J. Child Psychol. Psychiat. Vol. 33, No. 7, pp. 1141–1155, 1992
Printed in Great Britain.

0021-9630/92 $5.00 + 0.00
Pergamon Press Ltd
Association for Child Psychology and Psychiatry

Out of Sight or Out of Mind? Another Look at Deception in Autism

Simon Baron-Cohen

Abstract—The penny-hiding game is a deception game that occurs naturally in parent–child and child–child interaction. It involves minimal linguistic demands, and is lots of fun. Oswald and Ollendick (1989) employed it with subjects with autism and reported an impaired capacity for deception. They also found that this correlated with performance on both a false belief ("theory of mind") test as well as various measures of social behaviour. The experiment reported here set out to replicate Oswald and Ollendick's important results, and then extend them by using a new technique for error analysis.

We succeeded in replicating the autism-specific deception impairment as well as the finding that deception capacity correlates highly with performance on a false belief test. In addition, the new analytic technique discriminated the group with autism from controls more clearly than the traditional index of deception. Specifically, subjects with autism, whilst fully capable of enjoying the game as a game of *object occlusion* (keeping things out of sight), failed to perceive the game as a game of *information occlusion* (keeping things out of mind), unlike normal children or subjects with a mental handicap of an equivalent or lower mental age. The dissociation in autism between occluding objects vs occluding information is discussed in relation to other research showing that subjects with autism are impaired in understanding the principle that "seeing leads to knowing".

Keywords: Autism, deception, hiding, theory of mind

Recent research has shown severe deficits in the development of a theory of mind in autism, that is, in the ability to appreciate someone else's mental states (such as their thoughts and beliefs), and to make sense of and predict their behaviour on the basis of such states (Baron-Cohen, Leslie & Frith, 1985, 1986; Leslie & Frith, 1988; Baron-Cohen, 1989a,b; Perner, Frith, Leslie & Leekam, 1989; Leekam & Perner, in press; Harris, 1991; Reed & Peterson, 1991; Leslie & Thaiss, in press; Charman & Baron-Cohen, 1991). This deficit is assumed to be related to their social and communicative abnormalities (Baron-Cohen, 1985, 1988, 1990; Frith, 1989), and correlational studies provide preliminary support for these assumptions (Eisenmajer & Prior, 1991; Siddons, Happe, Rizq, Whyte & Frith, 1990).

Accepted manuscript received 25 *September* 1991

Departments of Psychology and Child Psychiatry, Institute of Psychiatry, University of London.
Requests for reprints to: Dr Simon Baron-Cohen, Department of Psychology, Institute of Psychiatry, Denmark Hill, London SE5 8AF, U.K.

One recent experiment has also shown that subjects with autism are unable to *deceive* (Sodian & Frith, 1992), a result that again is in line with predictions, given that deception entails manipulation of another person's thoughts—making someone *believe* something false.* Given the social and evolutionary importance attributed to "Machiavellian intelligence" (Byrne & Whiten, 1988; Whiten, 1991, in press), this finding is of considerable significance, and merits further attention.

Sodian and Frith's (1992) investigation is well designed, in that it included a "sabotage" condition which did not require deception and in which children with autism were not specifically impaired. However, two queries need addressing in their deception task. First, it relies on considerable linguistic comprehension. For example, the experimenter tells the child that if the "nice smartie (M&M) friend" finds the smarties the child will get them, but if the "nasty smarty eater" finds them the child will get nothing. These sentence constructions involve complex conditional-clause comprehension. Although Sodian and Frith took care to match their subjects on the basis of verbal mental age, given the range of verbal comprehension ability in autism (Tager-Flusberg, 1989), one might question if autism-specific deficits in deception would still emerge in a paradigm involving fewer linguistic demands.

A second question is whether failure on Sodian and Frith's deception task might have occurred for motivational rather than cognitive reasons, since deception was not studied in a natural context. Whilst the experiment was set in the context of a game (which can be a natural context for deception), and whilst the child could receive rewards (which can be another natural context for deception), the game was not one which occurs naturally in either parent–child or child–child interaction.

Fortunately, an earlier experiment is available which answers both of these queries. Oswald and Ollendick (1989) investigated deception in autism using the *Penny Hiding Game* (Gratch, 1964; Devries, 1970). This technique (described later) is virtually free of linguistic demands, and the deception game is one which occurs naturally in child–child and parent–child interaction. Since Oswald and Ollendick also found an inability to deceive in autism on this task,† and found that this correlated with performance on a false belief ("theory of mind") test, this strengthens Sodian and Frith's (1992) conclusion that this deficit is primarily *cognitive.*

In the present study we first set out to replicate Oswald and Ollendick's (1989) result, as this phenomenon seemed too important to leave unchecked: teenagers (with autism) performing on a deception task like 2-year-olds. It scarcely seemed credible. A second reason for testing if this result could be replicated was because, given its simplicity, we felt that this test could be of future diagnostic importance.

*Russell *et al.* (1991) also claimed to find evidence of a deception impairment in autism, although a later study by this group led to a reinterpretation of this data in terms of "frontal" abnormalities. This point is discussed briefly at the end of our paper, and by Sodian and Frith (in press) and Harris (in press).

†Other results in the Oswald and Ollendick (1989) paper however failed to find evidence of autism-specific deficits false belief tasks, instead finding them in mental handicap controls too. From the details reported in their paper, this may have been because (a) no minimum verbal MA was used as an inclusion criterion, (b) only a subset of pictures were used in the picture sequencing task—the authors do not specify which were used—and (c) the sample sizes ($n = 10$ in each group) were insufficient for the trend between the groups on the Sally-Anne task to reach significance.

