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4/01

Journal of Autism and Developmental Disorders, Vol. 32, No. 2, April 2002 (© 2002)

Do Children with Autism Who Pass False Belief Tasks Understand the Mind as Active Interpreter?

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Interpretive diversity is the term used by Carpendale and Chandler (1996) to refer to the fact that two individuals exposed to precisely the same stimulus may interpret it in quite different, but equally plausible, ways. An appreciation of interpretive diversity is said by Carpendale and Chandler to represent a development in understanding that is qualitatively different from that necessary to succeed on false belief tasks. A study is reported in which children with autism and children with general delay were given a battery of tasks consisting of false belief tasks and tasks designed to test for an understanding of interpretive diversity. Findings from the present study offer limited support for Carpendale and Chandler's claim that tasks which test for an understanding of interpretive diversity may be more difficult than false belief tasks. Between-group differences in the consistency and quality of responses given by participants suggest that autistic and delayed children may have differed somewhat in their approach to the tasks given.

KEY WORDS: Autism; theory of mind; interpretive diversity.

INTRODUCTION

Autism has long been considered a disorder in which understanding about the mind is specifically impaired (see Baron-Cohen, 2001, for a recent review). Yet most investigations concerned with theory of mind pathology in autism continue to focus on children's understanding of epistemic states within only a narrow range of contexts. Among the most common of these is the "seeing-leads-to-knowing" paradigm, in which children must apply the principle that visual access to an object or event is a necessary condition for knowledge concerning it (Baron-Cohen, 1992; Baron-Cohen & Goodhart, 1994; Perner, Frith, Leslie, & Leekam, 1989). For example, it seems likely that understanding the principle of "seeing-leads-to-knowing" constitutes one of the processes involved in solving standard location-change false belief tasks like the Sally-Ann (Baron-Cohen, Leslie, & Frith, 1985). To succeed with this task, children are required to understand that a character in a story will assume an item to be in its original location because she was absent when the object was moved to another place. Broadly speaking, typically developing children of around 4 years and older have been found to succeed on false belief tasks of this kind. Children with autism, however, have usually been found to perform worse on false belief tasks than do language- and mental age–matched control subjects (e.g., Baron-Cohen, 1989; Leekam & Perner, 1991; Reed & Peterson, 1990).

Recently, there has been some concern within the literature that a continued focus on understanding of false belief both in autism and in typical development may persist at the expense of research into other aspects of children's developing understanding about the mind. In particular, a number of authors have begun to question the assumption that a *belief-desire psychology* of the kind assessed by false belief tasks constitutes the

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0162-3257/02/0400-0127/0

single most important feature of a mature theory of mind. Among these authors are Carpendale and Chandler (1996), who have debated Perner and Davies' (1991) assertion that the ability to pass false belief tasks at age 4 years demonstrates a fledgling understanding of the mind as an *active interpreter.* An understanding of this latter kind is reserved by Chandler & Boyes (1982, p. 393) for "a subject-oriented or constructivistic epistemology," in which knowledge is no longer seen to be reactive to objective events but rather the product of "two-way" communication between the mind and environment. Central to this idea is an understanding that two persons exposed to precisely the same sensory stimulus can interpret this in quite different ways. For example, Carpendale and Chandler found that, of their sample of 5- to 8-year-olds, only the older children understood that it would be difficult to predict which of two interpretations another child would choose first of Jastrow's (1900) ambiguous duck/rabbit figure. One crucial difference between this task, which is said by Carpendale and Chandler to test for an understanding of *interpretive diversity* and those which assess an understanding of false belief, is that the former *cannot be approached using the principle of "seeing-leads-to-knowing."* Indeed, the fact that most 5-year-olds failed and most 7- and 8-year-olds passed their Duck/Rabbit task is said by Carpendale and Chandler to indicate a development in children's understanding about minds that is qualitatively different from that required to succeed on false belief tasks. Unfortunately, however, Carpendale and Chandler do not offer a detailed account of the processing capacities required for an understanding of interpretive diversity, a matter they presumably hope to explore in further research.

