Exploration of the Autistic Child's Theory of Mind: Knowledge, Belief, and Communication

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PERNER, JOSEF; FRITH, UTA; LESLIE, ALAN M.; and LEEKAM, SUSAN R. *Exploration of the Autistic Child's Theory of Mind: Knowledge, Belief, and Communication.* CHILD DEVELOPMENT, 1989, **60**, 689–700. 26 autistic children with mental ages of 3–13 years were tested on 3 tasks that are within the capability of 3- or 4-year-old normal children. The first task tested understanding of a mistaken belief. Children were shown a typical box of a certain brand of sweets, and they all thought that it contained that kind of sweet. To their surprise, however, the box contained something else. Yet, only 4 out of the 26 autistic children were able to anticipate that another child in the same situation would make the same mistake. In contrast, all but 1 of 12 children with specific language impairment, matched for mental age, understood that others would be as misled as they had been themselves. The autistic children were also tested for their ability to infer knowledge about the content of a container from having or not having looked inside. All 4 children who had passed the belief task and an additional 4 performed perfectly, but most failed. The third task assessed children's pragmatic ability to adjust their answers to provide new rather than repeat old information. Here, too, most autistic children seemed unable to reliably make the correct adjustment. These results confirm the hypothesis that autistic children have profound difficulty in taking account of mental states.

Many of the known impairments of autistic children become explicable if seen as a consequence of an impaired understanding of mental states (Frith, in press; Leslie, 1987; Leslie & Frith, 1987). Having a theory of mind implies being able to conceive of mental states in oneself and others. This is of critical importance in social, affective, and communicative relationships. Thus emotional and behavioral reactions are often contingent upon knowledge or belief rather than upon the real state of the world. Likewise, communication, both verbal and nonverbal, is often deliberately aimed at conveying or influencing states of mind.

Autistic children have been shown to have difficulties in the appreciation of certain facial, bodily, and vocal expressions of feeling states (Hobson, 1986a, 1986b). They have also been found not to use gestures that express mental states such as embarrassment but to use gestures such as beckoning that aim at manipulating behavior (Attwood, Frith, & Hermelin, in press). Autistic children have also been shown to have severe difficulties with the pragmatics of language (e.g., Baltaxe, 1977; Lord, 1985; Tager-Flusberg, in press). Mundy, Sigman, Ungerer, and Sherman (1986) and Sigman, Mundy, Sherman, and Ungerer (1986) have shown that from early childhood autistic children show profound problems with pragmatic-communicative skills such as establishing joint attention, informing, and initiating. Paul (1987) stresses the difficulties that autistic children appear to

The authors thank Mrs. Graves, head of Spring Hallow School for Autistic Children; Mr. Connelly, head of Sybil Elgar School for Autistic Children in Ealing; Mrs. Gillies, head of John Horniman School for Language Disordered Children in Worthing, West Sussex; and their staff and students for their friendly cooperation. Josef Perner also acknowledges financial assistance through a Social Science Research Fellowship from the Nuffield Foundation and a fellowship from the Alexander-von-Humboldt Foundation. Requests for reprints should be directed to either Josef Perner, Experimental Psychology, University of Sussex, Brighton BN1 9QG, England, or to Uta Frith, MRC—Cognitive Development Unit, 17 Gordon Street, London WC1, England.

[*Child Development,* 1989, **60**, 689–700. 0009-3920/89/6003-0018$01.00]

have with taking account of what is old and new information for the listener. All these observations are suggestive of a common underlying factor involving difficulties with employing a theory of mind.

Existing empirical evidence for autistic children's lack of a theory of mind is striking. It includes evidence of their inability to attribute false beliefs (Baron-Cohen, 1988; Baron-Cohen, Leslie, & Frith, 1985), true knowledge (Leslie & Frith, 1988), and to sort picture sequences involving surprise reactions on the basis of a violated false belief (Baron-Cohen, Leslie, & Frith, 1986). The false-belief test of Baron-Cohen et al. (1985) was modeled after the study by Wimmer and Perner (1983). It involved a doll who put an object into one location and who was absent when that object was unexpectedly transferred to another location. Understanding the doll's resulting false belief about the object's location was indicated if subjects predicted that on her return the doll would look for the object in the original, now empty location. A control group of children with Down syndrome performed like normal 4-year-olds on this task. They correctly indicated the empty location as the one where the doll would look. The group of autistic children, in contrast, wrongly pointed to the location where the object really was, even though their mental ages were considerably higher than those of both the normal and Down syndrome children. This failure revealed that the autistic children had difficulty in taking the doll's belief into account.