A third reason for replicating their experiment was to permit an *error-analysis* to be carried out, in order to identify the precise difficulty a child might have with the task. Oswald and Ollendick only reported a pass–fail score; no error-analysis was performed. Nor was any data reported on the relationship between performance on this task and mental age (MA), which might be expected to be an important variable. The experiment reported here aimed to overcome these problems. Finally, we also retested Oswald and Ollendick's finding that deception ability correlated with performance on a false belief (theory of mind) test.

We begin by describing the penny-hiding game, along with our new technique for error-analysis. We have gone into some detail in this section because almost no methodological information is available in the Oswald and Ollendick (1989) paper.

The penny-hiding game and the traditional index of deception

The penny-hiding game is a two-person game in which the subject is actively involved, either as a *guesser* (Condition 1) or as a *hider* (Condition 2). Both try to win. The hider hides the penny in one hand or the other, and then invites a guess. This is repeated over a row of trials, after which the participants change roles.

Oswald and Ollendick (1989), in their study of this game, used the criteria that Gratch (1964) and DeVries (1970) had employed earlier: they looked at the hand pattern children used in guessing and hiding. Both Gratch and DeVries had found that "mature" players were less likely to use a *regular* pattern of repeating or alternating hiding locations or guesses, because they could anticipate that the other person would soon recognize these regularities and "win" simply by following a clear rule (e.g. same location each time, or simple alternation). In the Experiment in this paper, this traditional index of deception (hand-use strategy) was also examined, and this was then compared to our new index of deception (*information occlusion*), described next.

Information occlusion as an index of deception

We propose that this game can be analysed in terms of what the subject as hider attempts to occlude. Minimally, the hider has to ensure the guesser doesn't *see* the penny. This we call *object occlusion.* But the game is not simply about keeping the penny out of sight. It is also about preventing the guesser from getting access to clues or *information* about where the penny might be. This we call *information occlusion.* Thus, during the hiding process, the *transfer* of the penny from one hand to another must take place out of sight; and whilst inviting the guesser to guess, the penny must not only remain out of sight, but the hider must also occlude other tell-tale clues (e.g. the hider mustn't *tell* the guesser where it is, or *show* the guesser where it is).

Thinking about the game in this way allows one to examine if the hider is playing the game as if it is just about object occlusion (keeping objects out of sight), or as if it is also about information occlusion (keeping the object's true location out of mind). The simplest way to ensure information occlusion is, of course, to keep the penny behind one's back (or under the table) while transferring (or pretending to transfer) it from one hand to the other, and then to keep it in a closed fist whilst inviting the guess. It is also essential not to say anything, and to keep the other hand closed too!

In successful information occlusion, the hider must be explicitly employing a theory of mind, that is, must be taking into account and trying to influence the mental state of the other person: the hider *knows* where the penny is, but is acting in such a way as to prevent the guesser from knowing this.

Our new index of *simple* deception is scored if information occlusion occurs, since this is evidence that the child is attempting to remove clues that would allow the guesser to infer (and thus come to know) the penny's whereabouts. Finally, we also looked for "cheating" (attempting to deliberately mislead the opponent into thinking the penny is in the empty hand), as evidence for more *advanced* deception. To distinguish this from information occlusion, we call this more advanced deception *misinformation,* as the hider presents false information in an attempt to create a false belief in the guesser.

Experiment

Subjects

Each subject was tested in a quiet room in his or her school. All subjects were tested on both the penny hiding game and a false belief test. The order of these tests was counterbalanced in each group. There were 15 subjects with autism who met our inclusion criteria (see below), all of whom had been diagnosed according to established criteria (DSM-III-R, 1987) and who were attending a special school for autism. In addition, there were 15 subjects with mental handicap but without autism who also met our inclusion criterion. These were tested in order to control for mental age (MA) and chronological age (CA). They were attending a school for pupils with learning difficulties. Finally, there were 15 clinically normal children (seven 3-year-olds, and eight 4-year-olds), in order to collect normative data. The sex ratio in the normal group and in the group with mental handicap was approximately 1:1, whilst in the group with autism it was approximately 3:1 (m:f). Details of the subjects are summarized in Table 1.

Table 1. Subject variables: Means, S.D.s, and ranges of chronological age (CA) and mental age (MA)

Diagnostic groups	*n*		CA	Nonverbal MA*	Verbal MA†
Autism	15	Mean	15.3	7.9	6.2
		S.D.	2.4	1.7	1.7
		Range	12.8–18.0	5.0–11.2	3.4–9.4
Mental handicap	15	Mean	15.44	5.3	5.0
		S.D.	1.9	0.8	1.6
		Range	11.9–18.3	4.0–7.6	3.1–6.8
Normal	15	Mean	3.8		
		S.D.	0.47	—	—
		Range	3.2–4.9		

*Ravens matrices.
†BPVS.

The first inclusion criterion for the clinical subjects was a verbal MA of at least 3 years old, matching the age at which normal children have been found to participate readily in the procedures used in this experiment (Perner, Leekam & Wimmer, 1987; Gratch, 1964). The second inclusion criterion was that subjects attempted to guess in their role as guesser in the penny hiding game (Condition 1). Those who did not were excluded from the experiment as a whole. This resulted in one subject with autism being excluded. The third (and final) inclusion criterion was that subjects passed a control condition for the false belief test, which ensured the subject possessed certain minimal linguistic and memory skills. (The control condition is described later.) This resulted in two subjects with autism and two subjects with mental handicap being excluded because they failed this control condition. The final sample size, after these subjects had been excluded, was 15 in each of these two groups.

