched on the BPVS.

Relating to Verbal Ability

8. Verbal ability will be significant in subject's performance on the theory of mind tasks.

Chapter 2: METHOD

2.1 Participants

To be included in the study all participants had to have a receptive verbal age of at least 4 years on one of the verbal assessments. Three subject populations participated in this research namely autistic, learning disabled and normally developing children and adolescents.

Autistic

There were 23 participants with autism initially recruited to take part in the study (20 boys and three girls), who had all received a formal diagnosis of autism, and were attending schools for children with autism in Bristol, Bath and Oxford. These subjects were all given the British Picture Vocabulary Scale (BPVS) Long form, (Dunn, Dunn, Whetton & Pintilie, 1982) and the Test for Reception of Grammar (TROG; Bishop, 1983). The BPVS assesses understanding of single words whilst the TROG measures understanding of grammar. Five participants were excluded at this stage from the study because they did not fulfil the criteria of having a receptive verbal age of at least 4 years. A further two participants were later excluded because it was not possible to find matched control subjects. The remaining 16 participants (14 boys and two girls) ranged in age from 5 years 6 months to 14 years 5 months.

Learning Disabled

There were 28 participants with mild-moderate learning difficulties of mixed aetiology (19 boys and nine girls), who were attending special schools in Bristol or Weston-Super-Mare. They ranged in age from 8 years 6 months to 17 years 11 months, and were selected to match the autistic subjects on the BPVS and/or the TROG. Twelve participants were matched, in a pairwise manner, to subjects with autism on the basis of the BPVS and a

further 12 were matched on the TROG. Four learning disabled participants were matched with four autistic subjects on both the BPVS and TROG.

Normally Developing

There were 31 normally developing participants in the study (10 boys and 21 girls), who were all attending a mainstream school in Bath. They ranged in age from 4 years 1 month to 10 years 7 months. Fifteen of these participants were matched with individuals with autism on the basis on the BPVS, 15 were matched on the TROG and one subject was matched on both the BPVS and TROG.

Table 1 shows details of the three participant groups, matched on the British Picture Vocabulary Scale (BPVS), in terms of their chronological and receptive verbal age.

		Autism (n = 16)	**Learning disabled** (n = 16)	**Normally developing** (n = 16)
CA	Mean	11;0	12;11	6;6
	SD	2;5	2;5	2;3
	Range	5;6 - 14;5	8;6 - 17;11	4;1 - 10;7
Verbal age (BPVS)	Mean	6;5	6;5	6;5
	SD	3;0	3;0	3;0
	Range	3;1 - 13;11	3;4 - 13;9	3;3 - 13;9

Table 1. Description of the participant groups: Chronological age (CA) and verbal age as measured by the BPVS

Note. Ages shown in years; months.

Table 2 shows details of the three participant groups, matched on the Test for Reception of Grammar (TROG), in terms of their chronological and receptive verbal age.

		Autism (n = 16)	Learning disabled (n = 16)	Normally developing (n = 16)
CA	Mean	11;0	12;4	5;9
	SD	2;5	2;5	1;0
	Range	5;6 - 14;5	8;6 - 15;4	4;1 - 7;11
Verbal age (TROG)	Mean	6;6	6;5	6;6
	SD	2;5	2;5	2;5
	Range	4;0 - 11;0	3;9 - 11;0	4;0 - 11;0

Table 2. Description of the participant groups: Chronological age (CA) and verbal age as measured by the TROG

Note. Ages shown in years; months.

The learning disabled and normally developing participants were all matched to the subjects with autism, on the basis of receptive verbal age, within 3 months.

2.2 Materials

A portable tape recorder was used to record each child's responses to the theory of mind tasks. The British Picture Vocabulary Scale (BPVS), Long Form (Dunn, Dunn, Whetton & Pintilie, 1982) and the Test for Reception of Grammar (TROG; Bishop, 1983) were used to assess participant's verbal receptive skills. The BPVS was chosen because it has been used predominantly in past research in this area as a means of matching subjects. In addition the TROG was used, since it was hypothesised that this may be a better way to match subjects as theory of mind tasks involve understanding sentences.

Sally-Anne Task: This first order theory of mind task was based on that used by Baron-Cohen *et al.* (1985), and employed two dolls named Sally and Anne, a basket with a lid and a small bag.

Ben's Toy Car Task: This is a first order theory of mind task designed by the author, with a scenario similar to that in the Sally-Anne task, but using a series of eight cartoon drawings with the story written underneath (see Appendix 1A for the drawings).

The Ice-Cream Man Task: This second order theory of mind task was based on that used in Baron-Cohen's (1989) study. A three-dimensional display, representing a village, was constructed in order to act out the scenario for this task. This consisted of a church, a park, John's house, an ice-cream van and two toy people (John and Mary).

The Puppy Task: This second order task was modelled on that designed by Sullivan *et al.* (1994). A three dimensional house was constructed from card with a basement and appropriate props e.g. a small toy puppy, a telephone and dolls for the main characters in the story.

The Classroom Task: This is a second order theory of mind task designed by the author to be similar to the Ice-cream Man task, but involving different characters and locations, and using a series of nine cartoon drawings to tell the story (see Appendix 1B for the drawings).

2.3 Design

The participants in the study were seen on two to four occasions, no more than three weeks apart. On the first occasion they were all assessed using the TROG and/or the BPVS, which were administered in a counterbalanced order. For some children it was necessary to see them twice to administer the verbal tests, due to concentration difficulties. In the next session, children were given the two first order theory of mind tests. Children who passed either one of the first order theory of mind tasks were then given the three second order theory of mind tasks. The order of presentation of the first and second order theory of mind

tasks was counterbalanced, within each participant group, to control for any effects of practice, fatigue and attention. Trios of matched subjects received the theory of mind tasks in same order.

2.4 Procedure

2.4.1 Participant Groups

Autistic Participants

A letter was sent to the Headteachers of nine schools/units for children with autism in Bristol, Bath and Oxford explaining the research and asking whether it would be possible to recruit subjects from the school (see Appendix 2A for a copy of the letter). Three of these schools had suitably able pupils, and agreed to participate in the research. The Headteachers then identified pupils with sufficient verbal ability to participate in the research, and letters were sent home to their parents asking for consent (see Appendix 2B for a copy of the letter).

Children, for whom consent had been given, were seen individually by the author, in a quiet room in their school. In the first session it was explained to the child that he/she would be shown some pictures, and the BPVS and/or the TROG was then administered. Some children were able to complete both the BPVS and TROG in one session, whilst others needed to be seen a second time. Participants with a receptive verbal age of 4 years of more, on either the BPVS or TROG, were then given the theory of mind tasks as outlined in the design. The sessions in which the theory of mind tasks were administered were recorded on tape so that the author did not have to take notes. This also enabled the author to check for any bias in testing such as giving prompts etc. Children were seen on each occasion for a maximum of 20 minutes.

Learning Disabled Participants

A letter was sent to the Headteachers of five schools for children with learning difficulties in Bristol and Weston-Super-Mare (see Appendix 2C), explaining the study, and two schools agreed to participate. Letters were sent home to the parents of about 60 children, who had been identified by the teachers as both willing and able to participate in the study, to obtain consent (see Appendix 2D). Replies giving consent were received from 37 pupils, who were then all seen individually by the author in a quiet room in the school. In the first session participants were given both the BPVS and the TROG, and for 28 pupils their scores on either one or both of these verbal tests matched that of an autistic subject. As with the autistic subjects, these pupils were then seen on another one or two occasions to be given the theory of mind tasks.

Normally Developing Participants

A mainstream school in Bath, with an autistic unit attached, agreed to participate in the study. Letters were sent home to the parents of 162 children explaining the research (see Appendix 2E) and consent was obtained for 52 pupils to take part. The same procedure as for the learning disabled participants was then followed, and 31 children were found to match the autistic participants in terms of their receptive verbal age on the BPVS, TROG or both.

2.4.2 Theory of Mind Tasks

The Sally-Anne Task

The following story was told by the experimenter, whilst the characters were moved accordingly:

> This is Sally and this Anne. This is a bag and there is a basket.
>
> Naming question: '*Which is Sally...and which is Anne?*'
>
> Sally is playing with her marble, but now she wants to go outside to play.
>
> So Sally puts her marble in the bag and then goes outside.
>
> Now Anne takes the marble and she puts it in the basket.
>
> Sally comes back, and she wants to play with her marble.
>
> Belief question: '*Where will Sally look for her marble?*'
>
> Justification question: '*Why?*' (This was only asked if the belief question was answered correctly).
>
> Reality control question: *'Where is Sally's marble really?'*
>
> Memory control question: *'Where did Sally put her marble, in the beginning?'*

To pass this task a subject must say that Sally will look in the bag for her marble (i.e. where she believes it is) or point to that location, and also correctly answer the reality and memory control questions.

Ben's Toy Car Task

The first picture was shown to the participant and the experimenter pointed out Ben, Ben's Mother, the box and the cupboard. The participant was then asked to point to each in turn e.g. "Can you show me the box?" The remaining seven pictures were then shown to the child one at a time. If the participant could read he/she was encouraged to read the story underneath the cartoon pictures, but otherwise the author told the story. At the end of the

story the experimenter told the participant that now Ben wants to play with his toy car and the following questions were asked:

Belief question: '*Where will Ben look for his car?*'

Justification question: *'Why?'* (This was only asked if the belief question was answered correctly).

Reality control question: '*Where is Ben's car really?*'

Memory control question: *'Where did Ben put his car, before he went outside to play?'*

A subject was considered to pass this task if he/she stated that Ben would look in the box for his car (or pointed to this location on the picture, in response to the belief question). A subject was said to fail the task if he/she either indicated that Ben would look in the current location for his car (i.e. in the cupboard) or if they failed to answer either of the control questions correctly.

The Ice-Cream Man Task

The story below was read out, whilst the characters were moved accordingly:

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

Naming question: '*Which is John and which is Mary?*'

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 is 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 here in the park all afternoon.' 'Oh good' says John, 'I'll be back in the afternoon to buy an ice-cream.'

Prompt question (1): '*Where did the ice-cream man say to John that he would be all afternoon?*'

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

Prompt question (2): '*Where did the ice-cream man say he was going?*'

Prompt question (3): '*Did John hear that?*'

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', and off he drives to the church.

Prompt question (4): '*Where did the ice-cream man tell John he was going?*'

Prompt question (5): '*Does Mary know that the ice-cream man has talked to John?*'

So John goes to the church to buy an ice-cream. Now Mary 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 an ice-cream.'

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

Justification question: '*Why?*' (This was only asked if the belief question was answered correctly).

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

Memory control question: '*Where was the ice-cream man in the beginning?*'

If any of the prompt questions were answered incorrectly by a participant, then the correct answer was provided. For example if in response to prompt question (3) the participant stated that John did hear, then the experimenter explained that 'No, John could not have heard because he is in his house.' In order to pass this task the subject had to point to or say the park in response to the belief question, and also correctly answer the reality and memory control questions.

The Puppy Task

The experimenter read out the following story, and the events were enacted using the props:

Tonight it's Peter's birthday and Mum is surprising him with a puppy. She has hidden the puppy in the basement. Peter says, 'Mum, I really hope you get me a puppy for my birthday.' Remember, Mum wants to surprise Peter with a puppy. So instead of telling Peter she got him a puppy Mum says, 'Sorry Peter, I did not get you a puppy for your birthday. I got you a really great toy instead.'

Prompt question (1): '*Did Mum really get Peter a toy for his birthday?*'

Prompt question (2): '*Did Mum tell Peter she got him a toy for his birthday?*'

Prompt question (3): '*Why did Mum tell Peter that she got him a toy for his birthday?*'

Now Peter say to Mum, 'I'm going outside to play.' On his way outside, Peter goes down to the basement to fetch his roller skates. In the basement, Peter finds the birthday puppy! Peter says to himself, 'Wow, Mum didn't get me a toy, she really got me a puppy for my birthday.' Mum did NOT see Peter go down to the basement and find the birthday puppy.

Prompt question (4): '*Does Peter know that his Mum got him a puppy for his birthday?*'

Prompt question (5): '*Does Mum know that Peter saw the birthday puppy in the basement?*'

Now the telephone rings, ding-a-ling! Peter's grandmother calls to find out what time the birthday party is. Grandma asks Mum on the phone, 'Does Peter know what you got him for his birthday?'

Second-order ignorance question: '*What does Mum say to Grandma?*'

Now remember, Mum does not know that Peter saw what she got him for his birthday. Then, Grandma says to Mum, 'What does Peter think you got him for his birthday?'

Second-order false belief question: '*What does Mum say to Grandma?*'

Justification question: '*Why does Mum say that?*' (This was only asked if the second-order false belief question was answered correctly).

If any of the prompt questions were answered incorrectly then the experimenter provided the correct answer. To pass this task the participate had to answer correctly the second order ignorance question, stating that Mum would say 'No', Peter doesn't know what he is getting for his birthday. In addition participants had to answer the second-order false belief question correctly, by saying that Mum would say 'a toy.'

The Classroom Task

The first picture was shown to the participant and the experimenter pointed out Tom, Jane, the teacher, the drawers and the store cupboard. The participant was then asked to point to each in turn e.g. "Can you show me the teacher?" The remaining eight pictures were then shown to the child one at a time. The story shown below, which accompanies the pictures, was read out and various questions were asked:

Tom and Jane are in the classroom. Tom has finished his painting.

Tom puts his painting in his drawer.

Tom goes outside to play.

Prompt question (1): '*Where did Tom put his painting?*'

'Oh dear' says the teacher, 'Tom's painting will not be dry.'

So the teacher goes to Tom's drawer and takes out Tom's painting.

The teacher puts Tom's painting in the store cupboard to dry.

Then Jane goes outside to play.

Prompt question (2): '*Where did the teacher put Tom's painting?*'

Prompt question (3): '*Did Tom see the teacher put his painting there?*'

Tom and Jane are in the playground. Jane says to Tom 'Your painting was not dry, so the teacher put it in the store cupboard.'

Prompt question (4): '*Where did Jane tell Tom the teacher had put his painting?*'

Prompt question (5): '*Did the teacher hear Jane talking to Tom?*'

Tom and Jane are back in the classroom. The teacher says, 'It is time to go home. Tom do not forget to take your painting'.

Belief question: '*Where does the teacher think Tom will look for his painting?*'

Justification question: '*Why?*' (This was only asked if the belief question was answered correctly).

Reality control question: '*Where will Tom really look for his painting*'

Memory control question: '*Where did Tom put his painting at the beginning of the story?*'

If any of the prompt questions were incorrectly answered then the experimenter provided the correct answer. To pass this task subjects had to answer the belief question correctly, by saying that the teacher thinks Tom will look for his painting in the drawer or by pointing to the drawer. In addition subjects had to answer correctly the reality and memory control questions.

2.4.3 Response Coding of the Justification Questions

Participants who correctly answered the belief question, in any of second order theory of mind tasks, were asked to justify their responses. The responses given to the justification questions were then coded into categories, based on those used by Perner and Wimmer

(1985) and Sullivan *et al.* (1994). In the Ice-Cream Man task the justification question 'why?' (i.e. does Mary think John has gone to the park to buy an ice-cream) was asked. In the Puppy task the following justification question was asked: 'why does Mum say that?' (i.e. say to Grandma that Peter thinks he is getting a toy for his birthday). In the classroom task the justification question 'why?' (i.e. does the teacher think Tom will look in his drawer for his painting) was asked.

The categories were divided into two groups:

1. ***Appropriate justifications***: These all demonstrated that the participant was aware of what one character does or does not know about the other character's knowledge of events or relevant information.

    a) *Explicit second order reasoning:* the participant refers explicitly to both characters' beliefs. For example in the Ice-Cream Man task: "Mary doesn't know that John knows where the ice-cream man is" e.g. Puppy task: "Mum does not know that Peter knows what he is getting for his birthday" e.g. Classroom task: "The teacher doesn't know that he knows".

    b) *Implicit second order reasoning:* the participant implicitly refers to both characters' beliefs. For example in the Ice-Cream Man task: "She didn't hear the ice-cream man tell John he was going to the church" e.g. Puppy task: "His mum doesn't know that he's found the puppy" e.g. Classroom task: "The teacher didn't tell him she'd moved the painting and she doesn't think Jane told him".

    c) *Communicated information:* Information about the salient object (namely the Ice-cream van or the puppy/toy) or its location is communicated to the secondary

character (namely John or Peter). For example in the Ice-Cream Man task: "The ice-cream man told John he would stay in the park" e.g. Puppy task: "Mum told Peter that he was getting a toy".

d) *Location:* The original location of the salient object (i.e. the ice-cream van or the painting) is mentioned. For example in the Ice-Cream Man task: "Because the ice-cream man was in the park" e.g. Classroom task: "Because first his painting was in there and then he went out to play."

e) *Deception:* In the Puppy task reference is made to Mum trying to deceive Peter about his birthday present e.g. "Because Mum wanted to surprise Peter".

2. ***Inappropriate justifications:*** The other categories were designated inappropriate because they did not indicate that the participant understood which information was relevant.

a) *First-order reasoning:* Irrelevant knowledge of the main character (i.e. Mary, Mum or the teacher) is mentioned. For example in the Ice-Cream Man task: "Mary knows the ice-cream van is at the church" e.g. Puppy task: "Mum knows Peter isn't getting a toy" e.g. Classroom task: "The teacher knows his painting is in the cupboard".

b) *Story facts/ nonsense:* Facts that may be correct or incorrect are mentioned or nonsensical, irrelevant or novel information is mentioned. For example in the Ice-Cream Man task: "John went home to get his money" e.g. Puppy task: "For his birthday" e.g. Classroom task: "Because it wasn't dry".

Chapter 3: RESULTS

3.1 Statistical Analyses

Pearson chi-square test was predominantly used in the analysis of the data, since the data is categorical and the observations are independent. Chi-square, however, may not be a valid statistical test when the expected frequencies are too small. It is generally accepted that, in contingency tables, all cells must have an expected frequency of at least one and no more than 20 per cent of cells should have an expected frequency of less than five in order to use chi-square. Where these assumptions are violated, in a contingency table containing two rows and two columns, then Fisher's Exact probability test can be used reliably. It should be noted, however, that Camilli and Hopkins (1978) demonstrated that even with small expected frequencies the chi-square test produces few Type I errors (i.e. incorrectly rejecting the null hypothesis), as long as the total sample size is greater than seven.

3.2 Summary of Results for Theory of Mind Tasks

Table 3 shows the numbers of participants in each group (matched on the BPVS), who passed and failed each of the theory of mind tests.

Theory of mind tasks	**Autistic**		**Learning disabled**		**Normally developing**	
	Pass	*Fail*	*Pass*	*Fail*	*Pass*	*Fail*
First order tasks						
Sally-Anne	6	10	10	6	13	3
Ben's toy car	10	6	11	5	14	2
Second order tasks						
Ice-Cream Man	1	15	2	14	8	8
Puppy	3	13	3	13	9	7
Classroom	3	13	4	12	10	6

Table 3. Participant's performance (matched on the BPVS) on the theory of mind tasks.