Both the false belief experiment (Baron-Cohen et al., 1985) and the picture-sequencing task (Baron-Cohen et al., 1986) are based on understanding false belief that arises from an unexpected change in the world. As Perner, Leekam, and Wimmer (1987) argued, children's failure in this task may reflect nothing more than a difference in common-sense assumptions about what people normally expect to happen. By using a "deceptive-appearance" paradigm, these authors were able to show that normal 3-year-olds have a deeper conceptual difficulty with false-belief attribution. This paradigm avoids the mentioned shortcoming of the original false-belief task as children first experience how they themselves are misled by the appearance of a well-known European confectionery box ("Smarties")[1] about the contents of that box. When shown the box, they all answer "Smarties" and are surprised when the box is opened and something quite different emerges. Their understanding of another child's false belief is assessed by asking them what another child would think (or say) was in the box when shown the box in the same deceptive way. This paradigm is a particularly compelling way of demonstrating difficulties with false belief as the child experiences how the misleading situation creates a false belief in him/herself before an attribution has to be made to the other person.

One major objective of the present study was to replicate autistic children's problem with belief attribution with this compelling paradigm. We also made an effort to control for linguistic difficulties that are frequent even in able autistic children (Paul, 1987) by testing a group of language-delayed children, all attending a special school, matched for verbal mental age with a subgroup of our autistic sample. If autistic children's difficulties with false-belief tasks are due to impaired language development, then we would expect that children who are not autistic but who are impaired in the development of language comprehension should show similar difficulties.

The second objective of our study was to explore autistic children's ability to attribute mental states other than false beliefs. Although understanding false belief may be a hallmark in children's acquisition of a theory of mind at about the age of 4 years (e.g., see chapters in Astington, Harris, & Olson, 1988), the younger 3-year-old child cannot be characterized as lacking an understanding of the mind completely. In fact, from as young as 2 years old children rapidly acquire our mental terminology (Bretherton, McNew, & Beeghly-Smith, 1981) and use it appropriately in the context of everyday life (Shatz, Wellman, & Silber, 1983). Even in experimental contexts, surprisingly sophisticated understanding of mental phenomena has recently been demonstrated in these young children (Wellman, 1988; Wellman & Estes, 1986).

One of these tasks where young children do better than on false belief is to distinguish what a person does know given that he has seen something, and what the person does not know if he did not have access to relevant information (Hogrefe, Wimmer, & Perner, 1986). This developmental lag between the

[1] Smarties are chocolate pastilles of different colors known as M & Ms in the United States. They are sold in tubular containers about 13 cm long and 2.5 cm in diameter that show a picture of their contents on the outside.

ability to attribute knowledge and ignorance and the ability to attribute false belief has important theoretical implications, but although it is a very reliable finding, the size of the lag is not very large. It is, therefore, not clear whether the observed lag reflects an important conceptual development or just a transitional difficulty in the development of a theory of mind (Perner & Wimmer, 1988).

The findings reported by Leslie and Frith (1988) suggest that in autistic children there is only a small and nonsignificant difference between their ability to attribute knowledge and false belief. It is therefore important further to clarify the relation between the two tasks.

A third objective of the study was to investigate the relation between these aspects of theory of mind and the pragmatic skill of making a communicative adjustment to the knowledge of the listener. Typically, language is used to communicate new information to a listener and not merely to repeat what is already known. Perner and Leekam (1986) examined the development of this ability in the young child. They used two conditions. In the condition with a partially ignorant partner, the child and the partner were together shown that a toy bee can "fly" (i.e., flap its wings). Then the partner left and the child was shown that the bee can also "nod" its head. In the condition with a totally ignorant partner, the partner was outside the room while both actions of the bee were demonstrated to the child. In both conditions, the partner entered wondering about what the bee could do and asked the child, "What can the bee do?" Most children, as young as 3–3½ years, mentioned "nodding" first to the partially ignorant partner (presumably because they realized that he had not seen that action before), while no such preference for mentioning nodding first occurred when the partner was totally ignorant, as both actions were new to that partner.

We adopted this paradigm for our autistic children to see whether their reported pragmatic difficulties are specifically linked to taking another person's informational access or knowledge into account (i.e., what the other person was able to perceive).