Whilst a minimum verbal MA of 3 years old was required, in fact the mean MAs of both clinical groups were over 5 years (see Table 1), and the group with autism had a mean non-verbal MA significantly higher than that of the group with mental handicap ($t = 5.24$, 28 d.f., $p < 0.001$). The group with autism had a higher verbal MA too, and this approached statistical significance ($t = 1.97$, 28 d.f., $p < 0.058$). This selection of MA controls ensured that any deficits emerging in the tests by subjects with autism could not be due to inadequate MA.

Non-verbal MA was higher than verbal MA for both clinical groups, markedly so in the case of the group with autism, reflecting typical discrepancies in the IQ profile (De Myer, 1975). Verbal MA was assessed using the British Picture Vocabulary Scale (BPVS: Dunn, Dunn, Whetton & Pintillie, 1982). Non-verbal MA was assessed using Raven's Coloured Progressive Matrices (Raven, 1956). Our normal control group had a mean CA of 3.8 years, ranging from 3.2 to 4.9. We assumed that for the normal group, MA would roughly correspond to CA.

Method

The penny-hiding game

The game was introduced as follows: The experimenter said "Let's play a game. Here's a penny. Now, I'm going to hide it in one of my hands". The experimenter then put both hands behind his back, then produced his two fists in front of him and at equal distance, and said "Now where's the penny? Can you find the penny?"

In condition 1 there were 12 trials in which the experimenter hid the penny and the subject guessed. These 12 trials were divided into three blocks of four. In the first block (the "no-lose" block) the subject always "won"* because there was actually a penny in each of the experimenter's hands, although the subject believed there was only one penny. No subject cottoned on to this trick. This block was designed to ensure a rapid build-up of the subject's interest in the game. During this first block, the experimenter feigned a mixture of praise and annoyance ("Oh dear! Well done! How did you guess it was there?" etc.), whipping up the suspense and competitive fun with such comments as "I hope you won't find it next time!", etc. Subjects in all three groups reponded to this, smiling and getting excited.

In the second block (the "no-win" block) the subject always "lost" since there was actually no penny in either of the experimenter's hands, the pennies having been surreptitiously dropped on a cushion behind the experimenter's back before the start of this second block.

*By "win" we mean that the guesser discovered a penny in the chosen hand. The guesser did not then keep the penny. Rather, it was hidden again in the next trial.

No subjects "twigged" that this was the case. This block was designed to motivate the subject further by leading them to hope for a return to their initial run of "luck". During this block of trials, the experimenter showed rapturous pleasure whenever the subject "lost" ("Aha! you didn't find it then, did you? Bad luck! Let's see if you can guess again!", etc.). In the final block (the "real game"), the experimenter played competitively, using only one coin, hiding it unpredictably. Naturally, the subject was unaware of the transition between these three blocks of trials.

Twelve trials were considered necessary to ensure the child entered fully into this experiment as a game. The four "no lose" trials served as a warm-up, confidence-building phase. The following four "no win" trials shook the child out of this "easy" phase, forcing him or her to try to figure out what was going on in the game. The final four trials allowed, by chance factors, the child to experience a return to (occasional) winning, so that the subject did not become despondent and lose motivation for continuing into condition 2.

In condition 2 the experimenter said "OK. Let's change the game now. This time, you hide the penny, and I'll try to find it. Try to make it *really* difficult for me, so that I can't find it!" There were 12 trials in this condition too, in order to make the length of both conditions equivalent. During this condition the experimenter kept the enthusiasm of the subject up by interjecting comments like "Oh no! It's not there! You tricked me!" or "Aha! Found it! Now try to make it *really* difficult for me, so I won't find it next time", etc. With those subjects who were unskilled in this condition, the experimenter attempted to guess *in*correctly in half the trials, so that the subject had the experience of winning as well as losing.

Both conditions 1 and 2 were videorecorded, in order to enable us to carry out the information occlusion error-analysis and compare this to the traditional index of deception. The scoring methods for these are described later. Videorecording also enabled us to check for any possible experimenter bias in terms of how much prompting was being given to each group.

Finally, condition 1 was always followed by condition 2. Whilst this may have created an order-effect, this was thought to be the only feasible way of getting the subject interested in the game. It was also the format that parents use naturally when they play the game. It was assumed that if the order of conditions produced any bias at all, it would be in the direction of false positives. That is, some subjects who in fact could not deceive might *appear* as if they could, simply by imitating how the experimenter had acted in the previous condition. In this respect, it was felt that if any group differences emerged, these would probably reflect real differences in deception capacity.

Scoring: the penny-hiding game

The traditional index of deception. As mentioned earlier, the traditional index of deception, used by Gratch (1964), DeVries (1970), and Oswald and Ollendick (1989), entails coding which hand the subject points to (or hides the penny in) in a series of trials. We first scored each subject using this technique. In condition 1, the subject as guesser was coded for whether, following their first success (trial 1 of block 1), they *repeated* this location on their next five guesses (AAAAAA), or *switched* guesses alternately (ABABAB), or used an *irregular* strategy (e.g. ABBABA or AABABB, etc.). Recall that any of these strategies would lead to success on the first four trials (Block 1). The first six hiding trials in condition 2 were also rated for which of these three strategies was used. Six trials were considered to be the minimum number from which to diagnose the strategy being employed. Other regular strategies were also looked for (e.g. AAABBB, AABBAA or ABBABB), but these never occurred. Finally, the second set of six trials were coded using the same technique, to check the reliability of using the first six trials, and to check for either fatigue or learning effects.