The results in Tables 3 are represented graphically below in Figure 1.

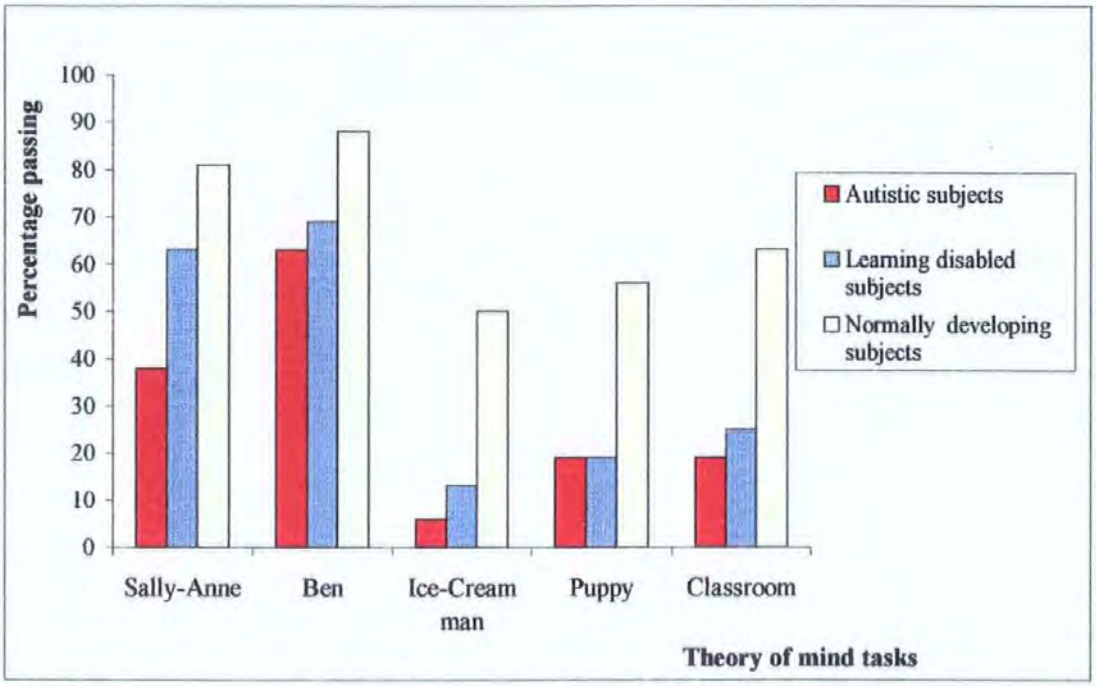


Figure 1. Percentage pass rates on the theory of mind tasks of participant groups matched on the BPVS.

Table 4 shows the numbers of participants in each group (matched on the TROG), who passed and failed each of the theory of mind tests.

Theory of mind tasks	**Autistic**		**Learning disabled**		**Normally developing**	
	Pass	*Fail*	*Pass*	*Fail*	*Pass*	*Fail*
First order tasks						
Sally-Anne	6	10	6	10	14	2
Ben's toy car	10	6	7	9	15	1
Second order tasks						
Ice-Cream Man	1	15	4	12	6	10
Puppy	3	13	3	13	7	9
Classroom	3	13	4	12	12	4

Table 4. Participant's performance (matched on the TROG) on the theory of mind tasks.

The results in Tables 4 are represented graphically below in Figure 2.

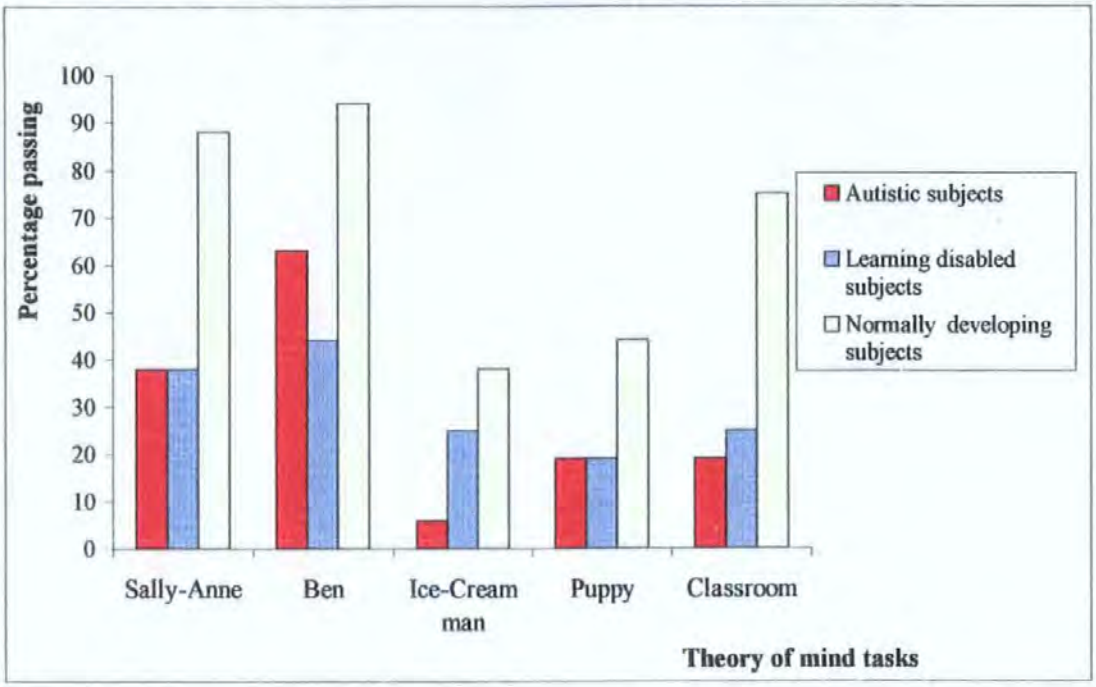


Figure 2. Percentage pass rates on the theory of mind tasks of participant groups matched on the TROG

As can been seen in the graphs, there is a definite trend (in each participant group) for more subjects to pass the 'simplified' Ben task than the standard Sally-Anne task. This improvement in performance is greatest for the autistic subjects. Similarly there is a general trend for more participants to pass the 'simplified' Puppy and Classroom tasks than the standard Ice-Cream task.

3.3 First Order Theory of Mind Tasks

Sally-Anne Task

All the participants correctly answered the naming question. All the participants, except for one learning disabled child, correctly answered the reality control question, saying that the ball was really in the basket at the end of the scenario. In addition, all but one autistic and one learning disabled child passed the memory control question, correctly stating that Sally had put her marble in the bag at the beginning of the story.

For the three participant groups matched on the BPVS, 38 per cent of the autistic, 63 per cent of the learning disabled and 81 per cent of the normally developing subjects passed the Sally-Anne task. For those matched on the TROG, 38 per cent of the autistic and learning disabled subjects and 88 per cent of the normally developing subjects passed this task (see Figures 1 and 2). Three participants who failed this task did so due to incorrectly answering one of the control questions (as mentioned above). The majority of subjects who failed this task, however, did so because of failing the belief question. All the participants who failed the belief question did not take account of Sally's false belief, and stated that she would look for her marble in the basket where it really was.

Hypothesis 1: A Pearson chi-square analysis showed that there was a significant difference between the three participant groups (i.e. autistic, learning disabled and normally developing), matched on the BPVS, in terms of their performance on the Sally-Anne task **($\chi^2 = 6.45$, d.f. = 2, p = .04)**, thereby confirming Hypothesis 1. There was, however, no significant difference between the performance of the autistic subjects and those with a learning disability on the Sally-Anne task **($\chi^2 = 2.0$, d.f. = 1, p = .16).**

Ben's Toy Car Task

For the autistic, learning disabled and normally developing groups (matched on the BPVS) 63 per cent, 69 per cent and 88 per cent of subjects passed the Ben task respectively. Whilst for those participants matched on the TROG, 63 per cent of the autistics, 44 per cent of the learning disabled and 94 per cent of the normally developing subjects passed this task (see Figures 1 and 2). All the participants correctly answered the reality control question. One autistic participant failed this task by incorrectly answering the memory control question, whilst the rest all failed because of answering the belief question wrongly by stating that Ben would look in the cupboard for his toy car.

Hypothesis 2: A Pearson chi-square analysis showed that there was no significant difference between the autistic, learning disabled and normally developing subjects (matched on the BPVS) in their performance on the Ben task **($\chi^2 = 2.74$, d.f. = 2, p = .25)**, thereby confirming Hypothesis 2. It should be noted that for this Pearson chi-square analysis the assumptions have been violated, since three cells (50 per cent) have an expected count of 4.33 (i.e. less than five).

A Fisher's Exact test was therefore calculated for the autistic and normally developing groups only, and it showed that there was no significant difference between these two participant groups on the Ben task **(p = .11).** The number of learning disabled subjects who passed this task fell between the number of autistic and number of normally developing subjects who passed. It can therefore be assumed that there will also be no significant difference in performance between the autistic and learning disabled subjects, and between the learning disabled and normally developing subjects. These results help to substantiate the finding of the chi-square analysis, that there was no significant difference between the three participant groups on the Ben task.

Comparison Between the First Order Tasks

Hypothesis 3: Thirty-eight per cent of the autistic participants passed the Sally-Anne task, whilst 63 per cent passed Ben's toy car task. This difference did not reach significance on a chi-square test **($\chi^2 = 2.0$, d.f. = 1, p = .16)**, thereby not proving Hypothesis 3 to be true.

3.4 Second Order Theory of Mind Tests

All the participants in the study were given the first order theory of mind tests, however if a subject failed both of these tests it was assumed that they would not pass the more complex second order tests, which were therefore not administered.

Ice-Cream Man Task

All the participants, except for one learning disabled subject, correctly answered the reality and memory control questions. Four learning disabled and seven normally developing subjects incorrectly answered at least one of the prompt questions. In these cases the experimenter provided the correct answers to the prompt questions, and these subjects were not considered to fail the task provided they correctly answered the control and belief questions. All the participants, who failed the belief question, said that Mary would think John had gone to the church to buy his ice-cream (i.e. where John had really gone) and did not take account of Mary's false belief.

For the autistic, learning disabled and normally developing groups (matched on the BPVS) 6 per cent, 13 per cent and 50 per cent of subjects passed this task respectively. Whilst for those subjects matched on the TROG, 6 per cent of the autistic participants, 25 per cent of the learning disabled and 38 per cent of the non learning disabled participants passed the Ice-Cream Man task (as shown in Figures 1 and 2).

Hypothesis 4: A Pearson chi-square analysis showed that there was a highly significant difference between the three participant groups (matched on the BPVS) in terms of their performance on the Ice-Cream Man task **(χ^2 = 10.14, d.f. = 2, p = .006)**, thereby confirming Hypothesis 4. It should be noted that for this Pearson chi-square analysis the assumptions have been violated, since three cells (50 per cent) has an expected count of less than five. As mentioned earlier, however, the chances of incorrectly rejecting the null hypothesis in this case are small. In addition, from observation of the graph there is clearly a large difference in performance between the normally developing subjects and the other two participant groups. Fisher's Exact test showed that there was no significant difference between the autistic and learning disabled subjects' performance on this task **(p = .50).**

Puppy Task

There were six autistic, six learning disabled and three normally developing participants who answered one or two of the prompt questions incorrectly. As with the Ice-Cream Man task, provided these subjects correctly answered the ignorance and false belief questions they were not considered to fail this task. All the participants who failed this task did so because of incorrectly answering the second order false belief question. The vast majority of those that failed said, that Mum would say to Grandma, that Peter thought he was getting a puppy/dog for his birthday (i.e. they did not take account of the fact that Mum believes that Peter thinks he is getting a toy).

On the Puppy task, 19 per cent of both the autistic and the learning disabled participants and 56 per cent of the normally developing participants (matched on the BPVS) passed. For the groups matched on the TROG, 19 per cent of the autistic and learning disabled and 44 per cent of the normally developing participants passed this task (as shown in Figures 1 and 2).

Hypothesis 5a: A Pearson chi-square analysis showed that there was a significant difference between the three participant groups (matched on the BPVS) in their performance on this task (**$\chi^2 = 6.98$, d.f. = 2, p = .03**), thereby not confirming Hypothesis 5a. There was, however, no significant difference between the performance of the autistic and learning disabled participants on this task **(Fisher's exact test, p = .5).**

Classroom Task

Apart from three normally developing children, who failed the reality control question, all the participants correctly answered the memory and reality control questions. One autistic, one learning disabled and two normally developing participants failed one of the prompt

questions. These participants' answers to the prompt questions were corrected, and they were not considered to fail the task provided they correctly answered the belief and control questions. All the participants, who failed the belief question, incorrectly answered that the teacher would think that Tom would look in the cupboard for his painting. Whilst both the teacher and Tom know his painting is in the cupboard, the teacher does not know that Tom knows where his painting is.

For those participants matched on the BPVS, 19 per cent of the autistic, 25 per cent of the learning disabled and 63 per cent of the normally developing subjects passed this task. For the autistic, learning disabled and normally developing participants (matched on the TROG) 19 per cent, 25 per cent and 75 per cent of subjects passed respectively (as shown in Figures 1 and 2).

Hypothesis 5b: A Pearson chi-square analysis showed that there was a significant difference in performance on this task, between the three participant groups matched on the BPVS **($\chi^2 = 7.83$, d.f. = 2, p = .02)**, thereby not confirming Hypothesis 5b. There was, however, no significant difference between the performance of the autistic and learning disabled participants on this task **(Fisher's exact test, p = .5).**

Comparison Between the Second Order Tasks

Hypothesis 6: For the autistic participants, 6 per cent passed the Ice-Cream Man task, 19 per cent passed the Puppy task and 19 per cent passed the Classroom task. The difference between performance on the Puppy or Classroom task as compared with performance on the Ice-Cream Man task did not reach significance, on Fisher's exact test **(p = .5).**

Post-hoc analysis: From observation of the results there appears to be a large difference in the performance of the normally developing participants (matched on the TROG) on the Ice-Cream Man and Classroom tasks. A chi-square analysis showed that significantly more normally developing participants passed the Classroom task than the Ice-Cream Man task **($\chi^2 = 4.57$, d.f. = 1, p = .03).**

3.5 Matching Participants on the Basis of the BPVS or TROG

The majority of participants in the study were given two tests of verbal age, namely the BPVS and the TROG. In addition a large number of children were screened to see whether they fulfilled the criteria to be included in the study, and whether their score on one of the verbal tests matched that of an autistic participant. Figure 3 below shows the verbal ages on the BPVS and TROG of all those children who were given both verbal tests.

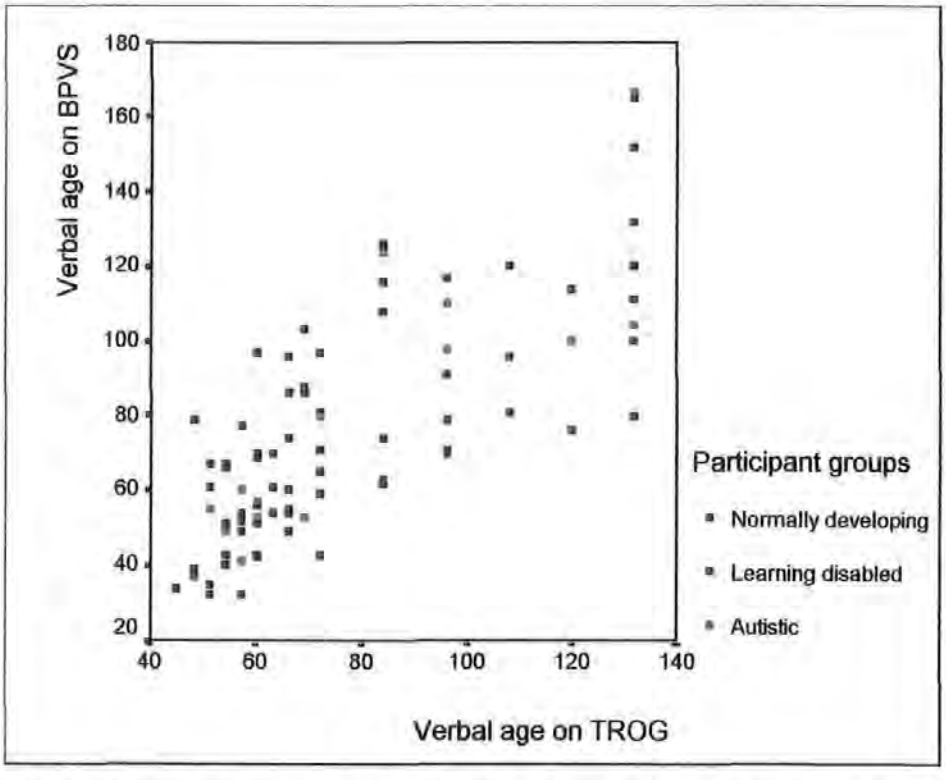


Figure 3. Verbal age as assessed on the BPVS against verbal age as assessed on the TROG for all children.

As can be seen in the graph there is a linear relationship between verbal age on the TROG and on the BPVS. Some children, however, scored much higher on the BPVS than the TROG whilst for others the reverse was true. Pearson's correlation was calculated for all the individuals who were administered both the BPVS and TROG, and it was found that there was a significant correlation between scores on the two verbal tests **($r = 0.734$, $p < .01$, one-tailed).**

Hypothesis 7: Since a significant difference in performance on the Sally-Anne task was found between the three participant groups, matched on the BPVS, the analysis was repeated for those participants matched on the TROG. A Pearson chi-square analysis showed that there was also a significant difference between the three participant groups, matched on the TROG, in terms of their performance on the Sally-Anne task **($\chi^2 = 10.74$, d.f. = 2, $p = .005$)**.

There was no significant difference in performance between the three participant groups, matched on the BPVS, on the Ben task. In addition, when matched on the TROG, there was no significant difference in performance between the autistic and normally developing subjects on this task, Fishers exact test **($p = .08$).**

As a significant difference in performance on the Ice-Cream Man task was found between the three participant groups, matched on the BPVS, the analysis was repeated for those subjects matched on the TROG. A Pearson chi-square analysis showed that there was no significant difference between the three participant groups, matched on the TROG, in their performance on the Ice-Cream Man task **($\chi^2 = 4.48$, d.f. = 2, $p = .11$).** It should be noted that for this Pearson chi-square analysis the assumptions have been violated, since three cells (50 per cent) have an expected count of less than five. Observation of Figure 2,

however, shows little difference between the participant groups on this task, especially when compared with the results shown in Figure 1.