Method

Subjects

Subjects were 26 children (five girls and 21 boys) diagnosed according to established criteria (Rutter, 1978) as autistic from two schools for autistic children in greater London. Their chronological age ranged from 7-5 to 18-10 (mean = 13-6). Their mental age, assessed by the British Picture Vocabulary Test, ranged from 3-1 to 12-8 (mean = 6-2). Twelve children (two girls and 10 boys) from a special school for linguistically impaired children in Worthing, West Sussex, served as a control group on the false-belief test. These children were admitted to the school on the basis of their *specific language impairment* (SLI: Leonard, 1982, 1987) resulting in severe delay in language comprehension. Their chronological ages ranged from 6-11 to 9-11 (mean = 8-8), and their mental ages, as assessed by the British Picture Vocabulary Test, ranged from 5-5 to 8-7 (mean = 6-9).

Design

Autistic children were tested on two occasions about one-half year apart. At the first meeting, they were tested on the "boxes" communication task, then on the false-belief task, followed by the "bee" communication task. For half the children (14, due to a counterbalancing error), the boxes task involved a partially ignorant, and the bee task a completely ignorant, question asker. For the other half (only 12), the assignment of kind of ignorance and type of task was reversed.

For the second testing session, two of these children were absent. The available 24 children were given the British Picture Vocabulary Test and were assessed for their understanding of visual access in knowledge formation. This was assessed in two tasks. In one the subject was shown the selected object and the other person was kept ignorant, while in the other task the subject was kept ignorant and the other person was shown the object. The order of these two tasks was counterbalanced.

The SLI children were tested on two false-belief tasks. One of these tasks was the same "deceptive-appearance" or "Smarties box" task used in this experiment on autistic children. The other task was an adaptation of the "unexpected-transfer" paradigm used on autistic children by Baron-Cohen et al. (1985). The order of administering these two tasks was counterbalanced.

Procedure

Children were tested individually in a quiet room of the school. Each child was led by the main experimenter to the testing room where the child was introduced to the cooperating experimenter, who, the child was told, would join in for a hiding game. Child and main experimenter were seated at a small table facing each other, and the cooperating experimenter was seated at right angles on the side of the table. Subjects' responses were recorded by the main experimenter, and a videorecording was made of both testing sessions for all but one subject where no consent was given. For SLI subjects, the experiment started directly with one of the two false-belief tasks.

Communication test: Boxes.—The main experimenter produced two plastic containers (one about 8 cm, the other about 10 cm in each dimension) and declared that she and the subject would hide some things from the other experimenter in those boxes. The other experimenter was sent out of the room. The main experimenter produced a wax apple, asked the child what it was, and put it into the slightly larger container. She then produced a piece of crumpled-up paper, asked the child what it was, and put it into the other container. Then the child was asked to repeat the contents of each box. Called back to find out for himself, the cooperating experimenter displayed great interest in finding out the content of each box. He first tried the box with the piece of paper: "Let's see what's in this box." However, unable to open it, he stated: "I can't open it" and turned to the other container: "Now let's see what's in the other box." In the Total Ignorance condition, he also failed to open the second container, stating: "I can't open it." In the Partial Ignorance condition, he managed to open that box and exclaimed: "Ah, there is an apple in here." He closed the box, and as in the other condition, put it next to the other container and, turning to the subject, asked the test question: "What's in there?" An effort was made not to look at or point to any of the two containers. If the subject mentioned only one of the contents, memory for the other contents of the other box was checked by asking: "What is in the other box?"

False-belief test.—Subject and cooperating experimenter were asked whether they would like to play another game. After an enthusiastic response from the cooperating experimenter, he was told that it was time for him to fetch the next child from the classroom. The subject was asked where that child was to be found, and the cooperating experimenter left the room. The main experimenter produced a Smarties box from her bag and asked the child: "What's in here?" All children answered with "Smarties" or "sweets." The experimenter opened the box, and to the subject's surprise, a pencil emerged; the experimenter stated: "No, it's a pencil." She put the pencil back into the box, closed the box, and asked two Prompt Questions:

Reality Prompt: "What's in here?"

Own-Response Prompt: "When I first asked you, what did you say?"

Then the subject was asked about the next subject (who the other experimenter had gone out to fetch): "Who will come after you?" (Subject names next person.) "S/he hasn't seen this box. When s/he comes in, I'll show her/him this box just like this and ask: [Name] what's in here?"

Prediction Test: "What will [Name] say?"

Reality Check: "Is that what's really in the box?" (if answer is "No"): "What is really in the box?"

Own-Response Check: "Do you remember, when I took the box out of my bag [experimenter reenacts that episode] and asked you what was in it, what did you say?"