The information occlusion index of deception. In condition 2, the subject as hider was coded first for whether they succeeded in keeping the penny out of sight (i.e. closing the fist which contained the penny) on seven or more out of the 12 trials (i.e. on the majority of trials). This was scored as object occlusion. They were then also coded for whether they occluded information as to the penny's whereabouts, on seven or more out of the 12 trials. Success on this was coded if the subject:
(a) kept their hands out of sight (e.g. behind their back, or under the table) whilst putting the penny into one of the hands;
(b) kept both hands closed (and not just the one with the penny in) whilst inviting the guess;
(c) did not open the hand with the penny in before the experimenter had had his guess;
(d) did not say where the penny actually was before the experimenter had had his guess.

If the subject failed to show any of these behaviours, they were scored as failing on information occlusion, and the type of error committed was noted. The error types corresponding to the four criteria for information occlusion were: visible transfer, one hand open, premature showing, and premature telling.

Misinformation. Finally, subjects were also coded for whether they ever tried to "cheat", as an index of "advanced" deception. This was scored if the subject
(a) presented two empty hands (having concealed the penny elsewhere and out of sight); or
(b) emphasized the wrong hand, extending an empty fist for the experimenter to search, and/or said "It's in *this* hand!" etc.; or
(c) before opening either hand said that the experimenter was wrong when he was right; or
(d) attempted to transfer the penny to the other hand when the experimenter pointed to the correct hand.

The false belief test

This test was part of a larger study, reported elsewhere (Baron-Cohen, 1991), and the procedure was adapted from tests with normal children (Perner, Leekam & Wimmer, 1987; Gopnik & Slaughter, 1991). All subjects were first tested in a control condition. As mentioned earlier, this was also an inclusion criterion for the rest of the experiment. In the control condition, subjects were shown a black box and the lid was then removed, revealing a small green wooden brick inside. The lid was then replaced, and the experimenter asked a confirmation question: "What's inside the box?". Subjects replied "A green brick". The experimenter then opened up the box again and said "Let's take the green brick out and put this yellow one in". The lid was replaced again, and the subjects were asked "Now what's in the box?" Subjects replied "A yellow brick". They were then asked "When I first showed you the box, before we opened it, what was inside then? (Was there a yellow brick or a green brick?)"* As will become apparent, the control condition functioned not only as a control for memory, but as a linguistic control for the wording of the false belief test question. It mirrors this question in every way except for the inclusion of a mental state term.

Following this, the false belief test was administered: The subject was shown a milk carton (very familiar to British children) and was asked a question to confirm their initial belief: "What do you think is inside this?" All the subjects said "Milk". The box was then opened and the subject was shown it really contained a small green ball. They were then asked a question to confirm their changed belief: "Now what do you think is inside this?" All of them now said "A ball". The subject was then asked the Test Question "When I first asked you, before we opened the carton, what did you think was inside? (Did you think there was a ball inside, or did you think there was milk inside?)".†

Scoring: the false belief test

Subjects were scored as passing the false belief test if on the test question they reported their original belief (contents = milk). They were scored as failing the test if on the test question they reported their subsequent belief (contents = ball). The number of subjects in each group passing this test was analysed.

*The prompt question is put in brackets here to indicate that it was only asked if the subject did not respond spontaneously to the test question. Most subjects needed no prompting at all.

†When Perner, Frith, Leslie & Leekam (1989) used a similar test of "own false belief", they found that subjects with autism performed well on this, whilst Baron-Cohen (1991) did not. One explanation for this (Leslie, personal communication) may be in terms of the wording in each experiment: Perner *et al.* (1989) asked "When I first showed you this, what did you SAY was inside?" In contrast, Baron-Cohen (1991) asked "When I first showed you this, what did you THINK was inside?" Subjects with autism may have been able to understand the SAY wording (but not the THINK wording) by interpreting the former simply as a request to repeat their earlier answer.

Results

The penny-hiding game

During the videotape analysis, a check was carried out to determine if the experimenter had unwittingly given an unequal amount of prompting to the subjects with autism, given that he was not (nor could be) blind to their diagnosis. This analysis revealed that, as intended, prompting was introduced as a standard rate across subjects and across groups. In presenting the results, we present scores from the traditional index of deception and the information occlusion index of deception separately, so as to assess the power to each technique.

The traditional index of deception. Subjects were first scored for the type of hand strategy (repetition, switching or irregular) they used in the first six trials of each condition. Table 2 shows the number of subjects in each group showing each strategy type in each condition.

Table 2. Number of subjects in each group showing each guessing strategy (at least once) on the first six trials

Diagnostic group	n	Repeat	Switch	Irregular
Condition 1				
Autism	15	4*	11	0
Mental handicap	15	0	15	0
Normal	15	0	13	2
Condition 2				
Autism	15	6†	9	0
Mental handicap	15	0	15	0
Normal	15	0	11	4‡

*Autism × mental handicap, $p < 0.049$.
†Autism × mental handicap, or autism × normal, $p < 0.008$.
‡Normal × mental handicap, and normal × autism, $p < 0.049$.

As can be seen, the majority of subjects in each group showed the intermediate strategy of switching, in both conditions. No subjects with autism or mental handicap showed the most "mature" strategy (irregular), and only two normal children in condition 1, and 4 normal children (all among the oldest) in condition 2, did so. This latter difference just reached significance (Fisher's $p < 0.049$). The group with autism alone contained subjects who in either condition used a repetitive strategy, and again this difference reached significance (condition 1: $p < 0.049$; condition 2: $p < 0.008$, both Fisher's exact tests). Comparing the first six trials with the second six trials produced no significant differences in any of the groups (Fishers Exact tests, all $p > 0.05$).