Similarly, as a significant difference in performance on the Puppy task was found between the three participant groups, matched on the BPVS, the analysis was repeated for those subjects matched on the TROG. A Pearson chi-square analysis again showed that there was no significant difference between the three participant groups, matched on the TROG, in their performance on this task **($\chi^2 = 3.38$, d.f. = 2, p = .19).** It should be noted that for this Pearson chi-square analysis the assumptions have been violated, since three cells (50 per cent) has an expected count of less than five. Observation of Figure 2, however, shows little difference between the participant groups on this task, especially when compared with the results in Figure 1.

Lastly, as a significant difference in performance on the Classroom task was found between the three participant groups, matched on the BPVS, the analysis was repeated for those subjects matched on the TROG. A Pearson chi-square analysis showed that there was also a significant difference between the three participant groups, matched on the TROG, in their performance on this task **($\chi^2 = 12.72$, d.f. = 2, p = .002).**

3.6 Verbal Ability and Theory of Mind Performance

Table 5 below shows the mean age of subjects, for each participant group matched on the BPVS, who passed and failed each theory of mind task. The results for participants matched on the TROG show a very similar pattern (see Appendix 3).

Theory of Mind Tasks	Mean verbal age (on BPVS)					
	Autism		*Learning disabled*		*Normally developing*	
	'passers'	'failers'	'passers'	'failers'	'passers'	'failers'
Sally-Anne	7;11	5;7	7;4	5;0	7;0	3;11
Ben	7;2	5;3	7;5	4;4	6;9	4;3
Ice-Cream Man	13;11	6;0	9;7	6;0	7;7	5;4
Puppy	10;5	5;7	10;9	5;5	8;3	4;2
Classroom	10;5	5;7	9;9	5;4	7;10	4;2

Table 5. Mean age (years; months) of 'passers' and 'failers' in each participant group on each theory of mind task.

The table shows that on all the theory of mind tasks, for each participant group, the mean verbal age on the BPVS is higher for those subjects that passed as compared with those that failed. In addition, it can be seen that the mean verbal age of autistic subjects passing the Ben task is lower than for those passing the Sally-Anne task. Also for the autistic subjects, the mean verbal age of passing the Ice-Cream Man task is higher than that of the Puppy or Classroom tasks.

Hypothesis 8: Considering the three participant groups together (matched on the BPVS), independent samples t-tests showed that there was a significant difference in verbal age between those passing and those failing the Sally-Anne task **($t = -2.67$, d.f. = 46, $p = .01$, two-tailed)**; the Ben task **($t = -2.58$, d.f. = 46, $p = .01$, two-tailed)**; the Ice-Cream Man task **($t = -2.90$, d.f. = 46, $p = .01$, two-tailed)**; the Puppy task **($t = -5.47$, d.f. = 46, $p < .01$, two-tailed)** and the Classroom task **($t = -4.91$, d.f. = 46, $p < .01$, two-tailed).** Verbal age is, therefore, a significant factor in subject's performance on the theory of mind tasks, thereby confirming Hypothesis 8.

3.7 Contingency Between Tasks

Since the trends, in terms of contingency between various theory of mind tasks, were found to be very similar for the participants matched on the BPVS and those matched on the TROG it was decided to present the combined data for all participants.

Table 6 shows the number of subjects passing both, neither or either one of the first order theory of mind tasks.

Sally-Anne and Ben tasks (Passes)	**Autistic**	**Learning disabled**	**Normally developing**	*Total*
Both	5	13	27	*45*
Neither	5	13	3	*21*
Sally-Anne only	1	0	0	*1*
Ben only	5	2	1	*8*

Table 6. Contingency table for the Sally-Anne and Ben tasks.

Table 6 provides further evidence for the trend that the Ben task was easier for participants (especially with autism) than the Sally-Anne task. Since eight children passed the Ben task, but failed the Sally-Anne task, whilst only one child showed the opposite response pattern.

Table 7 shows the number of subjects passing both, neither or either one of the Classroom and Ice-Cream Man second order tasks.

Ice-Cream Man and Classroom tasks (Passes)	**Autistic**	**Learning disabled**	**Normally developing**	*Total*
Both	1	3	12	*16*
Neither	13	20	7	*40*
Ice-Cream Man only	0	2	2	*4*
Classroom only	2	3	10	*15*

Table 7. Contingency table for the Ice-Cream Man and Classroom tasks.

Similarly table 7 provides further evidence that the Classroom task was easier for subjects than the Ice-Cream Man task, since 15 children passed the Classroom task but failed the Ice-Cream Man task, whilst only four children showed the opposite response pattern.

Table 8 shows the number of subjects passing both, neither or either one of the Classroom and Puppy second order tasks.

Puppy and Classroom tasks (Passes)	**Autistic**	**Learning disabled**	**Normally developing**	*Total*
Both	3	4	15	*21*
Neither	13	22	8	*43*
Puppy only	0	0	1	*1*
Classroom only	0	2	7	*9*

Table 8. Contingency table for the Puppy and Classroom tasks.

Finally, it would appear from the above table that the Classroom task was also easier for participants than the Puppy task, since nine children passed the Classroom task but failed the Puppy task, whilst only one child showed the opposite response pattern.

There appeared to be little difference in difficulty between the Puppy and Ice-Cream Man task, since overall eight participants passed the Puppy task only (and failed the Ice-Cream Man) whilst five participants showed the opposite response pattern.

3.8 Justification Question Responses

As outlined in the method, subjects were asked to justify their correct answers to the belief questions in the second order theory of mind tasks and these justifications were then coded. Appendix 4A shows all the justification question responses and coding, for each

theory of mind task. A table showing the frequency of each type of justification is shown in Appendix 4B. As can be seen in the table in Appendix 4B, not one participant gave an explicit second order justification, and only 25 per cent of responses given were categorised as implicit second order. These results are summarised in Table 9 below.

Theory of mind tasks and justifications	**Autistic**		**Learning disabled**		**Normally developing**	
	Freq.	%	Freq.	%	Freq.	%
Ice-Cream Man task						
Total appropriate	1	100	4	80	6	43
Total inappropriate	0	0	1	20	8	57
Puppy task						
Total appropriate	3	100	2	67	16	89
Total inappropriate	0	0	1	33	2	11
Classroom task						
Total appropriate	2	67	5	83	13	58
Total inappropriate	1	33	1	17	9	42

Table 9. Summary of justification question responses for each second order task.

The number of autistic subjects passing the second order theory of mind tasks is small, however, they appear to be no worse at appropriately justifying their answers than the learning disabled or normally developing participants.

Chapter 4: DISCUSSION

In the following discussion, the aims of the study will be reviewed briefly and then the results will be discussed in relation to the hypotheses and relevant literature. It should be noted that the results and verbal ages quoted will refer to the BPVS (unless otherwise stated), since this is the verbal test that has most commonly been used in past research, and will therefore allow comparisons to be made with previous findings. This chapter will conclude with a critique of the study and consideration of the implications for future research, theory and practice.

4.1 Review of the Aims

The main aim of the study was to provide evidence that individuals with autism do have a theory of mind, but that the standard tests used in a number of previous studies need to be simplified for this population in order for their ability to show.

A further aim was to show that language ability is significant in terms of theory of mind task performance, and that matching participants in terms of their understanding of grammar (rather than single word understanding) would be more appropriate, due to the nature of the theory of mind tasks.

4.2 The First Order Theory of Mind Tasks

Sally-Anne Task

As predicted, there was a significant difference between the three participant groups (i.e. the autistic, learning disabled and normally developing subjects), on the standard first order theory of mind task, called the Sally-Anne task. This replicates a large body of past research, where failure on this and similar first order theory of mind tasks has been taken

to show that individuals with autism have a deficit in theory of mind (as discussed in Section 1.3 of the introduction).

Baron-Cohen *et al.* (1985), in their original study, found that 20 per cent of the autistic participants, 86 per cent of the learning disabled and 85 per cent of the normally developing participants passed the Sally-Anne task. In comparison, in this study 38 per cent of the autistic, 63 per cent of the learning disabled and 81 per cent of the normally developing participants passed the Sally-Anne task. The verbal ages of the autistic children in the current study were, however, slightly higher in comparison to those of the children included in Baron-Cohen *et al.'s* (1985) study. The lower age limit, in both Baron-Cohen *et al.*'s and the current study were very similar (2 years 8 months and 3 years 1 month respectively) however the upper age limits differed (7 years 5 months and 13 years 11 months respectively). Selecting, therefore, only the autistic children in the current study with a verbal age less than 7 years 5 months it was possible to make a more precise comparison. It was then found that 30 per cent of the autistic children passed the Sally-Anne task, which is similar to Baron-Cohen *et al.'s* finding. The number of normally developing subjects who passed the Sally-Anne task in the current study is also comparable to that found in previous research.

Regarding the learning disabled subjects, it is of interest to note that a higher percentage passed the Sally-Anne task in Baron-Cohen *et al.'s* study than in the current study (86 per cent and 63 percent respectively). This is even more significant when one considers that in Baron-Cohen *et al.'s* study the learning disabled subjects all had verbal ages less than 4 years, whilst in the current study all the participants had verbal ages greater than 4 years. This discrepancy in findings cannot be attributed to degree of learning disability, since the

groups in both studies were very similar in terms of chronological age, so it is likely that the participants in Baron-Cohen *et al.'s* (1985) study were more learning disabled.

Baron-Cohen *et al.*, and a number of other studies with similar results, employed learning disabled participants solely with Down Syndrome, whilst in the current study subjects' learning disabilities were of mixed aetiology. It may be, therefore, that individuals with Down Syndrome do not have the same difficulty with theory of mind as other learning disabled children. Individuals with Down syndrome have a unique profile, in that typically their cognitive abilities are more developed than their verbal abilities, and they show relative strengths in certain aspects of their attentional, social and emotional abilities, as compared with autistic individuals (Beeghly, Weiss-Perry & Cicchetti, 1990; Dodd, 1975; Kasari, Mundy, Yirmiya & Sigman, 1990; Mundy, Sigman, Kasari & Yirmiya, 1988; Rohr & Burr, 1978). It may be that these strengths have contributed to the better performance of Down syndrome subjects in past research. In comparison, several studies which have employed learning disabled individuals without Down syndrome, have found this participant group to be significantly worse than mental age matched normally developing children, on both first and second order theory of mind tasks (e.g. Benson *et al.*, 1993; Sodian & Frith, 1992.)

Ben's Toy Car Task

As predicted, contrary to prior research, there was no significant difference in performance between the autistic, learning disabled and normally developing participants (matched on the BPVS) on the simplified first order theory of mind task, known as the Ben task. Other studies have found no significant difference in performance, between autistic and learning disabled control subjects, on the standard first order theory of mind task (Oswald & Ollendick, 1989; Tager-Flusberg & Sullivan, 1994b; Yirmiya & Shulman, 1996.) Prior *et*

al. (1990) also found no significant difference between autistic and learning disabled participants on the Sally-Anne task, when they used real people to act out the scenario instead of dolls. A thorough literature review has, however, not revealed any other study that has found autistic participants to perform similarly to normally developing participants, on a first order theory of mind task.

This finding suggests that the modifications made, to the standard Sally-Anne task, had an effect on the performance of the autistic subjects. It is important to note, however, the difficulty in proving a null hypothesis. The changes were designed to focus the attention of the autistic children more on the story. They also prevented the actual location of the salient object (in this case Ben's car) from being a distraction, when the belief question was asked. From observations made during testing, it did appear that the autistic children were better able to concentrate on the Ben task than the Sally-Anne task, since during the Sally-Anne task a number of children wanted to play with the marble or open the bag and basket. In addition, when the belief question was asked in the Sally-Anne task ('where does Sally think her marble is?') a number of children opened up the basket, revealing the actual location of the marble. It would seem, from this behaviour, that the actual location of the marble was distracting for participants.

It is not possible to determine which of the modifications made to the Sally-Anne task might have aided the performance of autistic participants. The fact that 'simplifying' the standard first order theory of mind task may remove any significant differences in performance, between autistic subjects and matched controls, suggests that individuals with autism do have a theory of mind, and that previous research findings are the result of a task artefact.

Comparison Between the Two First Order Tasks

Autistic Participants

It was predicted that significantly more autistic subjects would pass the Ben task than the Sally-Anne task. It should be noted that whilst nearly double the number of autistic children passed the Ben task, as compared with the Sally-Anne task, this difference did not reach statistical significance. There are, however, a number of factors that indicate that the Ben task was easier for autistic children than the Sally-Anne task. Firstly, from the contingency results, it was found that five autistic children passed the Ben and failed the Sally-Anne task, whilst only one showed the opposite response pattern. Secondly, examining the data on verbal age and performance on the theory of mind tasks, it was noted that the mean age of autistic children passing the Ben task was 9 months lower than that of those participants passing the Sally-Anne task. Finally, it is of note that the least verbally able autistic child to pass the Sally-Anne task had a verbal age of nearly 4½ years, whilst one autistic participant passed the Ben task with a verbal age just over 3 years.

Non-autistic Participants

The modifications made to the standard first order task were specifically aimed at simplifying it for autistic subjects. There was, however, also a trend with the learning disabled and normally developing groups for a few more subjects to pass the Ben task than the Sally-Anne task. This difference was very small, which may partly be attributable to the fact that overall these groups were performing near ceiling level on the first order theory of mind tasks.

Wimmer and Perner (1983) in their original study found, in a group of normally developing subjects, that none of 3-4 year olds, 57 per cent of the 4-6 year olds and 86 per cent of 6-9 year olds passed the Sally-Anne task. In the current study, since overall the

normally developing subjects performed near ceiling level, it might be that examining the younger children will reveal some difference in performance on the Sally-Anne and Ben tasks. This was found to be the case, that the trend of more normally developing participants passing the Ben than the Sally-Anne task, was only apparent in the youngest age group, as shown in Table 10 below.

Theory of Mind Task	Percentage passing (in each age group)		
	4-5 years	5-6 years	>6 years
Sally-Anne Task	50	90	100
Ben Task	67	90	100

Table 10. Pass rates of different aged normally developing children, on the first order theory of mind tasks.

Other studies have shown that even some 3 year olds can pass first order theory of mind tasks (Hogrefe, Wimmer & Perner, 1986; Tager-Flusberg & Sullivan, 1994b). It might be the case that the difference in performance on the Sally-Anne and Ben tasks, in the current study, would be greater still in a group of 3 year olds.

4.3 The Second Order Theory of Mind Tasks

Ice-Cream Man Task

As predicted there was a significant difference in performance between the three participant groups in terms of their performance on the Ice-Cream Man task. In the current study, 6 per cent of the autistic, 13 per cent of the learning disabled and 50 per cent of the normally developing subjects passed this task. Baron-Cohen (1989) in his original study, selected only those participants who had passed a first order theory of mind task, and

found that none of the autistic, 60 per cent of the learning disabled and 90 per cent of the normally developing subjects passed the Ice-Cream Man task.

In the current study, selecting out only those participants that passed one of the first order theory of mind tasks (i.e. 11 autistic, 11 learning disabled and 14 normally developing subjects), allows a better comparison to be made with Baron-Cohen's (1989) study. It was found that this made little difference to the percentage pass rates on the second order task, with 9 per cent of the autistics, 18 per cent of the learning disabled and 57 per cent of the normally developing then passing the Ice-Cream Man task.

It is surprising that whilst the autistic group in Baron-Cohen's (1989) study were older and verbally more able, in comparison to the current study, none of them passed the second order task. It should be noted that in the current study the 9 per cent of autistic subjects to pass this task, only represents one participant. There is also an apparent discrepancy in the performance of the learning disabled participants, between Baron-Cohen's study and the current one (60 per cent and 18 per cent of subjects passed respectively). In Baron-Cohen's study the learning disabled participants did not differ significantly in their performance from the normally developing participants on the Ice-Cream Man task. Whilst in this study the learning disabled group and the autistic group did not differ significantly in their performance on this task. This finding is more remarkable when one considers that, although the learning disabled subjects in each study were of a similar age, in the current study they were more verbally able. This difference in results, across the two studies, may again be attributable to the fact that in Baron-Cohen's study the learning disabled group consisted only of individuals with Down syndrome.

In the current study, whilst the autistic subjects' performance was significantly worse than the normally developing subjects on the Ice-Cream Man task, there was no significant difference in performance between the autistic and learning disabled participants. A number of more recent studies have reported similar results, in so far as finding no significant difference between learning disabled subjects and those with autism or Asperger's syndrome, in their ability to attribute second order beliefs (Bowler, 1992; Ozonoff, Rogers & Pennington, 1991; Tager-Flusberg & Sullivan, 1994a).

Simplified Puppy and Classroom Tasks

It was predicted that there would be no significant difference between the three participant groups (on the BPVS) on either of the simplified second order tasks (i.e. the Puppy and Classroom tasks), however, this was not found to be the case. This difference in performance could be due to matching the subjects on the basis of the single word understanding rather than on comprehension of grammar (see later discussion in Section 4.4).

Puppy Task

Nineteen per cent of both the autistic and learning disabled subjects and 56 per cent of the normally developing subjects passed the Puppy task. In comparison, Tager-Flusberg and Sullivan (1994a), who were the first to employ the Puppy task with individuals with autism, found that 58 per cent of the autistic and 67 per cent of the learning disabled subjects passed this task. Tager-Flusberg and Sullivan (1994a) found a much higher percentage of both autistic and learning disabled subjects passed the Puppy task than in the current study, but this can be attributed to their participants being older and verbally more able. In line with the current study they found no significant difference between the autistic

and learning disabled participants on this task. They did not include a normally developing control group, so it is not possible to make a comparison in this respect.

Classroom Task

In the current study, 19 per cent of the autistic, 25 per cent of the learning disabled and 63 per cent of the normally developing subjects passed the Classroom task. These pass rates are similar to those found for the Puppy task in this study, with a slightly higher percentage (though not significantly) of learning disabled and normally developing subjects passing the Classroom task. There was found to be no significant difference in performance between the autistic and learning disabled participants, on the Classroom task.

Comparison Between the Three Second Order Tasks

Autistic Participants

It was predicted that significantly more autistic subjects would pass the simplified Puppy and Classroom tasks than the standard Ice-Cream Man task. It should be noted that whilst three times the number of autistic children passed the Puppy and Classroom tasks, as compared with the Ice-Cream Man task, the numbers involved were very small and this difference did not reach statistical significance.

There are a few indications that the Classroom and Puppy tasks were slightly easier for autistic children than the Ice-Cream Man task. Firstly, from the contingency results it was found that two autistic children passed the Classroom and Puppy tasks but failed the Ice-Cream Man task, whilst none showed the opposite response pattern. Also examining the data on verbal age and performance on the theory of mind tasks, it was noted that the autistic participant who passed the Ice-Cream Man task was 3½ years older than the mean age of autistic children passing the Puppy or Classroom. In addition, it is of note, that the

one autistic child to pass the Ice-Cream Man task had a verbal age of nearly 14 years, whilst the least verbally able participant to pass the Puppy and Classroom tasks had a verbal age of just over 8 years.