The SLI subjects were also tested on another false-belief test involving unexpected change. In this task, subjects watched the cooperating experimenter hide a coin in one of three containers. In the cooperating experimenter's absence, the main experimenter and subject switched the coin to one of the other two containers. As a test for understanding false belief, subjects were asked where the cooperating experimenter would look for the coin when he came back. As a control for memory of actual events, subjects were asked where the coin actually is and where the cooperating experimenter had put the coin originally. For autistic children, the experiment continued with the second communication task.

Communication test: Bee.—The cooperating experimenter returned from the classroom without the next subject. The main experimenter asked him and the subject whether they would like to play another game and proceeded with the "bee" task described by Perner and Leekam (1986). The main difference from the original study was that the person asking the question was not another child but the cooperating experimenter, who left under the pretext of having lost his handkerchief outside the room. In the Total Ignorance condition, however, he left the room before any of the bee's actions were demonstrated. In the Partial Ignorance condition, he left after the demonstration of the bee "FLYing" by flapping its wings. After the second demonstration of the bee "NODding" its head, the other experimenter returned with his kerchief and, when told that the demonstration had already been carried out, asked the subject: "What can the bee do?"

Knowledge-formation task.—Subject and cooperating experimenter were shown a box with several objects. The main experimenter checked whether the subject was familiar with each object and explained that she would choose one of these objects and put it into a cup without anyone being able to see it. After the object had been put into the cup, the experimenter let the other experimenter and the subject confirm that they could not see which object it was.

In the Other Ignorant condition, the experimenter then let the subject peek into the cup, explaining: "I'll show you what I put into the cup, but I won't show it to [name of other experimenter]." In the Subject Ignorant condition, the experimenter let the other experimenter peek into the box, emphasizing that she would not let the subject look into it. In both conditions, the following series of test questions was then asked:

Other-Knows: "Does [name of experimenter] know which thing I put into the cup?"

Justification: "Why does [name] not know that?"

Other-Seen: "Did I let [name] look into the cup?" (omitted if already answered by justification).

Self-knows: "Do you know which object I put into the cup?"

Justification: "Why do you know that?"

Self-Seen: "Did I let you look into the cup?" (omitted if already answered by justification).

Results

Results are analyzed in four sections. In the first-section results from the false-belief task are analyzed for autistic and SLI subjects. The next two sections deal with autistic children's performance on the knowledge-formation and the communication tasks. Finally, there is a brief discussion of how all three types of tasks relate to children's mental and chronological age.

False Belief

Autistic children.—Three children from the lower end of the spectrum of mental ages (3-1, 3-8, and 4-1) needed so much prompting on questions that their responses became meaningless as indicators of understanding. Responses by the remaining 23 subjects could be clearly interpreted. On four occasions, subjects spontaneously corrected their wrong answer (once on the Reality Prompt, two times on the Reality Check, and once on the Own-Response Check). Since these subjects did not dither on any other questions, we accepted their spontaneous corrections.

All subjects gave correct answers to prompt questions (i.e., Reality and Own-Response Prompt). Answers to the prediction test were scored as correct if the answer was "Smarties" (four children). All other answers were scored as incorrect, which consisted of saying "pen(cil)" (17) or "I don't know" (2). All 23 children gave correct answers to the Reality-Check question "Is that what's really in the box?" Answers consisted of either saying "pen(cil)" (16) or "yes" after answering the previous question with "pencil" (7). All correct answers to the Own-Response Check consisted of saying "Smarties" (13) or "sweets" (1), and all incorrect answers of saying "pencil" (8). The data of one subject were missing on this question.

Responses to the prediction test closely replicate the results by Baron-Cohen et al. (1985), where only four of 20 autistic children of comparable mental ages (mean M.A. = 5-5) were able to make correct predictions. In the present sample, only four of 23 children (mean M.A. = 4-11, or of 26 children, including the three problem cases, mean M.A. = 5-2) answered the prediction test correctly.

The fact that the vast majority of autistic children with mental ages well in excess of 3 years were again incapable of understanding false belief is the more remarkable as their task seemed easier in the present paradigm. They should have been helped in predicting others' response by having experienced making exactly the same mistake themselves. Furthermore, as their correct answers to the Own-Response Prompt show, they were fully aware of their own mistake.

Table 1 shows the contingency between answers to the prediction test and children's awareness of their own wrong response (Own-Response Prompt). As these two questions are similar to the questions asked of normal 3-year-old children by Perner et al. (1987, Experiment 2), the first and second columns in Table 1 compare 3-year-olds with our sample of autistic children. The autistic children were markedly worse in their ability to make correct belief attribution (first row), despite the fact that their average mental age was far higher than 3 years and that they made fewer errors in answering the question about their own wrong response than 3-year-olds (last row).