Object vs information occlusion. In condition 2, there were no significant differences in terms of the number of subjects in each group who succeeded in object occlusion on at least seven out of 12 trials. The mean number of trials in which subjects showed successful object occlusion also did not differ between the groups (one-way ANOVA, $F = 1.26$, d.f. (2,42), $p > 0.2$). However, in coding successful information occlusion, there were significantly fewer subjects in the group with autism who showed this on seven or more trials out of 12 trials than in either of the other two groups (all comparisons, Fisher's exact probability tests, $p < 0.004$). In order to check for the possibility that this criterion for passing the test (seven or more out of 12 trials) was unnecessarily harsh, an ANOVA was carried out on the mean number of trials in which subjects showed successful information occlusion. This also showed significant differences between the groups (one-way ANOVA, $F = 9.51$, d.f. (2,42), $p < 0.004$). Scheffe's *post-hoc* tests showed the group with autism showed information occlusion on significantly fewer trials on average than either of the other two groups (Scheffe's, $p < 0.005$). These results are shown in Tables 3 and 4, and Fig. 1.

Table 3. Percentage of subjects showing object occlusion and information occlusion in condition 2

Diagnostic group	n	Object occlusion*	Information occlusion*
Autism	15	80	15.4†
Mental handicap	15	100	66.6
Normal	15	86.6	84.6

* = on at least seven out of 12 trials.
† = Autism × mental handicap, $p < 0.004$.

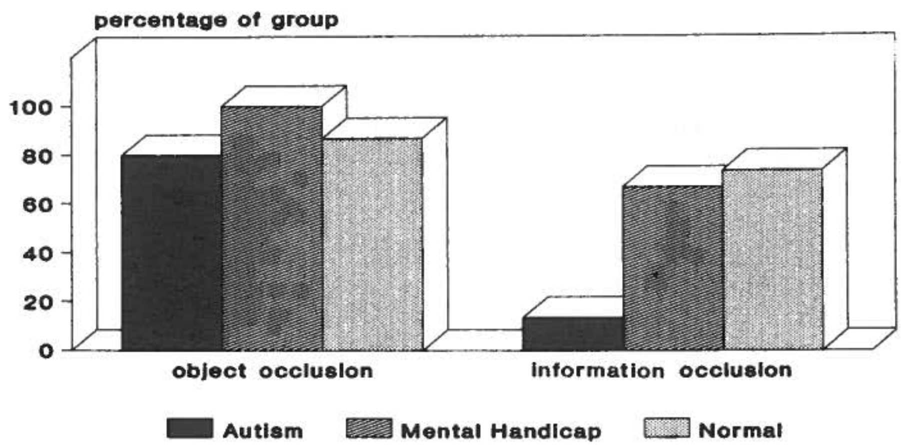

Fig. 1. Percentage of each group showing object occlusion and information occlusion.

The errors leading to unsuccessful information occlusion were then analysed in terms of the number of subjects who showed one or more instances of a particular error. This revealed that more subjects with autism *showed* the experimenter where the penny was before he had guessed (Fisher's, $p < 0.009$) or failed to close the empty hand (Fisher's, $p < 0.03$) or ommitted to occlude the *transfer* of the penny into its hiding place (Fisher's, $p < 0.0001$). These data are summarized in Table 5 and Fig. 2.

Table 4. Mean number of trials in which successful object occlusion or information occlusion occurred, in condition 2, in each group

Diagnostic group	n		Object occlusion*	Information occlusion*
Autism	15	$\bar{x}$	8.9	2.3†
		s.d.	3.4	3.9
Mental handicap	15	$\bar{x}$	10.1	7.3
		s.d.	3.1	4.4
Normal	15	$\bar{x}$	10.7	8.3
		s.d.	3.0	3.9

*Minimum = 1; maximum = 12.
†Autism × mental handicap, $p < 0.004$.

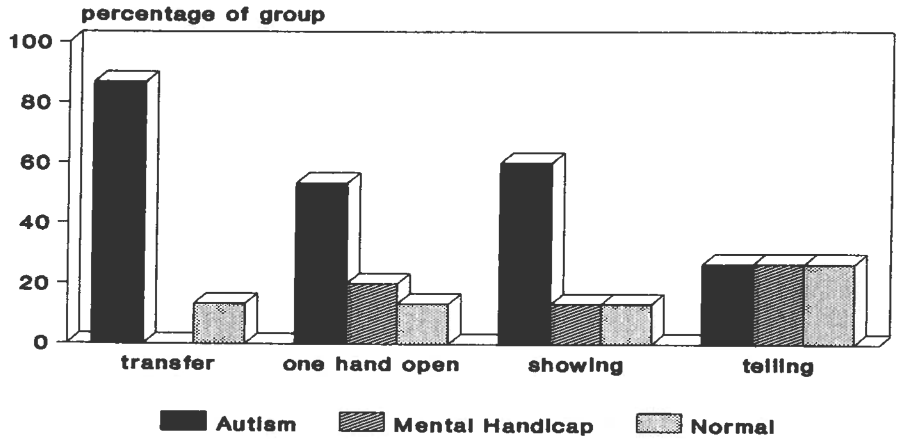

Fig. 2. Percentage of each group showing different types of information occlusion errors.