Non-autistic Participants

The modifications made to the standard second order task were specifically aimed at simplifying it for autistic subjects. There was also a trend with the learning disabled and normally developing groups for a few more subjects to pass the Puppy and Classroom tasks than the Ice-Cream Man task. It was also found that significantly more normally developing subjects passed the Classroom than the Ice-Cream Man task when matched on the TROG. Considering the contingency data, it is of particular interest that 10 normally developing subjects passed the Classroom task, but failed the Ice-Cream Man task, and only two showed the opposite response pattern. In addition seven normally developing subjects passed the Classroom task but failed the Puppy task and only one showed the opposite response pattern.

Sullivan *et al.* (1994), who designed the Puppy task, employed it with normally developing 4-8 year olds. They found that significantly more subjects were able to pass this simplified version of a second order task (which included prompts and fewer characters, episodes and scenes) than passed the standard task. In addition, previous studies have found that normally developing children were not able to pass second order theory of mind tasks until the age of 6-7 years, however, on the Puppy task 40 per cent of the participants under the age of five succeeded. Similarly, considering the younger normally developing participants in the current study, it was found that 17 per cent of those under the age of five passed Ice-Cream and Puppy task whilst a striking 50 per cent passed the Classroom task.

Justification Question Responses

This study showed that the autistic subjects were no worse than the other two participant groups at appropriately justifying their answers, to the false belief question, in the second order theory of mind tasks. Tager-Flusberg and Sullivan (1994a) reported similar findings.

Perner and Wimmer (1985) and Baron-Cohen (1989) found in their studies that all the children who correctly answered the false belief question were able to appropriately justify their responses. In contrast, in the current study between 13 and 45 per cent of participants across the groups, failed to give appropriate justifications for their correct answers to the false belief question, on a theory of mind task. It is important to note that the participants with autism did not give the highest percentage of inappropriate justifications. Tager-Flusberg and Sullivan (1994a) also found a number of children, who passed their Puppy task, gave inappropriate justifications for their responses.

Consistent with Bowler's (1992) findings, in the current study none of the subjects, in any group, explicitly referred to the beliefs of both characters in their justification responses. In both Bowler's and the current study, it was found that the majority of justification responses were categorised as either 'location' or 'communicated information.' Bowler hypothesised that certain features of the scenarios used, in the second order tasks, focus the subject's attention on non-mental explanations, and that the justifications given tend to centre on the point in the story at which the false belief was set up. For example in the Ice-Cream Man task a large number of subjects stated that at the beginning of the story the Ice-Cream Man was in the park, or that he said he would be there all afternoon. Bowler (1992) found support for this theory in a further study in which the false belief, that was set up in the mind of one of the protagonists about the other one's belief, was caused by an

unintentional act. This led subjects to give an increased number of justifications that made a reference to the beliefs of one or both of the characters in the story.

4.4 Verbal Ability and Theory of Mind Task Performance

Matching on the Basis of the BPVS or the TROG

It was predicted that matching subjects on the basis of the TROG would remove any significant differences, in performance on a theory of mind task, found between the three participant groups matched on the BPVS. It was believed that matching subjects on the basis of their understanding of grammar would be more appropriate, considering the nature of the theory of mind tasks, than matching them according to single word understanding. It was found that when subjects were matched on the TROG, there was no significant difference between the three participant groups on either the Ice-Cream Man or Puppy tasks. This is a surprising finding considering the huge difference in performance, found in past research, between autistic subjects and matched controls on second order theory of mind tasks. It needs to be interpreted with caution, however, because of the difficulty in proving a null hypothesis.

Tager-Flusberg and Sullivan (1994a, b) appear to be the only other researchers, to date, to have matched subjects according to their comprehension of grammar, using a sub-test of the Clinical Evaluation of Language Fundamentals (CELF). Tager-Flusberg and Sullivan (1994a) found no significant difference between the autistic and learning disabled groups on the Puppy task. In addition, Tager-Flusberg and Sullivan (1994b) found that subject's performance on the CELF was a better predictor of theory of mind performance than the PPVT (an older version of the BPVS, which assesses single word understanding).

There was still a significant difference between the three participant groups, on the Sally-Anne task, when matched on the TROG. This may be due to an inherent problem with the task, in terms of the props causing a distraction, and the true location of the salient object being overriding, as previously discussed. It could also be the case that matching subjects more appropriately on the TROG only has an impact on the second order theory of mind tasks, as these require subjects to have a better understanding of language, since they use more complex grammar than the Sally-Anne task.

This explanation is not entirely consistent with the current findings, as there was still a significant difference in performance between the three participant groups, on the Classroom task, when matched on the TROG. This remaining difference seems attributable to the good performance of the normally developing subjects on this task. One of the differences between the Classroom task and the other two second order tasks, is that the former had the story written out underneath the pictures, whilst in the other tasks the story was read out by the experimenter. Participants were encouraged to read the story out loud, for the Classroom task, if they were able to do so. It may be that more of the normally developing children, than those in the other two participant groups, were able to read and that this disproportionately helped the former in passing the Classroom task. On re-examining the data, however, this was not found to be the case in that similar proportions of subjects in each group (between 60 and 80 per cent) were able to read out loud.

Verbal Age of 'Passers' and 'Failers'

As predicted, verbal ability was a significant factor in subject's performance on the theory of mind tasks. There was a significant difference in verbal age between those participants passing and failing on all the theory of mind tasks. This finding is consistent with a large

body of research, which has also found a link between verbal ability and theory of mind task performance (as described in Section 1.4 of the introduction.)

There appears to be substantial support from a number of studies for a developmental cognitive explanation of the deficiencies shown by autistic children, in that once a certain level of language ability has been acquired, a theory of mind is more likely to also develop. A certain level of language ability is, however, not sufficient for success on theory of mind tasks. Since a number of children in the current study, with a verbal age greater than 6 years, were still unable to pass the theory of mind tasks. Also, Leslie and Frith (1988) and Perner *et al.* (1989) employed specific language impaired children as controls in their studies, and found that such children were significantly better than autistic children (matched on the basis of the BPVS) on false belief tasks. It may be the case that matching autistic children on the BPVS does not give a true representation of their ability, due to their difficulties with grammar and the pragmatics of language.

4.5 Summary of the Main Significant Findings

- There was no significant difference in performance between the autistic, learning disabled and normally developing children (matched on the BPVS) on the Ben task. When matched on the TROG, there was also no significant difference in performance between the autistic and normally developing children on the Ben task. These results demonstrate that if the theory of mind task is simplified for autistic children, then they may perform similarly to age matched control subjects.

- There was no significant difference in performance between the autistic and learning disabled participants (whether matched on the BPVS or on the TROG) on any of the

theory of mind tasks. This evidence suggests that any difficulties autistic subjects have with theory of mind is attributable to their learning difficulty, rather than to having autism per se. This may be as a result of, not only cognitive problems, but also concentration and language difficulties. It is of interest to note that individuals with Asperger's syndrome who, by definition whilst socially impaired are not cognitively impaired and do not have delayed language, have been found to perform equally to normally developing children on second order theory of mind tasks (Bowler, 1992; Dahlgren, & Trillingsgaard, 1996; Ozonoff, Rogers & Pennington, 1991).

- There was a significant difference between the three participant groups on the Ice-Cream Man and Puppy tasks when matched on the BPVS. When matched on the TROG, however, there was no significant difference between the three groups on these second order tasks.

- The participants with autism were as able to appropriately justify their answers to the belief question, on the second order tasks, as subjects in the other two participant groups.

- Verbal age was found to be a significant factor in theory of mind task performance.

- Considering the normally developing children under 5 years of age, it was shown that more of them passed the 'simpler' first and second order tasks than the equivalent 'standard' tasks.

4.6 The Critique

Participants

There were 16 subjects in each participant group, which is relatively few, and ideally it would have been better to have larger sample sizes. Since autism is a fairly rare disorder it was not possible to recruit more participants within the scope of this piece of research. In addition, if it had been possible to include more autistic subjects in the study it would have compromised the ability to match the control groups so closely, especially on two verbal tests.

There were very few autistic subjects who passed the second order theory of mind tasks, and so it would have been preferable to include a larger number of higher ability autistic subjects. Since only six participants with autism had a verbal age greater than 7 years, which is the age at which children normally develop an understanding of second order theory of mind. Similarly, it would have been interesting to include a younger group of normally developing children (aged 3-4 years), not only to avoid the near ceiling effect found on the first order tasks, but also to discover whether this would lead to an increased difference in performance on the Ben and Sally-Anne tasks.

It is worth noting that while all the participants with autism were attending schools specifically for children with autism, all had at some stage been given a formal diagnosis, it was not known what criteria were used to make this diagnosis. This is one difficulty faced when comparing results across studies, which have employed children with autism, since different studies have used different diagnostic and selection criteria.

The participants in the study were all recruited via a letter, which was sent home to their parents, asking for consent for their child to take part. Whilst it is unlikely to have affected the results overall, one needs to be aware that this means of recruitment could potentially lead to a biased sample. Since Noll, Zeller, Vannatta, Bukowski and Davies (1997) found that children who did not return consent forms were systematically different from classmates who did participate, although the differences were small.

Theory of Mind Tasks

An important point, in relation to the theory of mind tasks, is that this study is the first to employ the Ben and Classroom tasks and therefore the reliability and validity of these tasks is yet to be tested. In order to do this, it would be necessary either to repeat the tasks with the same subjects at a later date, or to give the same participants a number of versions of these tasks (i.e. using different characters and locations) at the same point in time.

Design

In this study the author was also responsible for collecting all the data and was therefore not blind to the study, in so far as knowing which participant group children were in and which were the 'simplified' and which the 'standard' tasks. There is, therefore, a potential for bias in terms of how the tasks were administrated and evaluated. The sessions in which participants were given the theory of mind tasks were all tape-recorded. This allowed the author to check for potential bias in administration of the tasks, for example giving hints or extra encouragement. Ideally, it would have course been preferable to have an experimenter that was blind to the aims of the study.

Lastly, it is worth noting that one must always be cautious when using multiple statistical tests on the same data set. Due to probability, and therefore potentially by chance alone,

one in 20 statistical tests may show a significant result. The chi-square analyses conducted in this study, however, were all related to a priori hypotheses and also were used across differing data sets.

4.7 Implications for Future Research, Theory and Practice

It will be important to replicate the findings in this study, especially considering the issues of reliability and validity that have already been raised. In addition, it would be useful to repeat the study employing subjects with a wider range of ability, in order to avoid the near floor effect with the autistic participants on the second order tasks, and the near ceiling effect for the normally developing children on the first order tasks.

A number of other hypotheses have been raised, within this study, that further research could help to clarify. For example whether children with Down syndrome perform better on theory of mind tasks than other learning disabled children and also whether subjects who are able to read the story on the 'simplified' theory of mind tasks are aided in their performance.

This study provides further evidence for the role of verbal ability in theory of mind task performance. A study conducted by Leslie and Frith (1988) found that specific language impaired children were significantly better than autistic subjects on theory of mind tasks. In the light of the current findings, that matching subjects on the TROG removes some of the group differences on second order tasks, it would be important to repeat Leslie and Frith's (1988) study but matching subjects on the basis of the TROG.

The findings in this study also provide support for the salient object hypothesis, which states that people with autism have difficulty disengaging from a salient object (as

discussed in Section 1.4 of the introduction.) Hughes and Russell (1993) found that autistic subjects failed a test of strategic deception, because of a difficulty with disengaging from a focal object, rather than due to an inability to implant a false belief into the mind of the competitor. Since the autistic participants found the task equally difficult when the competitive element was removed, Hughes and Russell hypothesised that the children and adolescents with autism were failing to disengage their attention from an object that is both desired by them and the focus of the task.

The inability to disengage from a salient object seems too simplistic an explanation to account for the many and varied features of autism. In addition, this was just one aspect of Hughes and Russell's (1993) task, which also required the ability to form a plan. The ability to plan, control impulses and inhibit a prepotent but irrelevant response are all components of executive functions, which have been thought to be impaired in autism (see Section 1.6 of the introduction). The explanation that autism is due to a disorder of the executive functions would be strongly supported by evidence that early frontal impairment results in later autism. The findings, however, are contradictory (Price, Daffner, Stowe & Mesulam, 1990; Welsh, Pennington, Ozonoff, Rouse & McCabe, 1991). There is other evidence that supports this explanation of autism. Firstly, the commonalities between frontal patients and individuals with autism have been well documented (Damasio & Maurer, 1978; Fein, Pennington, Markowitz, Braverman & Waterhouse, 1986; Rumsey, 1985). Secondly, an impairment of executive functions can offer an explanation of other central features of autism, besides the triad of impairments, e.g. stereotypies, excessive desire for sameness and repetitive interests in very narrow topics (Kanner, 1943; Prior & Macmillan, 1973). These other features of autism all involve perseveration in some form, which is also linked to frontal lobe damage. Lastly, a large number of studies have shown that autistic subjects and those with Asperger's syndrome perform poorly, in comparison to

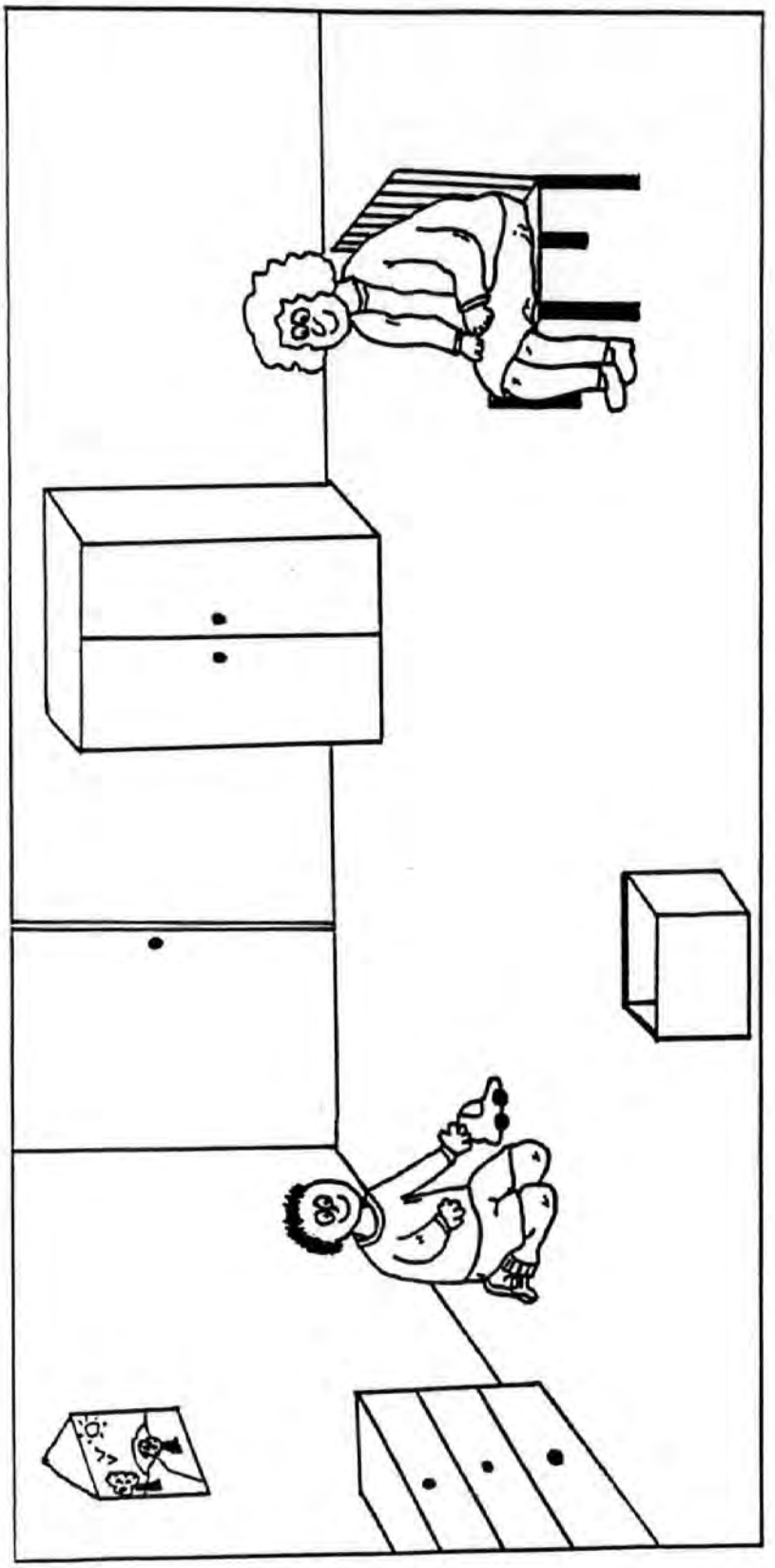
matched controls, on standard tests of executive function (as discussed in Section 1.6 of the introduction).

To conclude, the findings of this study suggest individuals with autism can demonstrate that they have a theory of mind and, in addition, any deficit in this ability is not specific to autism. Past research, which has found that autistic subjects perform worse on theory of mind tasks than matched controls, is more likely to have been the result of the type of theory of mind test employed and due to inappropriately matching subjects on the basis of single word understanding. It will be important in the future, therefore, that research is more focused on other theories of autism, and that especially the executive function explanation is given greater consideration. Lastly, this piece of research has implications for practice, in terms of interventions with individuals with autism focussing less on theory of mind. Instead people need to be more aware of how tasks are presented to individuals with autism and the limitations of their verbal understanding, executive functions, poorer concentration and distractibility.