For our autistic children, we could compare their belief attribution and their ability to remember at the end of the experiment what they had wrongly predicted at the beginning (third column, Table 1). First of all, as

TABLE 1

COMPARISON OF NORMAL 3-YEAR-OLDS[a] AND AUTISTIC CHILDREN OF VERBAL M.A. 6-2 ON THE MISLEADING-APPEARANCE TASK

CORRECT RESPONSES	NORMAL 3-YEAR-OLDS (Prompt)	AUTISTIC CHILDREN	
		Prompt	Memory Check[b]
Fully correct	12	4	4
Incorrect	17	19	19
Pattern of correct responses:			
Own response and attribution	12	4	4
Own response only	9	19	10
Attribution only	1	0	0
Neither	7	0	8

[a] Data from Perner et al. (1987).
[b] One case is missing.

a group they had noticeably more difficulty with this memory check than on the earlier Own-Response Prompt (binomial test [$x = 0$, $N = 9$], $p < .01$). This may be due to a difficulty in remembering a response after repeated questions all concerning the same fact. Nevertheless, there were 10 subjects who still remembered their own response perfectly well but had failed to predict that response for the other person. Not one subject showed the opposite response pattern: binomial ($x = 0$, $N = 10$) = 10.0, $p < .01$.

SLI children.—In contrast to our autistic sample, the SLI group had little difficulty with the false-belief task. All but one made correct predictions on both tasks. The one exception was probably due to some attentional lapse since this child made a correct prediction on the unexpected-transfer task.

To provide a fair comparison of performance on the false-belief test between autistic and SLI children, we compared performance on the misleading-appearance task by the 12 SLI children with that by the 12 autistic children highest in mental age. As Table 2 shows, the mean mental age of the autistic comparison group was higher than the mean of the SLI group. Yet our autistic children performed much worse on the false-belief test than the SLI children: $\chi^2(1, N = 24) = 13.6$, $p < .001$.

Knowledge Formation

Each child was asked four different questions in two tasks (Other and Self Ignorant). The correct answer to each question was "yes" in one task and "no" in the other. Besides this correct pattern of answers, there were three other possibilities: to say "no" on both tasks (No-Bias), or "yes" (Yes-Bias), or to invert the correct pattern of responses (Inverse). Very few responses could not be classified within these four categories. These responses consisted of blurting out with the known content or a guess, or not saying anything. Table 3 shows the frequency of these

TABLE 2

COMPARISON OF SLI CHILDREN AND AUTISTIC CHILDREN OF COMPARABLE MENTAL AGE ON MISLEADING-APPEARANCE TASK

	DIAGNOSIS	
	SLI	Autistic
Chronological age:		
Range	6-11 to 9-11	10-2 to 18-6
Mean	8-8	15-2
Verbal mental age:		
Range	5-5 to 8-7	5-9 to 12-8
Mean	6-9	8-3
False belief test:		
Correct	11	2
Incorrect	1	10

TABLE 3

FREQUENCY OF RESPONSE PATTERNS IN KNOWLEDGE-FORMATION TASK IN AUTISTIC CHILDREN ($n = 23$)

RESPONSE PATTERN	KNOW		SEE	
	Other	Self	Other	Self
Correct	10	13	17	16
Wrong	13	10	6	7
Breakdown of wrong answers:				
"No"-bias	3	0	2	0
"Yes"-bias	7	7	2	4
Inverse	3	0	2	1
Unclassifiable	0	3	0	2

response patterns for each of the four questions.

Most autistic children evaluated visual access correctly, both for themselves and for the other experimenter, which was to be expected from the findings by Hobson (1984) and Leslie and Frith (1988) on visual perspective-taking tasks. However, the number of failures in the present study was somewhat higher (6/23) than in Leslie and Frith (1988): 0/14 and 0/18. This could be due to procedural differences between the two studies. Like the Leslie and Frith sample, our sample of autistic children were much less able to make correct knowledge attributions to themselves or to the other person. There was a strong contingency between knowledge attribution and seeing judgments. All 10 children who made correct knowledge attributions also judged the other person's visual access correctly, and the six children who made an error in their judgments of visual access also failed on knowledge attribution. This yielded a significant positive correlation: $\Phi = .52$ (Fisher's test: $p < .05$).

Of the remaining seven children, all made correct judgments of visual access but failed to attribute knowledge correctly. Not a single subject showed the opposite pattern (binomial test: $x = 0$, $N = 7$, $p < .02$). This finding that visual access is easier to judge than knowledge is also typical of normal 3-year-old children (Perner & Ogden, 1988; Wimmer, Hogrefe, & Perner, 1988a).