Comparing object occlusion with information occlusion, it was found that all subjects who showed information occlusion also showed object occlusion, but the opposite did not apply. This supports the contention that object occlusion is a developmentally earlier skill than information occlusion. Finally, on coding attempts to "cheat" (as defined earlier), only one of the subjects with autism spontaneously did this, in contrast to six subjects with mental handicap, and four normal children. The difference between the groups with autism and mental handicap on cheating was significant (Fisher's, $p < 0.04$) but not between the normal group and those with autism (Fisher's, $p > 0.05$). This is shown in Table 6.

Table 5. Number of subjects showing one or more instances of the different information occlusion errors in condition 2

Diagnostic group	n	Transfer	One hand open	Showing	Telling
Autism	15	13*	8†	9‡	4
Mental handicap	15	0	3	2	4
Normal	15	2	2	2	4

* = Autism × normal, $p < 0.0001$.
† = Autism × mental handicap, $p < 0.05$.
‡ = Autism × mental handicap, or autism × normal, $p < 0.009$.

Table 6. Number of subjects who tried to cheat in condition 2

Diagnostic group	n	Cheating	No cheating
Autism	15	1*	14
Mental handicap	15	6	9
Normal	15	4	11

*Autism × mental handicap = $p < 0.04$ (but autism × normal = n.s.).

The role of mental age in the penny-hiding game

In the group with mental handicap, the five subjects who failed to show information occlusion on seven or more of the 12 trials all had verbal MAs of less than 3.5 years old, and this was significantly lower than the 10 subjects who succeeded on this ($t = 5.27$, 13 d.f., $p < 0.0001$). They did not however differ in terms of either CA ($t = 0.91$, 13 d.f., $p > 0.3$) or non-verbal MA ($t = 2.02$, 13 d.f., $p < 0.06$). Similarly, in the normal group, the four children who failed to show information occlusion on seven or more trials out of 12 were all aged less than 3 years 4 months, and their CA was significantly lower than the 11 who succeeded on this ($t = 2.8$, 13 d.f., $p < 0.01$). The two subjects with autism who did show information occlusion on seven or more of the 12 trials were among the oldest and most able of the sample, yet there were others who were as old and with a similar MA who did not.

The false belief test

Responses to the confirmation questions indicated that subjects' belief changed following the experimental manipulation. Since passing the control condition was an inclusion criterion for the rest of the experiment, this ensured that failure on the false belief test was unlikely to be due to memory or linguistic factors *per se*. Four subjects with autism, 10 with mental handicap, and 11 normal children passed the false belief test. Fisher exact tests showed that the group with autism performed significantly worse than either of the other two groups ($p < 0.05$).

The role of CA and MA in the false belief test

Analysis of the role of CA and MA in the group with autism revealed that the four subjects who passed the false belief test were not significantly older ($t = 0.19$, 13 d.f., $p = 0.84$), nor did they have a higher verbal MA ($t = 0.76$, 13 d.f., $p = 0.46$) or non-verbal MA ($t = 0.14$, 13 d.f., $p = 0.89$) than the 11 subjects with autism who failed this test. Nevertheless, whilst neither CA nor MA emerged as sufficient factors in accounting for those subjects with autism who passed the false belief test, CA did appear to be a necessary factor, in that all of these subjects had CA's greater than 9.9 years (and 3 out of the 4 subjects had CA's greater than 15 years old).

Relationship between the penny-hiding game and the false belief test

Although four subjects with autism passed the false belief test, only two passed the penny-hiding game, in showing information occlusion. No subject passed the penny-hiding game and failed the false-belief test, suggesting understanding false-belief may be a necessary (but insufficient) factor for showing information occlusion. In the mentally handicapped and normal groups, there was a total overlap between those subjects passing the false belief test and those showing information occlusion (10 subjects with mental handicap, and 11 normal children).

Discussion

This experiment set out to replicate Oswald and Ollendick's (1989) finding of a deception impairment in autism. The replication was successful, using the traditional (Gratch–DeVries) index of deception employed in the original study. Subjects with autism failed to show deception, as measured by hand strategy, in comparison to normal children and subjects with mental handicap, of an equivalent or lower mental age. This is thus in line with Sodian and Frith's (1992) findings.

The present study extended Oswald and Ollendick's (1989) study by using a new index of simple deception in terms of information occlusion, that is, the ability to hide clues that might allow a guesser to know where an object might be. It contrasted this with the lower-level ability of object occlusion. This revealed that the subjects with autism were treating the game as if it was simply about object occlusion, and seemed to enjoy it purely on this level. For them, the game was all about keeping things "out of sight", but not "out of mind". This technique also demonstrated the errors subjects with autism made. As a group, they tended to *show* the guesser where the object was too soon, or failed to prevent the guesser *inferring* the object's location, or simply failed to hide the object *out of view* of the guesser, more often than did the other two groups. These information occlusion errors, against a backdrop of normal understanding of object occlusion, suggest they were oblivious to the guesser's state of knowledge or belief. In this sense, they failed to employ a theory of mind.

Comparing the traditional index of deception with the new (information occlusion) index of deception showed the latter to be a far more powerful way of distinguishing the groups. Indeed, the traditional index only revealed a group difference when "repetitive" hand use was compared to "switching". "Irregular" hand-use strategy as an index of deception, and "cheating" (or misinformation) proved to be less useful ways of discriminating the groups, as both of these seem to be quite late acquisitions, even in the control groups.

The finding that children with autism are unimpaired in object occlusion is consistent with Sodian and Frith's (1992) finding that such children are unimpaired in sabotage ability, or manipulation of behaviour. It remains to consider possible explanations for the deception impairment. Could the difficulties have been due to linguistic factors? Although no verbal response was required of the subject in the penny-hiding game, the experimenter did use some verbal prompting, and subjects with autism may not have fully understood these. However, these prompts are unlikely to have been crucial to passing the task, as subjects with mental handicap, some of whom had very low verbal MAs, nevertheless passed easily. Equally, these prompts were not used in the Oswald and Ollendick (1989) study, yet similar results were obtained there. Similarly, a motivational explanation seems unlikely, as the subjects with autism enjoyed playing the game at the simple level of object occlusion.