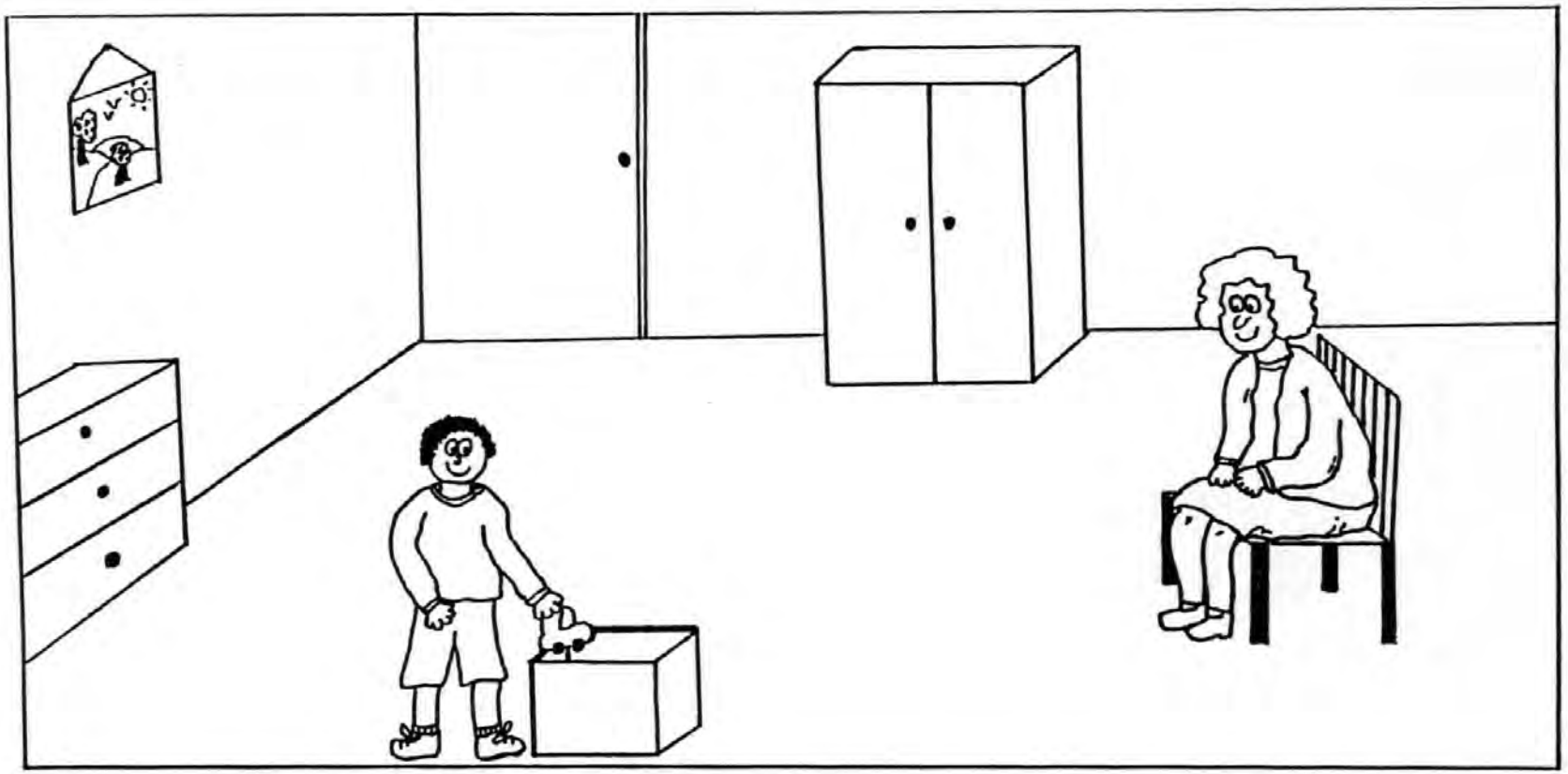
CONTENTS OF APPENDICES

Appendix 1A

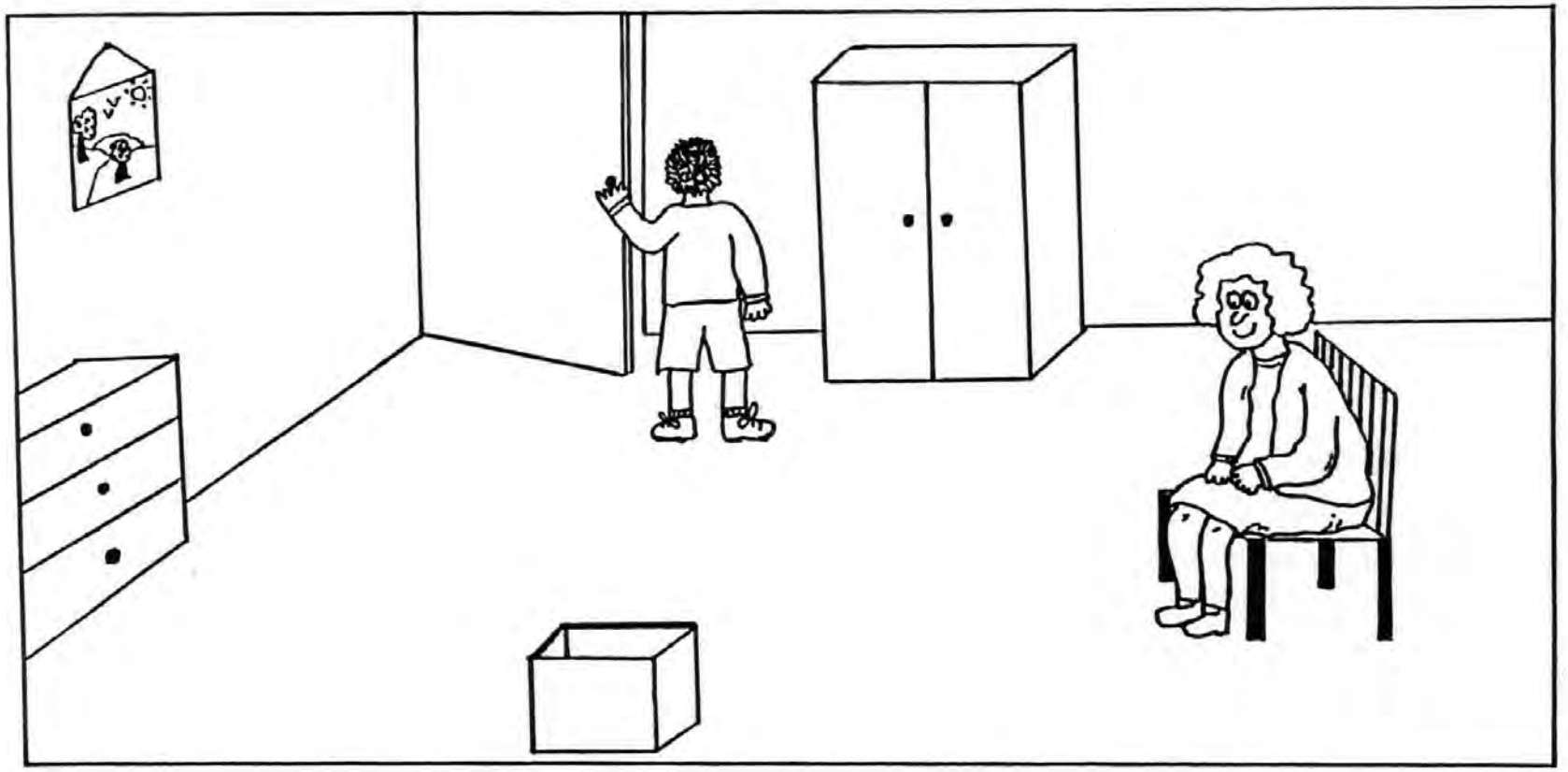
Drawings for Ben's Toy Car Task



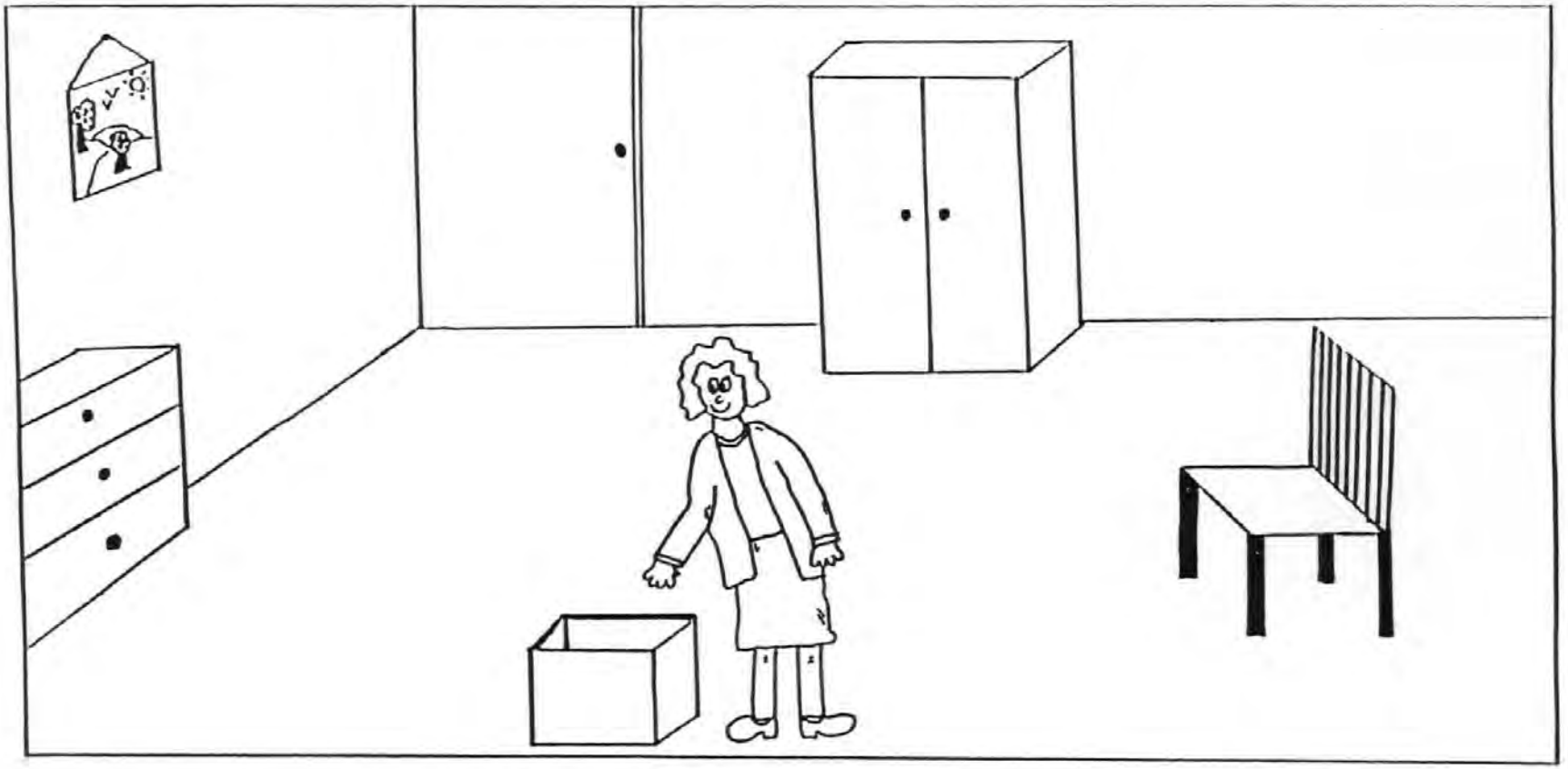
Ben is playing with his toy car.



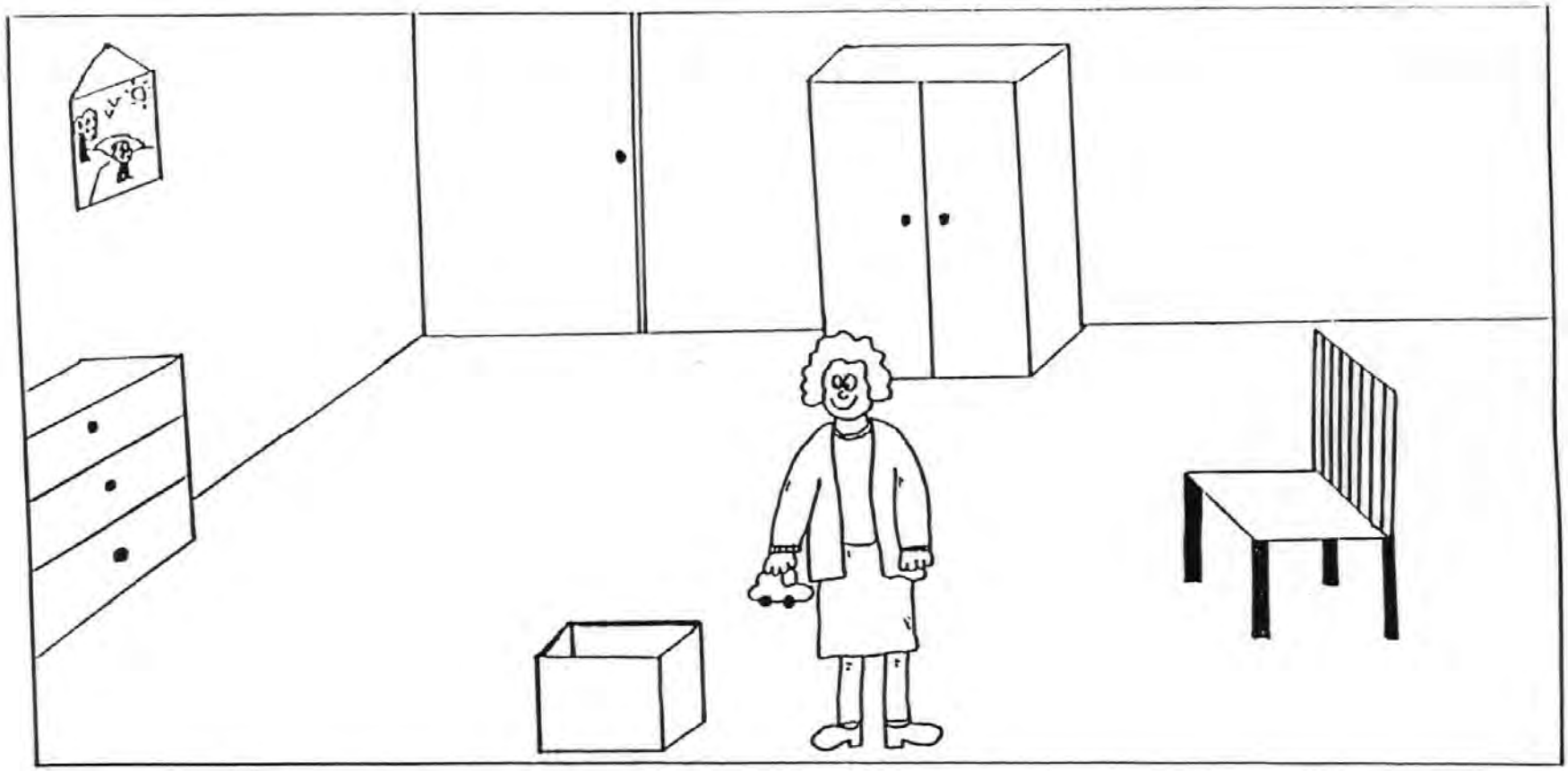
Ben puts his car in the box.



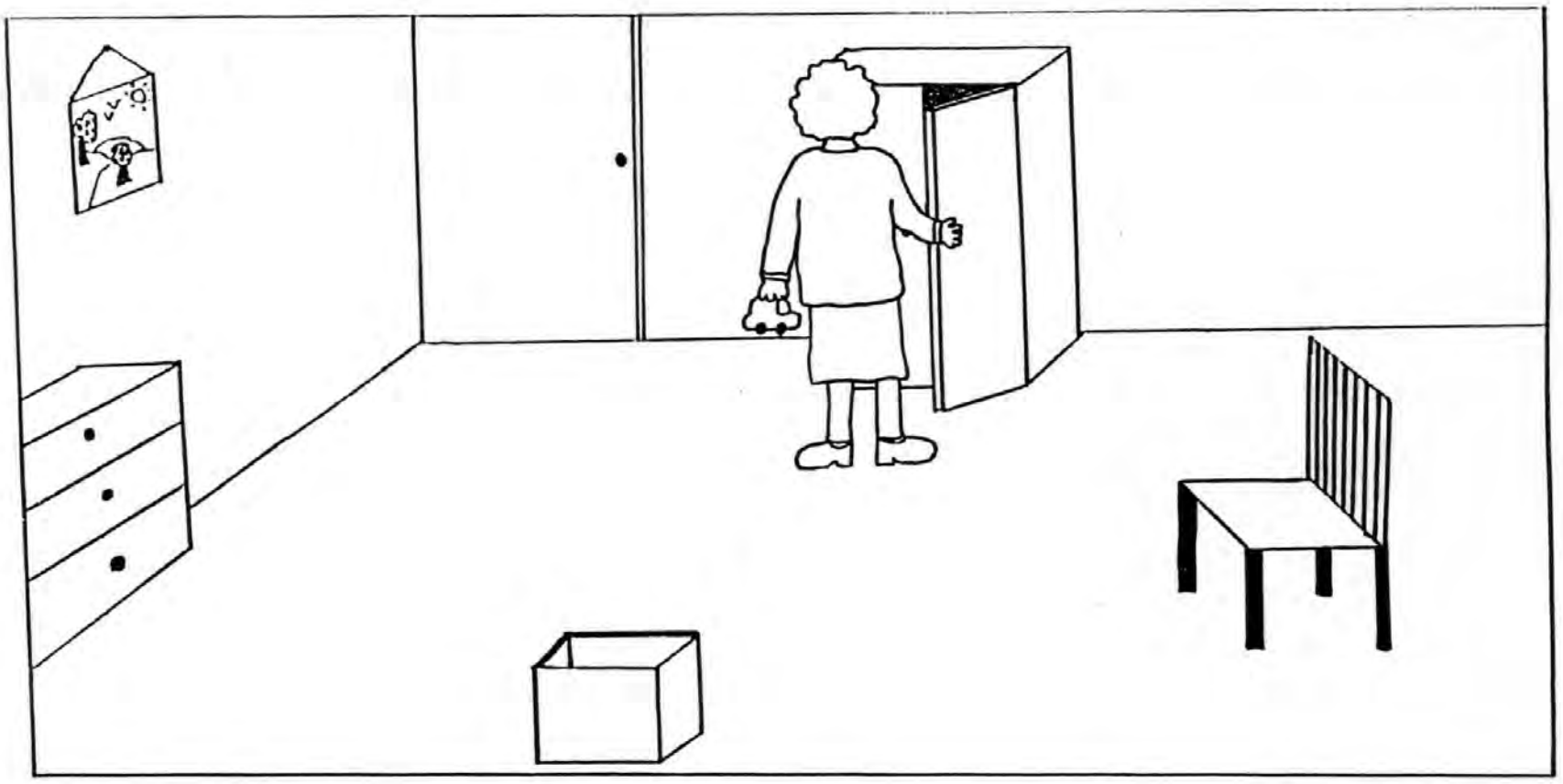
Ben then goes outside to play.