The conclusion that a small but sizable proportion of autistic children do understand the role of visual access in knowledge formation can be further strengthened by looking at children's justification of their knowledge judgment. We considered a "know" response adequately justified if the child mentioned "seeing" or "looking" (e.g., "she saw it," "she could look inside," "she saw it put in there," etc.). Insufficient justifications included "she knows," "it's a peg," "don't know," "magic." A "not know" answer was considered adequately justified if the child mentioned the lack of visual access, for example, "couldn't look," "haven't seen it," etc., or mentioned the obstacle to seeing (e.g., "the hand's on it") or experimenter's hiding intention (e.g., "it's a secret," "you hid it"). Most responses classified as insufficient justification consisted of "don't know" answers or silence.

The contingency between adequately justified correct knowledge attributions to other and to self was almost perfect: $\Phi = .91$, Fisher's test: $p < .001$. As there were eight subjects who gave adequate justifications for other and self on both tasks, we may conclude that about 35% of the children tested have made a clear connection between visual access and knowledge. This compares favorably with the 17.5% of the sample who passed on false-belief attribution, yet it is still lamentably low when the M.A. of the children is taken into account.

The contingency between belief and knowledge attribution shows a clear picture, though the data base is limited because only four children made correct false-belief attributions. Nevertheless, the four children who did so were also able to attribute knowledge on the basis of visual access and justify their attribution to another person. All 12 children who failed on knowledge attribution also failed on belief attribution. The resulting correlation is positive ($\Phi = .61$) and statistically significant (Fisher's test: $p < .05$). A very similar result was found by Leslie and Frith (1988).

There is some indication that adequately justified knowledge attribution may be slightly easier than understanding false belief, as the remaining four children could attribute knowledge and justify their attribution but could not make a correct false-belief attribution (binomial test: $x = 0$, $N = 4$, $p = .062$, one-tailed). This difference in task difficulty is also shown by normal 3- and 4-year-olds (Hogrefe et al., 1986).

Communication

In two cases, the experiment had to be terminated after the false-belief task. Consequently, there were only 24 subjects with complete data on both communication tasks. There was no discernible difference between the boxes and the bee task, and no difference due to the order in which the partial and total ignorance tasks were presented.

The materials for these tasks had been chosen such that one response item in each task was interesting and salient ("apple" in box task and "flying" in bee task), while the other was rather dull ("piece of paper" and "nodding," respectively). If salience has an effect on children's communication, then this should be most visible in the Total Ignorance condition since the partner is equally ignorant about both items. In fact, children's preference to mention the salient item first was overwhelming in this condition (21 of 24).

In the Partial Ignorance condition, the partner was ignorant of the dull item but knew about the interesting item. Children who understand that the purpose of their

TABLE 4

FREQUENCY OF RESPONSE PATTERNS COMBINED FOR THE TWO COMMUNICATION TASKS ($n = 24$)

RESPONSE PATTERN		
Partial Ignorance	Total Ignorance	FREQUENCY
Salient	Salient	10
Dull	Salient (correct)	11
Salient	Dull	3
Dull	Dull	0

communication is to inform the other person of what that person has not yet seen should recognize the dull item as the more relevant one, and therefore mention it first, whereas children who do not understand relevance in this way should show the same bias for the salient item in the Partial Ignorance condition as in the Total Ignorance condition.

Accordingly, if autistic children do not understand this principle of relevance to others, then we expect that most of them will prefer the salient item in both conditions (first row in Table 4), and that very few will choose the dull item in both conditions (last row). One would expect some intermediate frequency for choosing the dull item on just one occasion, regardless of which of the two conditions this happens in (equal frequencies in rows 2 and 3 of Table 4). If, however, some autistic children are able to adjust their answers to the question-asker's ignorance, then the frequencies in the second row ("Correct") in Table 4 should be boosted above the frequency of occasionally opting for the dull item indicated by the frequency in the third row.

The frequencies in Table 4 indeed indicate that the dull item was chosen for the ignorant partner more often (second row) than for the totally ignorant partner (third row): McNemar's $\chi^2(1, N = 14) = 4.57, p < .05$.