A more likely conclusion is that the subjects with autism failed for cognitive reasons, and two possible cognitive explanations are worth considering. First, might children with autism have difficulty in disengaging from the salient object (Russell *et al.*, 1991)? This notion is attractive in being simple, and finds some support from recent studies showing deficits on "frontal" tasks by children with autism (Ozonoff *et al.*, 1991; Hughes & Russell, 1991). However, this explanation seems unable to explain why children with autism can disengage from the salient object in some tasks (e.g. Leekam and Perner, in press; Leslie & Thaiss, in press; Charman & Baron-Cohen, 1991) and not others.

An alternative cognitive explanation for the deception impairment makes reference to the theory of mind abnormalities in autism, documented elsewhere and discussed at the start of this paper. This explanation finds some support from the comparison between deception capacity on the penny-hiding game and the test of belief comprehension. As Oswald and Ollendick (1989) showed, a strong correlation was found. This suggests that deception impairment is an example of how the theory of mind deficit in autism affects behaviour in the real world. Further support for this claim comes from Oswald and Ollendick (1989) who found an additional correlation between the penny-hiding game and measures of social behaviour (Sparrow, Balla & Cichetti, 1984, Vineland Adaptive Behavior Scales; Ollendick, 1981, Behavioral Observation; Lowe & Cautela's, 1978, Social Performance Survey Schedule).

In conclusion, the majority of subjects with autism played this game as if it was only about object occlusion and not as if it was also about information occlusion. One possibility, suggested by these results, is that they can understand *seeing* (and hence object occlusion), but cannot understand that *seeing leads to knowing* (and hence information occlusion). In support of this hypothesis, there is plenty of evidence from elsewhere that children with autism understand seeing (Hobson, 1984; Baron-Cohen, 1989c, 1991; Tan & Harris, 1991), and two other studies show they have specific difficulty in understanding the principle that *seeing leads to knowing* (Perner, Frith, Leslie & Leekam, 1989; Goodhart & Baron-Cohen, 1991). A related possibility is that subjects with autism may not understand the concept of *information,* in the full sense of the term: ". . . items of knowledge . . ." (Concise Oxford Dictionary, 1964). They may understand information in the limited sense (e.g. that smoke is a "sign" of fire insofar as it co-occurs with fire), but not in the deeper sense (e.g. that smoke *informs* you, that is, leads you to *know* that there is a fire). This possibility needs further testing.

As regards normal children, this experiment contributes some interesting data to the current controversy about the age at which they can deceive another person (Chandler, Fritz & Hall, 1989; Sodian *et al.,* 1991). Our results suggest that until about 3.5 years old, most normal children interpret the penny-hiding game simply as being about object occlusion, and not information occlusion. No spontaneous cheating occurred before this age either, and this was also true of the subjects with mental handicap whose verbal MA was lower than 3.5 years old. We conclude that deception in the sense of manipulating what someone knows or might believe, rather than simply what they see, is not present in children of less than 3.5 years old, and rarely develops in subjects with autism even with an adequate verbal mental age.

Acknowledgements—Parts of this paper were presented in invited addresses to the Zangwill Club, University of Cambridge, October, 1990, and to the Annual Conference of the British Psychological Society, Spearman Medal Lecture, London, December 1990. I am indebted to the staff and children at the following London schools: St Luke's, and Rosemary Schools, Islington, the Sybil Elgar School, Ealing, and Radlett Lodge School, Herts. Finally, I would like to thank Claire Hughes and Wendy Phillips for their valuable assistance as camera crew, and Josef Perner for his characteristically insightful comments on an earlier draft of this paper.

References

Baron-Cohen, S. (1985). Social cognition and pretend play in autism. Unpublished doctoral thesis, University College, University of London.

Baron-Cohen, S. (1988). Social and pragmatic deficits in autism: cognitive or affective? *Journal of Autism and Developmental Disorders,* **18,** 379–402.

Baron-Cohen, S. (1989a). The autistic child's theory of mind: a case of specific developmental delay. *Journal of Child Psychology and Psychiatry,* **30,** 285–298.

Baron-Cohen, S. (1989b). Are autistic children behaviourists? An examination of their mental-physical and appearance-reality distinctions. *Journal of Autism and Developmental Disorders,* **19,** 579–600.

Baron-Cohen, S. (1989c). Perceptual role-taking and protodeclarative pointing in autism. *British Journal of Developmental Psychiatry,* **7,** 113–127.

Baron-Cohen, S. (1990). Autism: a specific cognitive disorder of "mind-blindness". *International Review of Psychiatry,* **2,** 79–88.

Baron-Cohen, S. (1991). The development of a theory of mind in autism: deviance and delay? *Psychiatric Clinics of North America,* **14,** 33–51.

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

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

Byrne, R. & Whiten, A. (1988). *Machiavellian intelligence: social expertise and the evolution of intellect in monkeys, apes, and humans.* Oxford: Oxford University Press.

Chandler, M., Fritz, A. & Hala, S. (1989). Small-scale deceipt as a marker of two-, three- and four-year-olds' early theories of mind. *Child Development,* **60,** 1263–1277.