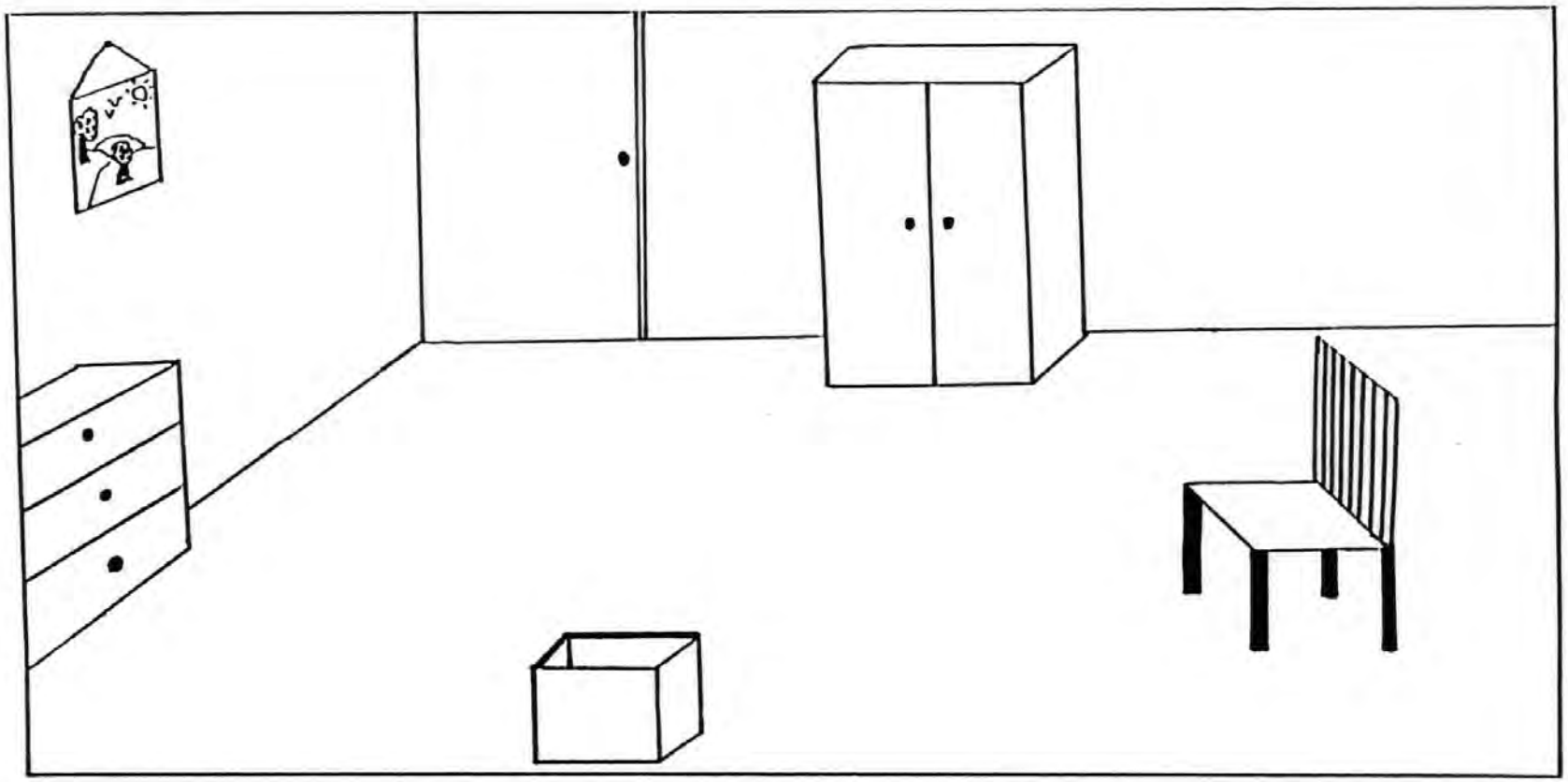
Ben's mother goes to the box.



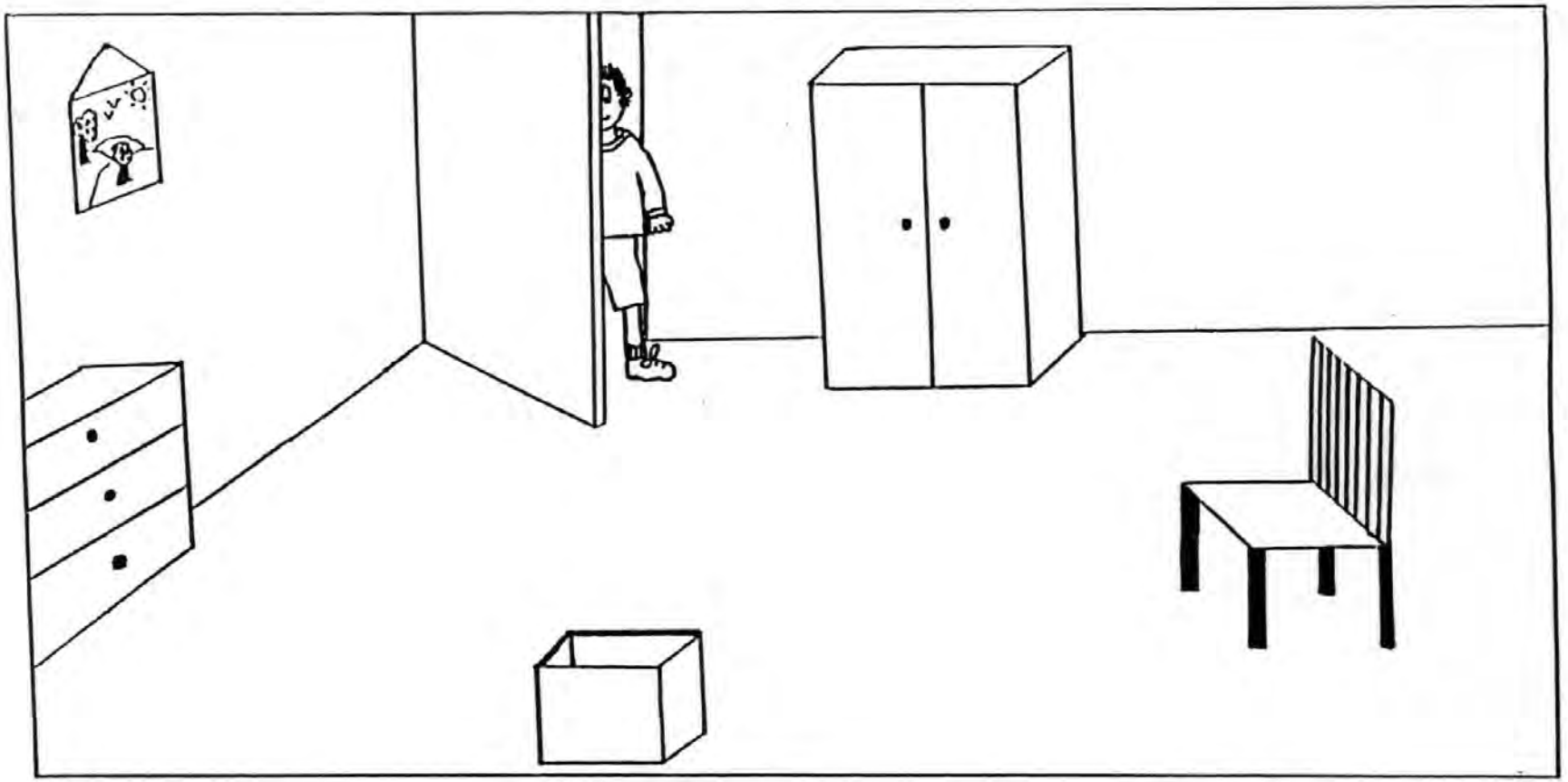
Ben's mother takes the toy car out of the box.



Ben's mother puts the car in the cupboard.



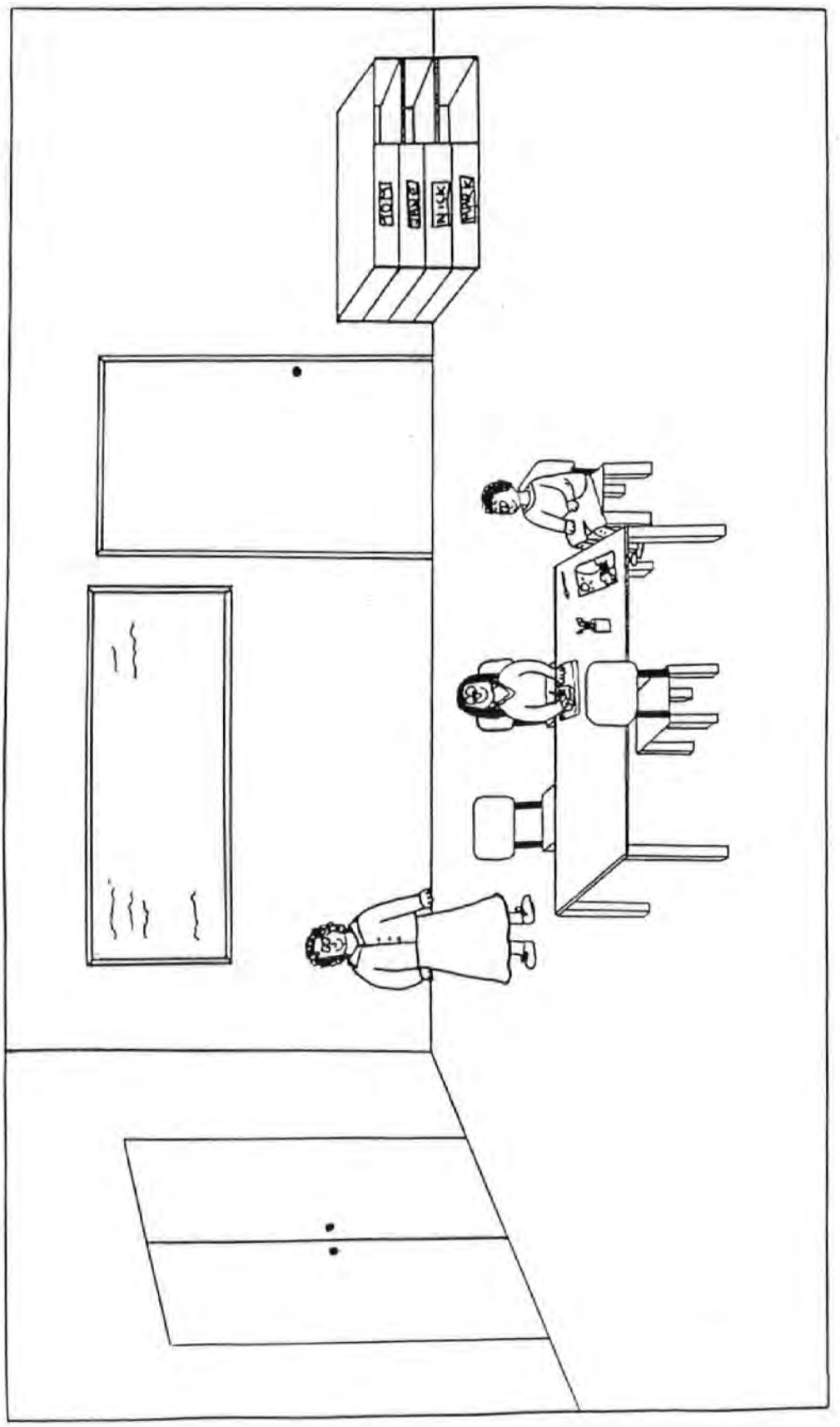
Ben's mother then goes to the kitchen.



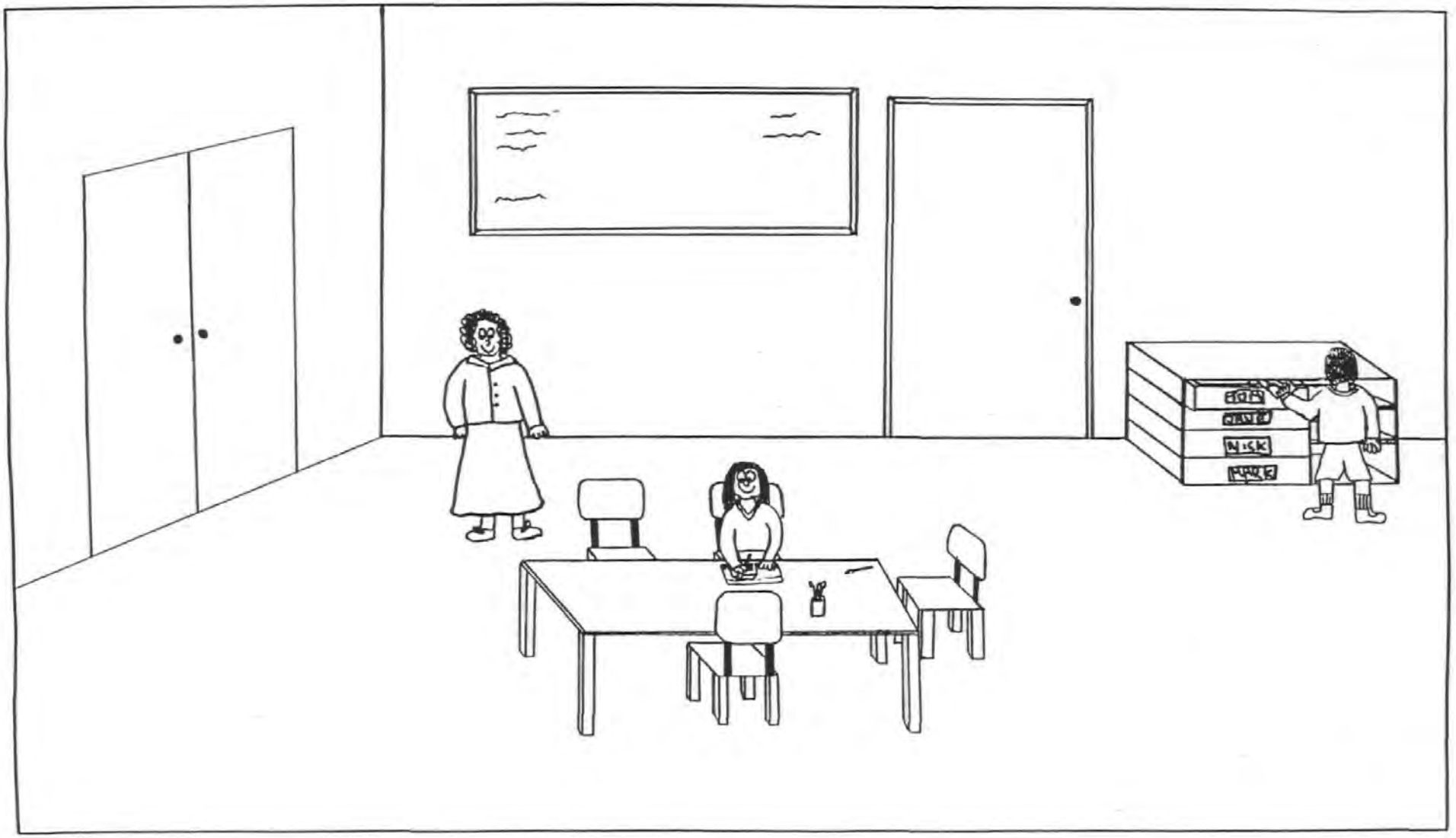
Ben comes back inside.
Ben wants to play with his car.