This result suggests that our able autistic children may have some ability to adjust their communicative response to another person's informational needs. Yet it also shows that their ability or willingness to make this adjustment was far from perfect, as correct mention of the dull item to the partially ignorant partner occurred in only about one-third of times.[2] This small incidence of correct communicative adjustment can reflect two distinct possibilities. One is that about one-third of our autistic sample are able to make this adjustment reliably, and the rest are incapable of doing so. In this case, if children were tested again, the one-third reliably correct responders should again make the correct adjustment, while the rest should fail to do so. The other possibility is that most of our autistic children have the ability to adjust their responses but use this ability only occasionally (about one-third of the time). In this case, only about one-third of the children who mentioned the dull item to the partial ignorant partner on the first test would do so again on a retest, while about one-third of those who did not make the adjustment on the first test will make it on the retest.

To find out which of these two possibilities might be correct, we retested 20 subjects in the Partial Ignorance condition using different test material. About half the subjects, all those who had the bee in the Partial Ignorance condition in the first test, were tested on the boxes task using as contents a calculator (salient) and a piece of wood (dull). The other half was shown a golden star (salient) and a piece of paper (dull) going up a "Magic Stick" (Perner & Leekam, 1986). Results strongly favored the second possibility of generally unreliable performance: only three subjects of those who had made the correct adjustment the first time mentioned the dull item again, while seven of those who had not made the adjustment the first time did so on the retest. This inconsistent performance confirms reports of autistic children's difficulty in using the pragmatic distinction between new and old information (Baltaxe, 1977; Paul, 1987).

Yet, despite this inconsistency, there were about two-thirds of our autistic sample who mentioned the nonsalient item first at least once in response to the partially ignorant partner. However, these adjustments need not have been based on understanding that one's answer is to fill a gap in the other per-

[2] Although there were 11 cases (somewhat more than one-third) in which the dull element was preferred as an answer for the partially ignorant partner, these cases need not all reflect sensitivity to that partner's informational needs. Rather, a certain number of these cases may be due to preference for mentioning the dull item regardless of partner's informational state. The best estimate of that incidence is the number mentioning the dull item to the totally ignorant partner, that is, three. On the basis of this estimate, eight of the 11 mentions of the dull item to the partially ignorant partner were genuine cases of communicative adjustment (8 of 24 = ⅓).

son's knowledge. This is actually suggested by an almost total lack of correlation between choosing the nonsalient item in the communication task and justified knowledge attribution in the knowledge-formation task: Φ = .21,[3] $\chi^2(1, N = 23) = 1.01, p > .30$. In fact, correct communicative adjustment may not even be based on the ability to judge the other person's informational access. Again, there was no correlation between communicative adjustment and judgment of visual access in the knowledge-formation task: Φ = .06, $\chi^2(1, N = 23) = 1.01, p > .10$. Instead, children's adjustment to old and new information may be based on very rough environmental indicators. From the child's point of view, it may be a question of verbally doing what the other failed to do, that is, calling out the name of the object in the box that the other did not open ("piece of paper").

Relation of task performance to mental and chronological age.—We tested the relation between performance on the three tasks (belief, knowledge, and communication) and mental and chronological age by comparing the mean age of children who gave correct answers on a particular task with the mean age of those who gave incorrect answers. We also checked whether the ability to correctly justify true knowledge attribution bore a relation. In addition to mental and chronological age, we also included (verbal) IQ as defined by Binet (IQ = [mental age ÷ chronological age] × 100). There was no indication in any of these comparisons that task performance bears any reliable relation to mental age, chronological age, or IQ: all t values < 1.2, p > .20.

This lack of relation with mental age and IQ underscores again that autistic children's problems with mental state attribution and communication are independent of their intellectual development otherwise.

Discussion

The present study has succeeded in confirming and extending the conclusions drawn on the basis of the experiments by Baron-Cohen et al. (1985, 1986) and Leslie and Frith (1988). It supports the claim that able autistic children are severely impaired in their theory of mind. Furthermore, this impairment is not a result of general mental retardation. The present investigation makes this point in comparison to language-impaired children with a new range of tasks and thus confirms and extends previous findings.

Indeed, the present results underline just how poor autistic performance in understanding false belief is: what normal children can do with ease when they reach a mental age of 4, only a small minority of autistic children can accomplish with a (verbal) mental age of up to almost 13 years.[4] We can rule out the possibility that general impairment in language comprehension is responsible for failure because of the near-perfect performance of nonautistic children with specific language impairment. Autistic children's difficulty in attributing a false belief is not due to memory failure. It exists even though they can remember their own erroneous response in the same situation. Our data leave it open whether this difficulty arises from an inability to infer false belief from the deceptive circumstances or from an inability to use false belief for predicting another person's response. In normal children, these two distinct possibilities seem to concur developmentally (Harris, Johnson, & Harris, personal communication; Perner et al., 1987), indicating that the common cause is a problem in conceptualizing mental representation (Perner, 1988a) or understanding how mental representations are causally related to the world (Leslie, 1988; Wimmer et al., 1988b).