Charman, T. & Baron-Cohen, S. (1991). Research Note: Understanding drawings and beliefs: a further test of the metarepresentation theory of autism. Unpublished manuscript, Institute of Psychiatry, London.

De Meyer, M. K. (1976). Motor, perceptual-motor and intellectual disabilities of autistic children. In L. Wing (Ed.) *Early childhood autism.* Oxford: Pergamon Press.

Devries, R. (1970). The development of role-taking as reflected by behaviour of bright, average, and retarded children in a social guessing game. *Child Development,* **41,** 759–770.

DSM-III-R (1987). *Diagnostic and Statistical Manual of Mental Disorders* (revised 3rd edn). Washington, DC: American Psychiatric Association.

Dunn, L., Dunn, L., Whetton, C. & Pintilie, D. (1982). *British Picture Vocabulary Scale,* Windsor, Berks: NFER: Nelson.

Eisenmajer, R. & Prior, M. (1991). Cognitive linguistic correlates of "theory of mind" ability in autistic children. *British Journal of Developmental Psychology,* **9,** 351–364.

Frith, U. (1989). *Autism: explaining the enigma.* Oxford: Blackwell.

Gratch, G. (1964). Response alternation in children: a developmental study of orientations to uncertainty. *Vita Humana,* **7,** 49–60.

Goodhart, F. & Baron-Cohen, S. (1991). Do children understand that seeing leads to knowing? Unpublished manuscript, Institute of Psychiatry, London.

Gopnik, A. & Slaughter, V. (1991). Young children's understanding of changes in their mental states. *Child Development,* **62,** 98–110.

Harris, P. (1991). The work of the imagination. In Whiten, A. (Ed.) *Natural theories of mind.* Oxford: Basil Blackwell.

Harris, P. (in press). Pretending and planning. In Baron-Cohen, S., Tager-Flusberg, H. and Cohen, D. (Eds). *Understanding other minds: perspectives from autism.* Oxford: Oxford University Press.

Hobson, R. P. (1984). Early childhood autism and the question of egocentrism. *Journal of Autism and Developmental Disorders,* **14,** 85–104.

Hughes, C. & Russell, J. (1991). Autistic children's performance on "frontal" tasks. Paper presented at the BPS Developmental Psychology Conference, Cambridge University, September 1991.

Leekam, S. & Perner, J. (in press). Does the autistic child have a theory of representation? *Cognition.*

Leslie, A. M. & Thaiss, L. (in press). Domain specificity in conceptual development: evidence from autism. *Cognition.*

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

Lowe, M. & Cautela, J. R. (1978). A self-report measure of social skills. *Behaviour Therapy,* **9,** 535–544.

Ollendick, T. (1989). Assessment of social interaction skills in school chidren. *Behaviour Counselling Quarterly,* **1,** 227–243.

Oswald, D. P. & Ollendick, T. (1989). Role taking and social competence in autism and mental retardation. *Journal of Autism and Developmental Disorders,* **19,** 119–128.

Ozonoff, S., Pennington, B. & Rogers, S. (1991). Executive functioning deficits in high functioning autistic children. *Journal of Child Psychology and Psychiatry,* **32,** 1081–1105.

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

Perner, J., Leekam, S. & Wimmer, H. (1987). Three-year-olds' difficulty with false belief: the case for a conceptual deficit. *British Journal of Developmental Psychology,* **5,** 125–137.

Raven, J. C. (1956). *Coloured Progressive Matrices.* London: H. K. Lewis & Co.

Reed, T. & Peterson, C. (1990). A comparative study of autistic subjects' performance at two levels of visual and cognitive perspective taking. *Journal of Autism and Developmental Disorders,* **4,** 555–568.

Russell, J., Mauthner, N., Sharpe, S. & Tidswell, T. (1991). The Windows Task as a measure of strategic deception in preschoolers and autistic children. *British Journal of Developmental Psychology,* **9,** 331–349.

Siddons, F., Happe, F., Rizq, R., Whyte, R. & Frith, U. (1990). Theory of mind in everyday life: an interview-based study with autistic, retarded, and disturbed children. Poster presented at the European Conference of Developmental Psychology, Stirling University, August 1990.

Sodian, B. & Frith, U. (1992). Deception and sabotage in autistic, retarded, and normal children. *Journal of Child Psychology and Psychiatry,* **33,** 591–605.

Sodian, B. & Frith, U. (in press). The theory of mind deficit in autism: evidence from deception. In Baron-Cohen, S., Tager-Flusberg, H. and Cohen, D. (Eds), *Understanding other minds: perspectives from autism.* Oxford: Oxford University Press.

Sodian, B., Taylor, C., Harris, P. & Perner, J. (1991). Early deception and the child's theory of mind: false trails and genuine markers. *Child Development,* **62,** 468–484.

Sparrow, S., Balla, D. A. & Cicchetti, D. V. (1984). *Vineland Adaptive Behavior Scales.* Circle Pines, MN: American Guidance Service.

Tager-Flusberg, H. (1989). A psycholinguistic perspective on language development in the autistic child. In Dawson, G. (Ed.), *Autism: nature, diagnosis, and treatment.* New York: Guilford Press.

Tan, J. & Harris, P. (1991). Autistic children understand seeing and wanting. *Development and Psychopathology,* **3,** 163–174.

Whiten, A. (1991). (Ed.) *Natural theories of mind.* Oxford: Basil Blackwell.

Whiten, A. (in press). Evolving a theory of mind: the nature of non-verbal mentalism in other primates. In Baron-Cohen, S., Tager-Flusberg, H. & Cohen, D. J. (Eds), *Understanding other minds: perspectives from autism.* Oxford: Oxford University Press.