Appendix 1B

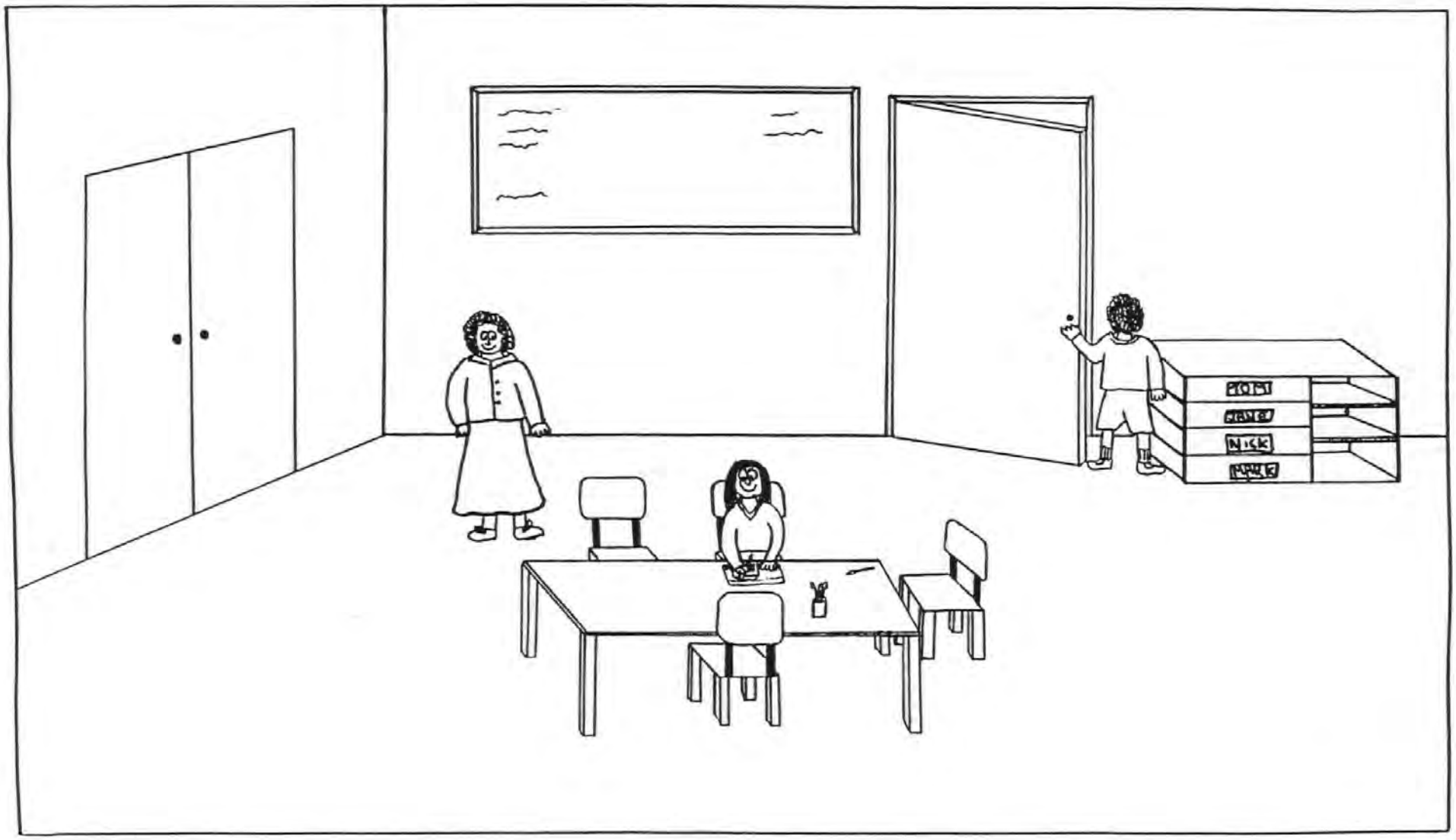
Drawings for the Classroom Task



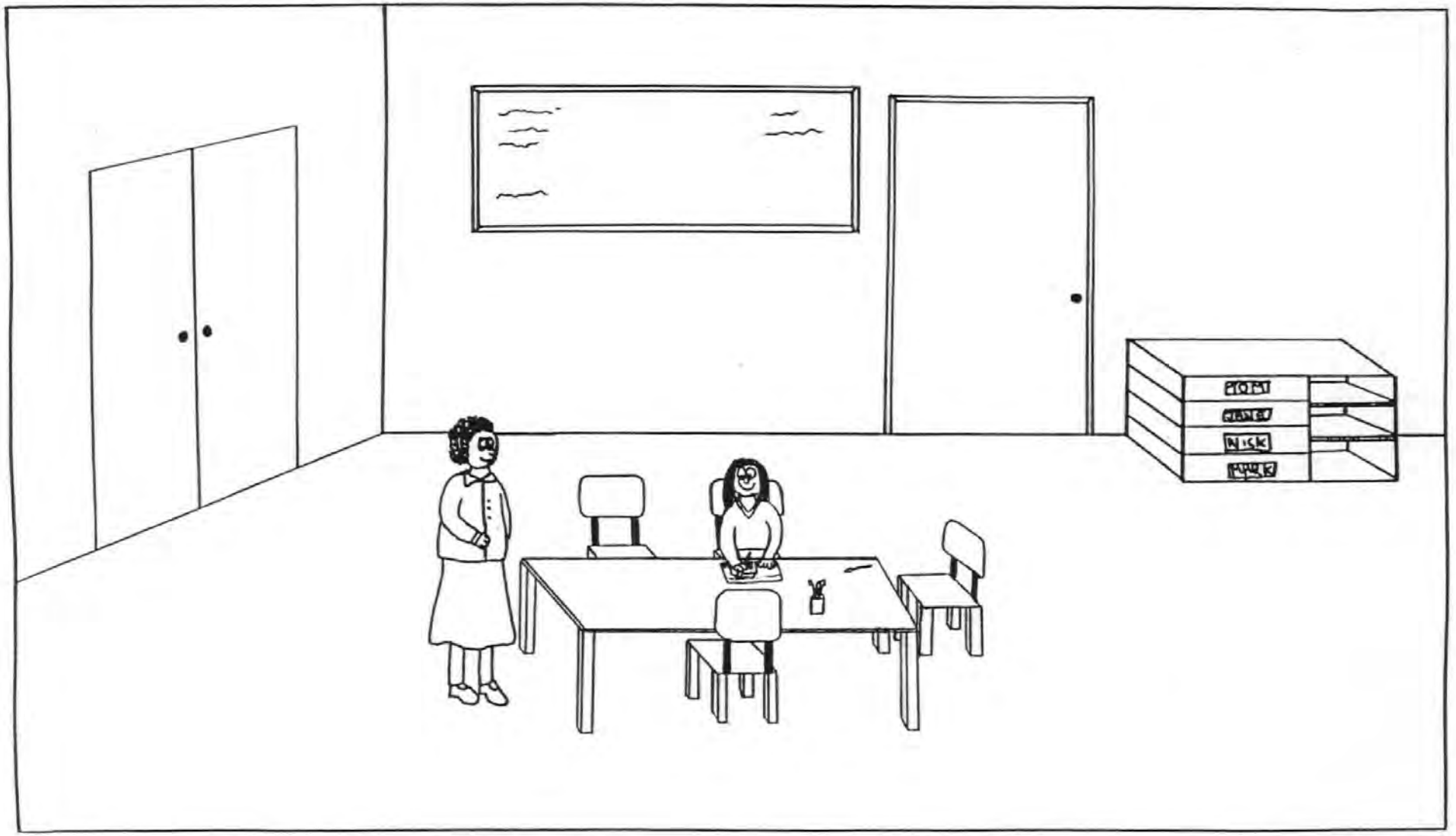
Tom and Jane are in the classroom. Tom has finished his painting.



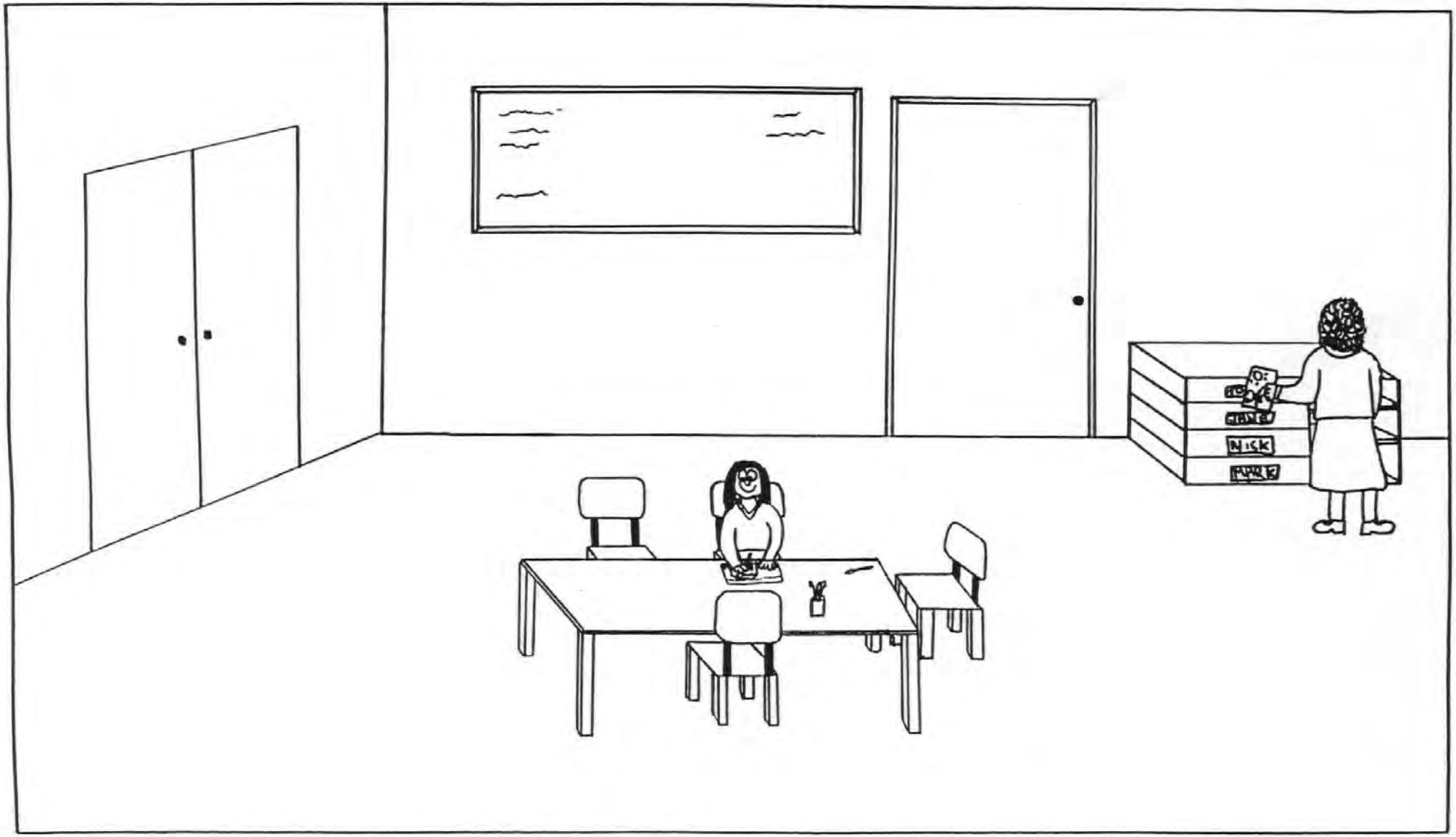
Tom puts his painting in his drawer.



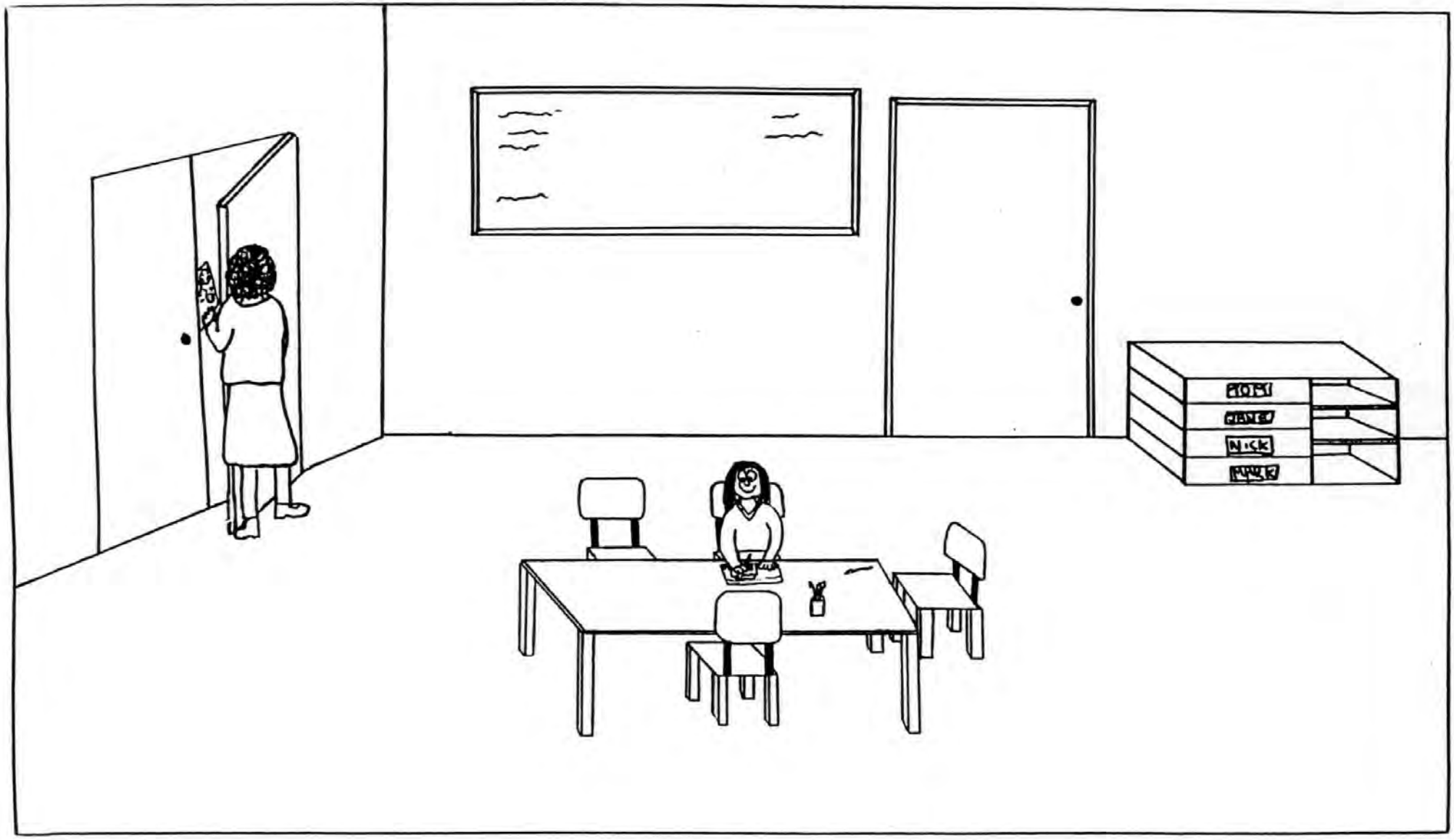
Tom goes outside to play.



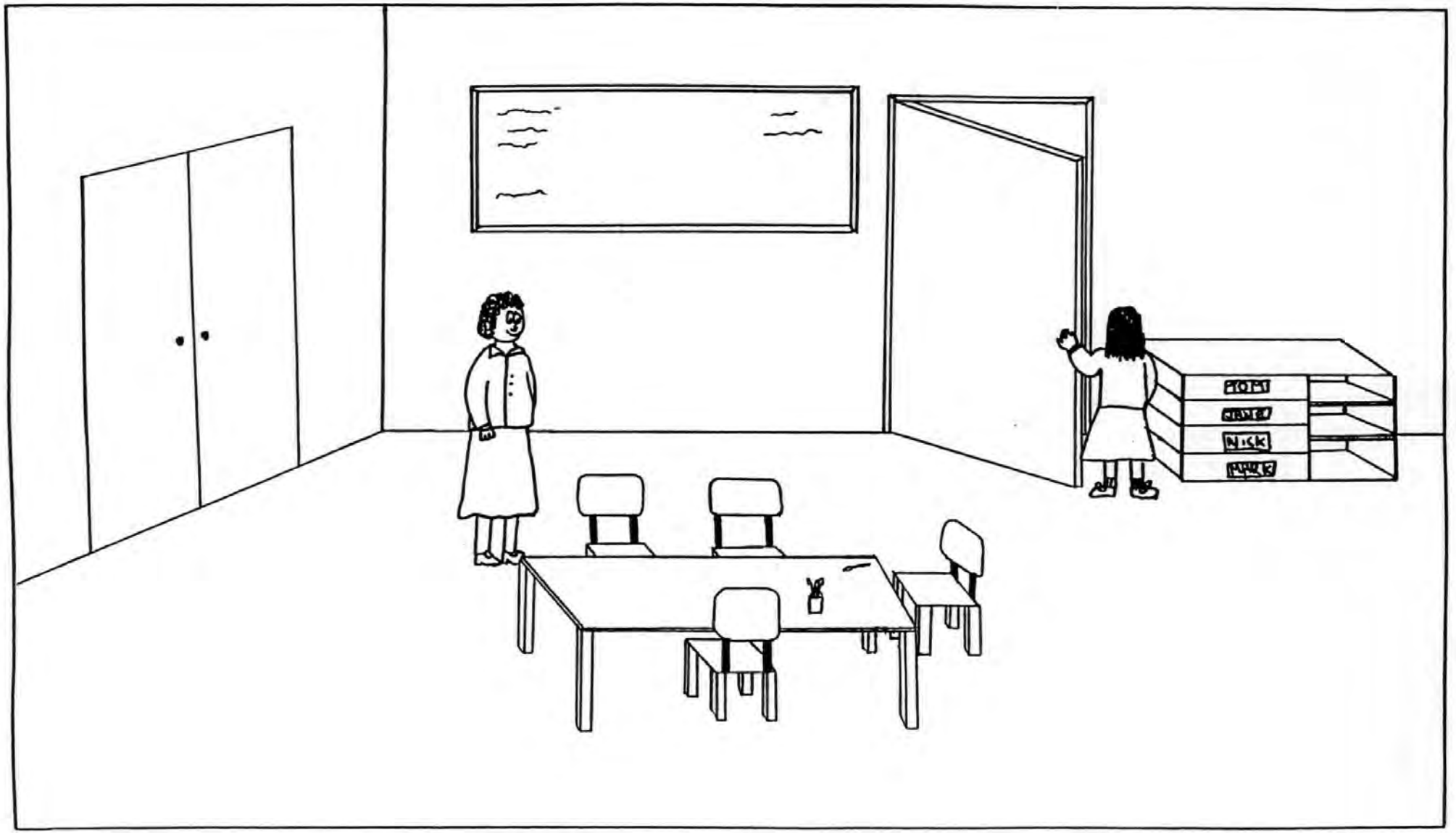
"Oh dear" says the teacher, "Tom's painting will not be dry."



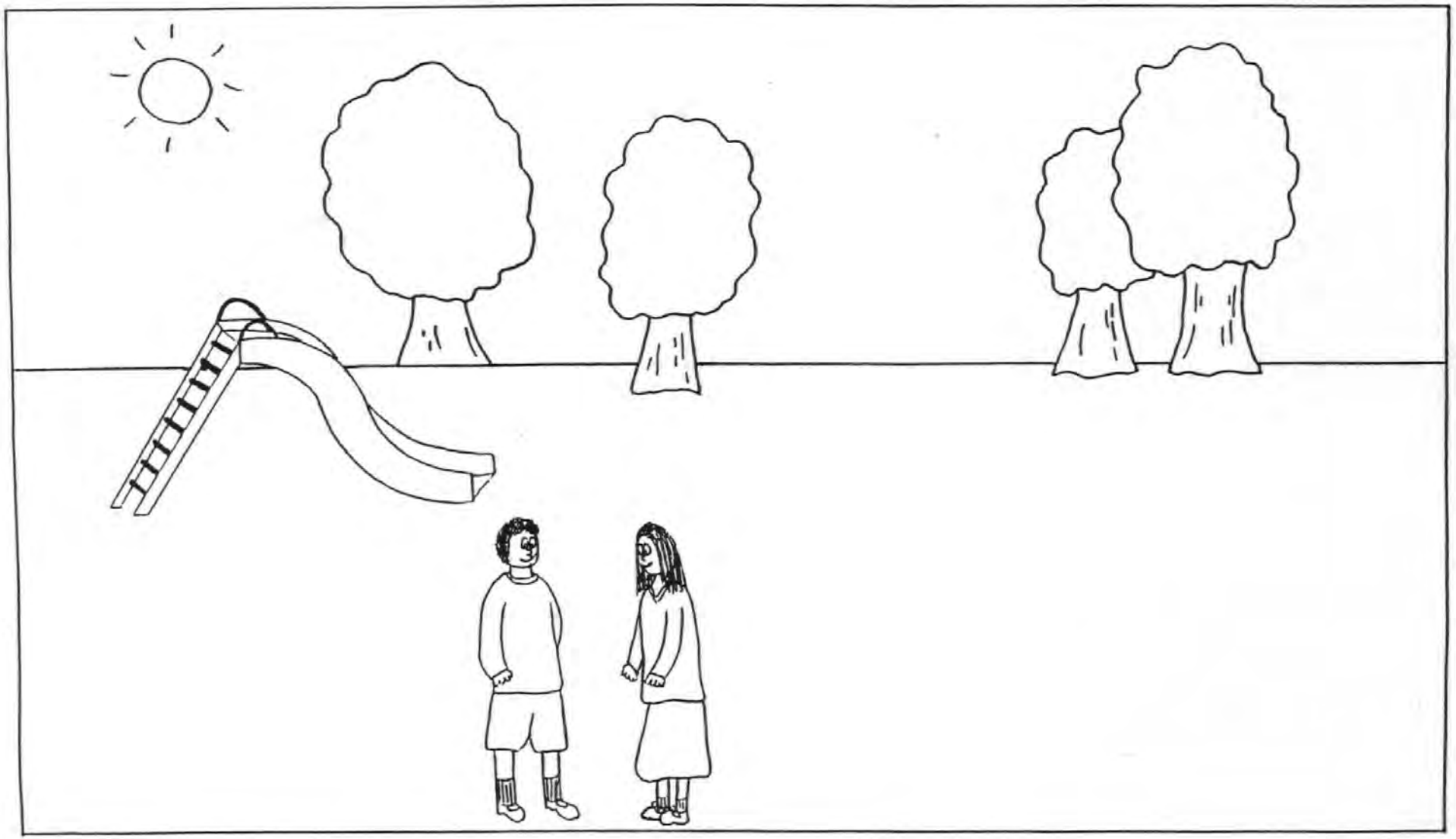
So the teacher goes to Tom's drawer and takes out Tom's painting.