Certain aspects of theory of mind are more easily developed than others. This is true for the normal as well as the autistic child. One aspect concerns understanding informational access, for instance, understanding that one knows something because one has seen it and, conversely, that one does not know something because one has not seen it. According to our results, we can expect that about one-third of able autistic children will understand this relation and thus understand "knowing" in terms of visual access. This performance is poor relative to mental age and is similar to that of the normal 3-year-old. There is some evidence that understanding knowing in this way is a component of understanding

[3] That this insignificant but positive correlation is but error variation around a true correlation of 0.0 is suggested by the fact that the corresponding correlation between justified knowledge attribution and answers for the partially ignorant partner in the second communication test was actually negative: = −.15.

[4] It should be borne in mind that our use of verbal mental age is a conservative method given that autistic children regularly show substantially higher nonverbal than verbal M.A.s, often by as much as 2 or 3 years.

false belief since all four children who could understand false belief also demonstrated understanding of the knowledge-ignorance distinction. However, there were another four children who demonstrated understanding of the knowing/not-knowing distinction without understanding false belief, which indicates that autistic children, like normal 3-year-old children (Hogrefe et al., 1986), find this distinction slightly easier to understand than false belief. Leslie and Frith (1988) also found a small group of autistic children who appeared to understand partial knowledge but not false belief.

Our results can be summarized descriptively by saying that autistic children are grossly delayed in their acquisition of a theory of mind. Their degree of impairment, however, spreads over a wide range in the normal child's development. About one-fourth of our sample were unable to make consistent judgments of visual access, an ability that develops by the age of 2 years or even earlier in the normal child (Flavell, Abrahams, Croft, & Flavell, 1981; Masangkay, McCluskey, McIntyre, Sims-Knight, Vaughn, & Flavell, 1974). It might be, however, that a difference in procedure (e.g., use of a more difficult question, "Did I let someone look?" rather than "Can someone see?") has produced slightly lower performance on this task than in other studies of autistic children (Hobson, 1984; Leslie & Frith, 1988).

About two-thirds of our sample had difficulty making knowledge attributions and justifying them. In the normal child, this ability develops between 3 and 4 years (Hogrefe et al., 1986; Marvin, Greenberg, & Mossler, 1976; Mossler, Marvin, & Greenberg, 1976; Wimmer et al. 1988a). Of the one-third who could make justified knowledge attributions, only half were also able to attribute a false belief, which most 4-year-old normal children can do (Perner et al., 1987; Wimmer & Perner, 1983). Extrapolating from results by Baron-Cohen (1988), we may assume that even these four autistic children who are most advanced in their theory of mind would fail second-order belief attribution (i.e., what John thinks that Mary thinks . . .). Normal children master this complex task by the age of 6 to 8 years (Perner & Wimmer, 1985).

This developmental sequence can be put in a theoretical context by drawing on several recent suggestions. Judgment of visual access is relatively easy because it does not involve understanding of mental states but only the judgment of a physical relation between the other person's eyes and the object in the box (Leslie & Frith, 1988; Perner, 1988a). Attribution of knowledge is difficult because the child has to understand how events in the real world (i.e., looking at something) cause a mental state of knowing (Wimmer et al., 1988b). This understanding of how events in the real world cause a mental state is made particularly difficult if the content of the mental state is nonreal, as in the case of a false belief (Leslie, 1988). The attribution of second-order false beliefs is yet more difficult again because of the recursive nature of such attribution (Perner, 1988b).

Finally, the results from the communication task reinforce this rather bleak picture. Only a tiny proportion of the autistic children (12.5%) reliably took into account the listener's knowledge in shaping a message, despite the fact that a larger number had shown themselves capable of working out what that knowledge might be. This raises the possibility that even where an autistic child has a certain level of facility in understanding mental states, he or she may not use it to the full in communication situations.

The foregoing description of the autistic child's range of impairment in theory of mind raises the question of whether there is a single neurodevelopmental malfunction leading to a single computational deficit with multiple cognitive effects, as originally suggested by Baron-Cohen et al. (1985) and Leslie (1987), or whether there are a set of such malfunctions perhaps affecting different autistic children in slightly different ways. Insight into these questions depends partly upon more explicit modeling of the computations underlying such tasks, as well as further investigation into the relation between the understanding of knowledge (true belief) and the understanding of false belief. In this, studies of childhood autism and normal development will complement each other in important ways.

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