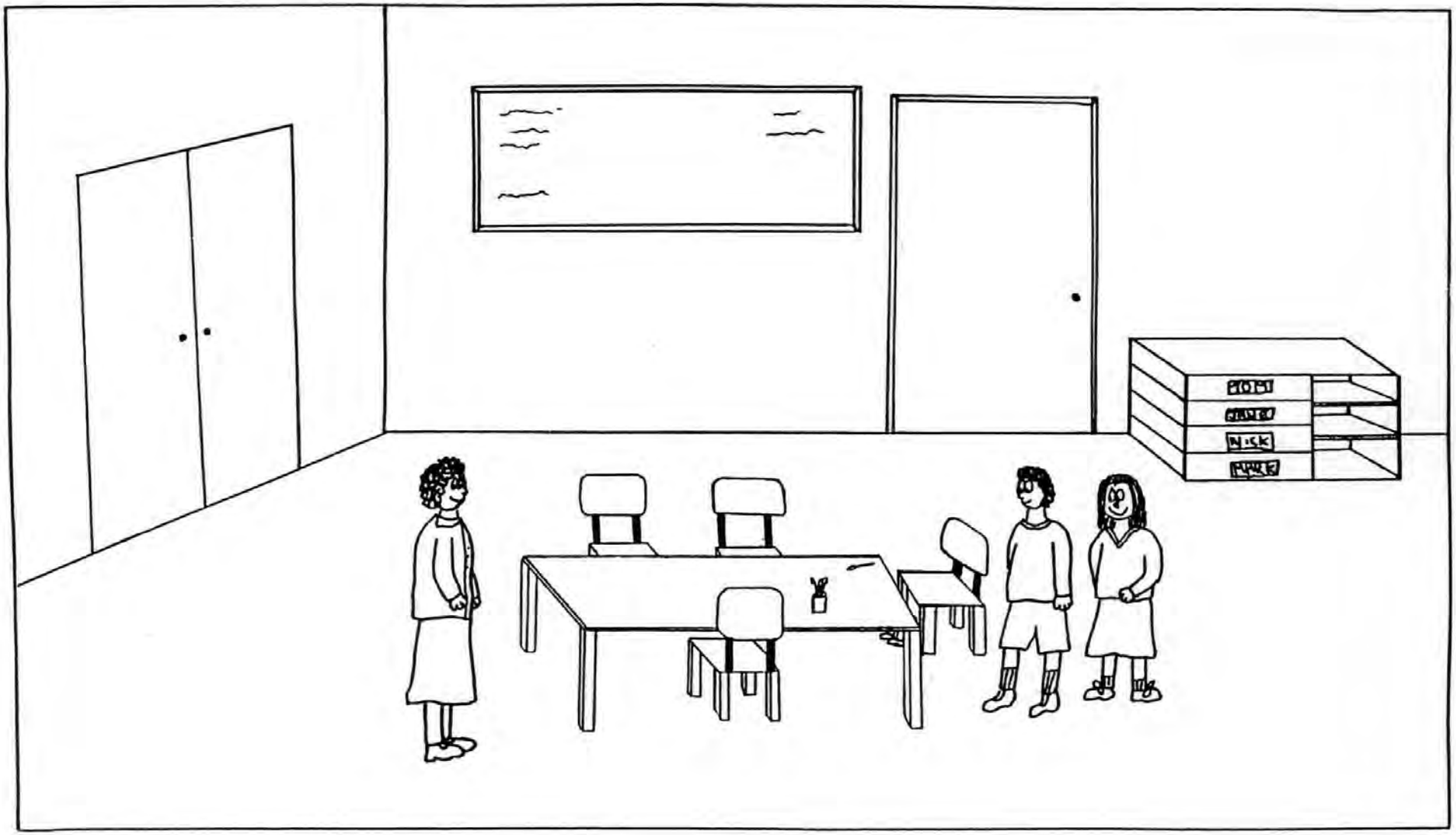
The teacher puts Tom's painting in the store cupboard to dry.



Then Jane goes outside to play.



Tom and Jane are in the playground. Jane says to Tom "Your painting was not dry, so the teacher put it in the store cupboard".



Tom and Jane are back in the classroom. The teacher says, "It is time to go home. Tom do not forget to take your painting."

Appendix 2A

Letter to Headteachers of Autistic Schools/Units

Clinical Teaching Unit

University of Plymouth

4/5 Rowe Street

Drake Circus

Plymouth

PL4 8AA

Dear (*Headteacher*)

I am currently training as a Clinical Psychologist and recently completed a placement with the Phoenix Learning Disability Trust. I am writing to you because as part of my training I am required to conduct a piece of research, and I have a particular interest in autism.

For my thesis I want to investigate theory of mind (that is the ability to understand that other people may have thoughts, beliefs and desires different one's own) in children and adolescents with autism. You may be aware that this is an area in which a lot of research has already been conducted, and predominantly it has been concluded that children with autism lack a theory of mind.

The main aim of my research is to provide evidence to support the idea that people with autism do possess a theory of mind. I will be arguing that the standard theory of mind tests used in past research, however, need to be modified to allow this ability to be exhibited.

For my research I need between ten and fifteen children/adolescents with autism to participate. I intend to assess children's verbal ability and then give them a number of theory of mind tasks. These tasks involve answering some questions about cartoon stories or a story told with puppets, which I hope will be enjoyable for the child. I would need to see each child on a maximum of three occasions, for about half an hour each time.

Whilst I do not plan to actually start collecting data until July 1998, I was hoping that at this stage I might be able to arrange a preliminary visit to discuss my research further with you. This would provide an opportunity for me to answer any questions or concerns you may have, and allow me to begin to gain an idea of how many pupils I might be able to recruit for my research.

I do hope you will consider whether you wish your school to be involved in my research, and I will be contacting you shortly. Thank you in advance for your help.

Yours sincerely

Ms Alex Proto

(Trainee Clinical Psychologist)

Appendix 2B

Letter to Parents of Children With Autism

Clinical Teaching Unit

University of Plymouth

4/5 Rowe Street

Drake Circus

Plymouth

PL4 8AA

Dear Parent

I am currently training as a Clinical Psychologist, and am writing to you because I have a particular interest in autism. For my thesis I want to investigate 'theory of mind' in children and adolescents with autism. As you may know, having a 'theory of mind' means that you realise that other people might have thoughts and beliefs that are different from your own. You may be aware that this is an area in which a lot of research has already been conducted, and predominantly it has been concluded that children with autism lack a theory of mind.

The main aim of my research is to provide evidence to support the idea that people with autism do possess a theory of mind. I will be arguing that the standard theory of mind tests used in past research, however, need to be simplified for individuals with autism, to allow this ability to show through.

I am hoping to recruit about 15 children/adolescents with autism for my research. I will need to assess each child's verbal ability and then give them a number of theory of mind

tasks. These tasks involve answering some questions about cartoon stories or a story told with puppets, which I hope will be enjoyable for the child.

I have discussed my research ideas with (*name of Headteacher)*, who is happy for (*name of school)* to be involved. I am hopeful that you will not have any objections to your child taking part in my research. If, however, you would prefer that your child is not involved, then I would be grateful if you could inform (*name of Headteacher)* of your wish. If you have any questions regarding my research, then please do not hesitate to contact me at the above address.

Yours sincerely

Ms Alex Proto

(Trainee Clinical Psychologist)

Appendix 2C

Letter to Headteachers of Schools for Learning Disabled Children

Clinical Teaching Unit

University of Plymouth

4/5 Rowe Street

Drake Circus

Plymouth

PL4 8AA

Dear (*Headteacher*)

I am currently training as a Clinical Psychologist, at the University of Plymouth. As well as completing various work placements in Bristol, for my training I also need to conduct a piece of research, which I am doing in the field of autism. Whilst I am conducting the majority of my research in schools for children with autism, I am writing to you because I also need a comparison group of learning disabled children to participate.

For my thesis I want to investigate 'theory of mind' in children, that is being able to put yourself in another person's shoes (i.e. understand that other people may have thoughts and beliefs that are different from one's own).

I am hoping to include a total of 40-60 children with learning difficulties in my study. I am approaching a number of schools, however, so if it would only be possible for me to see a smaller number of children, then I would still value your co-operation. I would initially need to see each child individually for 15 minutes, to administer a verbal test. Some of these children I will need to see again in order to complete several 'theory of mind' tasks.

These tasks simply involve the child answering some questions about cartoon stories or a story told with puppets. I have already been into a number of autistic schools and one mainstream school, to conduct my research, and all the children I have seen to date have enjoyed taking part.

I do hope you will consider whether you wish your school to be involved in my research, and I will be contacting you shortly. Thank you in advance for your help.

Yours sincerely

Ms Alex Proto

(Trainee Clinical Psychologist)

Appendix 2D

Letter to Parents of Learning Disabled Children

Clinical Teaching Unit

University of Plymouth

4/5 Rowe Street

Drake Circus

Plymouth

PL4 8AA

Dear Parent

I am currently training as a Clinical Psychologist, at the University of Plymouth, and am conducting some research into autism. Past research has suggested individuals with autism do not have a 'theory of mind', which means they have difficulty putting themselves in someone else's shoes. I will be arguing that the standard 'theory of mind' tests used in past research, however, need to be simplified for individuals with autism, to allow this ability to show through.

I have been conducting the main part of my research in a number of autistic schools. I also need a group of children with learning difficulties for comparison, which is why I am writing to you. I will need to assess each child's language ability, and then ask them some questions about cartoon stories and a story told with puppets. To date, all of the children involved in my research have enjoyed taking part.

I have discussed my research ideas with (*name of Headteacher)*, who is happy for (*name of school*) to be involved. If you have any questions regarding my research, then please do not hesitate to contact me at the above address.

I hope that you will agree to your child participating in my research, and I would be very grateful if you could return the tear off slip below.

Yours sincerely

Ms Alex Proto

Please return this slip with your child to his/her class teacher.

*I am happy for my child to participate in your research.

*I would rather my child was not involved in your research.

Child's name: Class teacher's name:

Date of birth:

Delete as necessary.

Appendix 2E

Letter to Parents of Normally Developing Children

Clinical Teaching Unit

University of Plymouth

4/5 Rowe Street

Drake Circus

Plymouth

PL4 8AA

Dear Parent

I am currently training as a Clinical Psychologist, at the University of Plymouth, and am conducting some research into autism. Past research has suggested individuals with autism do not have a 'theory of mind', which means they have difficulty putting themselves in someone else's shoes. I will be arguing that the standard 'theory of mind' tests used in past research, however, need to be simplified for individuals with autism, to allow this ability to show through.

I have been conducting the main part of my research in a number of autistic schools. I also need a group of children without autism for comparison, which is why I am writing to you. I will need to assess children's language ability, and then ask them some questions about cartoon stories and a story told with puppets. To date, all of the children involved in my research have enjoyed taking part.

I have discussed my research ideas with (*name of Headteacher)*, who is happy for (*name of school*) to be involved. If you have any questions regarding my research, then please do not hesitate to contact me at the above address.

I hope that you will agree to your child participating in my research, and I would be very grateful if you could return the tear off slip below.

Yours sincerely

Ms Alex Proto

Please return this slip with your child to his/her class teacher.

*I am happy for my child to participate in your research.

*I would rather my child was not involved in your research.

Child's name: Class teacher's name:

Date of birth:

Delete as necessary.

Appendix 3

Verbal Ability (on the TROG) and Theory of Mind Performance

Theory of Mind Tasks	Mean verbal age (on TROG)					
	Autism		*Learning disabled*		*Normally developing*	
	'passers'	'failers'	'passers'	'failers'	'passers'	'failers'
Sally-Anne	7;2	6;2	8;2	5;5	6;10	4;3
Ben	6;11	5;11	7;9	5;5	6;8	4;6
Ice-Cream Man	11;0	6;2	7;8	6;1	6;6	6;6
Puppy	9;0	5;11	9;4	5;10	7;5	5;10
Classroom	9;0	5;11	9;0	5;8	6;8	6;1

Table 1. Mean age (years; months) of 'passers' and 'failers' in each participant group on each theory of mind task.

Appendix 4A

Justification Question Responses and Coding

The Ice-Cream Man Task

Autistic subject

1. Because that's where he was last *(location)*

Learning disabled subjects

1. Because that's where the ice-cream man said he would be all day *(communicated information)*
2. That's where the ice-cream man said at first *(communicated information)*
3. Because the ice-cream van was there *(location)*
4. He got his money and the bus turned round to the church *(story facts nonsense)*
5. Because that's where the ice-cream man said he would be all day *(communicated information)*

Normally developing subjects

1. Don't know
2. No response
3. John went home to get his money and the ice-cream man went to the church *(story facts nonsense)*
4. Because she didn't see the ice-cream man and John go to the church *(first order reasoning)*
5. Don't know
6. The ice-cream man told her *(story facts nonsense)*
7. Because she didn't hear the ice-cream man talking to him *(implicit second order reasoning)*

8. No response
9. The ice-cream man was there *(location)*
10. Don't know
11. Because the ice-cream man was there last, and she doesn't know where the ice-cream man is *(location)*
12. She didn't hear the ice-cream man tell John he was going to the church *(implicit second order reasoning)*
13. She didn't hear the ice-cream man tell him *(implicit second order reasoning)*
14. She didn't hear the ice-cream man tell John *(implicit second order reasoning)*

The Puppy Task

Autistic subjects

1. Because she wants to keep it a surprise *(deception)*
2. To hide the surprise *(deception)*
3. She said to Peter she got him a toy, but she really got him a puppy *(communicated information)*

Learning disabled subjects

1. Because that's what she told him *(communicated information)*
2. No response
3. That's what she said to Peter *(communicated information)*

Normally developing subjects

1. She's lying *(deception)*
2. Because it was a surprise, but it isn't now *(deception)*

3. Because she said she's getting a toy, but she hasn't she's getting a puppy *(communicated information)*
4. Because she told him that *(communicated information)*
5. Don't know
6. Because she told him she's getting him a toy *(communicated information)*
7. Because she didn't know he went down into the basement *(implicit second order reasoning)*
8. Because she said to him she didn't get him a puppy, she got him a toy *(communicated information)*
9. No response
10. Because it's a surprise *(deception)*
11. Because she told him he's getting a toy when he had a puppy downstairs *(communicated information)*
12. Because she told him that first, but it's not really true as the puppy was hidden as a surprise *(communicated information/ deception)*
13. She told Peter he was getting a toy *(communicated information)*
14. She lied to Peter and told him he's getting a toy, but he's not *(communicated information/ deception)*
15. That's what she told Peter *(communicated information)*
16. She doesn't know he's found the puppy *(implicit second order reasoning)*

The Classroom Task

Autistic subjects

1. Because Jane told him where it is *(story facts/nonsense)*
2. Because that's where Tom put it *(location)*
3. That was the first place he put it *(location)*

Learning disabled subjects

1. She didn't tell him she'd put it in the store cupboard *(implicit second order reasoning)*
2. He put it in there before *(location)*
3. Because that's where he first put it *(location)*
4. That's where he put it *(location)*
5. Because it wasn't dry *(story facts/nonsense)*
6. That's where he put it *(location)*

Normally developing subjects

1. No response
2. Because she saw him put it in the drawer *(first order reasoning)*
3. Because he put it there and then went out to play and Jane told him *(location)*
4. No response
5. She thought Jane won't have told him *(implicit second order reasoning)*
6. No response
7. Because she didn't know Jane told Tom that it was in the store cupboard *(implicit second order reasoning)*
8. Don't know
9. Because it's not there *(story facts/nonsense)*
10. She didn't hear Jane tell him it was in the store cupboard *(implicit second order reasoning)*
11. Jane told Tom and the teacher didn't hear *(implicit second order reasoning)*
12. Because first his painting was in there and then he went outside *(location)*
13. Because she didn't hear Jane tell him that his painting is in the store cupboard *(implicit second order reasoning)*
14. No response
15. No response

16. Because he put it in there first then the teacher put it in the store cupboard *(location)*
17. She hasn't heard Jane talk to him *(implicit second order reasoning)*
18. No response
19. Because Jane told him outside when the teacher was inside *(implicit second order reasoning)*
20. She didn't hear Jane say to him that she put it in the store cupboard *(implicit second order reasoning)*
21. No response
22. She didn't tell him and she doesn't think Jane told him *(implicit second order reasoning)*

Appendix 4B

Number of Participants, Who Passed the Second Order Tasks, to Give Each Type of Justification Response

Theory of mind tasks and justifications	**Autistic**		**Learning disabled**		**Normally developing**	
(appropriate/ *inappropriate*)	No.	%	No.	%	No.	%
Ice-Cream Man task						
Explicit second order	0		0		0	
Implicit second order	0		0		4	29
Communicated information	0		3	60	0	
Location	1	100	1	20	2	14
First order reasoning	*0*		*0*		*1*	*7*
Story facts/nonsense	*0*		*1*	*20*	*2*	*14*
Don't know/no response	*0*		*0*		*5*	*36*
Puppy task						
Explicit second order	0		0		0	
Implicit second order	0		0		3	17
Communicated information	1	33	2	67	9	50
Deception	2	67	0		4	22
First order reasoning	*0*		*0*		*0*	
Story facts/nonsense	*0*		*0*		*0*	
Don't know/no response	*0*		*1*	*33*	*2*	*11*
Classroom task						
Explicit second order	0		0		0	
Implicit second order	0		1	17	10	45
Communicated information	0		0		0	
Location	2	67	4	66	3	13
First order reasoning	*0*		*0*		*1*	*5*
Story facts/nonsense	*1*	*33*	*1*	*17*	*1*	*5*
Don't know/no response	*0*		*0*		*7*	*32*

Table 2. Number and percentage of different types of justification response, given by each participant group, on each second order theory of mind task.

Appendix 5

Letter of Ethical Approval

Ms K Hughes
Tutor
Doctorate in Clinical Psychology
Clinical Teaching Unit
University of Plymouth
Drake Circus
Plymouth PL4 8AA

Phoenix
NHS TRUST
Services for People with Learning Difficulties

Our ref: AM/ajw

4 September 1998

Dear Kay

RE: ALEX PROTO'S RESEARCH THESIS

As you know Alex's subjects (sorry I can't remember the current label for subjects!) have been selected from within educational settings. This means she has not needed to go through the same process of ethics committees as she would have done, had they been selected from health settings.

I can therefore confirm that I fully support her work on this project, and that she has been careful to carry out the required steps for proper ethical scrutiny. She has kept me up-to-date with progress, including a copy of a letter to schools seeking permission and making reference to the appropriate ethics committee. She has also let me know that she will be seeking consent from the children and from their parents.

I am particularly pleased to support this project on a number of fronts. Firstly, it is refreshing to find someone keen to research in the area of learning disabilities. Secondly, I am hopeful that the children will enjoy participating and thirdly, there are potential long term benefits in increasing our understanding of Autism.

Please let me know if you need any other information.

Kind regards.

Yours sincerely

Avril Missen
Top Grade Clinical Psychologist & Supervisor
Kingswood Community Learning Difficulties Team (CLDT)
Hanham Road, Kingswood, Bristol, BS15 8PQ
Telephone (0117) 967 8900 • Fax (0117) 967 1669

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