To our knowledge, understanding of interpretive diversity has not previously been examined in individuals with autism or general cognitive delay. If supported by future empirical evidence, Carpendale and Chandler's distinction between two aspects of knowledge about the mind is important not the least of which because it offers an opportunity for investigating possible differences between the development of social understanding in typically developing, delayed, and autistic populations. Comparing performances by children with autism and those with cognitive delay on tasks that look at different "qualities" or "depths" of social understanding is of particular interest because of suspicions that at least some autistic children may pass or fail false belief tasks for reasons quite different than those of other children. When compared with typically developing preschoolers, for example, children with autism may present with unusual profiles across false belief tasks and tasks that test for an understanding of nonmental representation, such as false photographs (Zaitchik, 1990). To succeed on false photograph tasks, children are required to demonstrate an understanding that a photograph may misrepresent a current state of affairs because the scene it depicted has changed since the photograph was taken. Although 3- to 4 year-olds tend to perform similarly across both false photograph and false belief tasks, children with autism generally perform better on the former than on the latter (e.g., Leekam & Perner, 1991; Peterson & Siegal, 1998). This difference in performance profiles has been highlighted by Leslie and colleagues (Leslie, 1994; Leslie & Roth, 1993; Roth & Leslie, 1998; Scholl & Leslie, 1999; Surian & Leslie, 1999) in their modular account of theory of mind difficulties associated with autism. According to Leslie, false beliefs differ from false photographs in that their understanding requires the capacity to process *metarepresentations,* a function carried out by an innate module called the "Theory of Mind Mechanism" (ToMM). Success on a task like the Sally-Ann (Baron-Cohen *et al.,* 1985), for example, is said to require the appropriate specification of "agent," informational "content," and "anchor" within a metarepresentational "data structure": Sally BELIEVES (that) "it is in the basket" (is true of) the marble (Roth & Leslie, 1998, p. 4). Leslie and colleagues take poor performance on false belief tasks by children with autism to indicate a specific deficit in metarepresentational ability, assumed to arise from critical damage sustained to ToMM. In contrast, the more general difficulties shown by typically developing preschoolers across both false belief and false photograph tasks are suggested to arise from performance errors, brought about by immaturities in an executive system—the *selection processor.*

Although Leslie and colleagues assume that less able children with autism have an absolute impairment in the capacity for metarepresentation, it has been suggested that the disorder as a whole may more generally be characterized by a delay in or continuum of metarepresentational ability (Happe, 1994). This idea seems consistent with the findings that some autistic children perform well on first-order false belief tasks but not on higher-order tasks where the metarepresentational demands are increased and that good performance on first- and second-order tasks seems to correlate with different levels of competence in other areas. For example, Happe (1993) found first- and second-order false belief performance to correlate with understanding of metaphor and irony, respectively. Similarly, Hurlburt *et al.* (1994) noticed a marked difference in the capacities for introspection shown by individuals with Asperger's syndrome who performed at either floor, first-order, or second-order levels of false belief. Unfortunately, however, neither of these studies provides direct evidence for the role that metarepresentational ability may have played in generating the results reported. Indeed, in the case of Happe's study, the correlation between different types of figurative language understanding and false belief task performance extended to a group of children with cognitive delay, a finding that seems at odds with Leslie's suggestion that metarepresentational demands are not a factor in performance by nonautistic individuals. In the case of Hurlburt *et al.*'s investigation, too, the absence of any comparison group makes it difficult to ascertain whether the correlation between false belief task performance and introspection was autism specific or otherwise.

To obtain strong evidence for the hypothesis that autism is characterized by a continuum of metarepresentational ability, one would need to observe a difference in the performance profiles shown by children with autism and comparison children across tasks that make the same metarepresentational demands. It is our contention that Carpendale and Chandler's (1996) notion of interpretive diversity may present just such a test case. Importantly, there seems little reason to suppose that an understanding of interpretive diversity should make greater metarepresentational processing demands than an understanding of false belief (both require a first-order processing of attitudinal relations toward a representation). As a result, a continuum of damage to ToMM in autism should leave individual children equally impaired or unimpaired on tasks of both kinds. Furthermore, this profile across tasks should differ from that demonstrated by a subgroup of children with general cognitive delay, so long as Carpendale and Chandler are correct in their argument for a distinction between understandings of false belief and interpretive diversity in instances where children are following a typical path of development. As stated, Carpendale and Chandler do not provide a detailed account of the processing demands that are unique to an understanding of interpretive diversity. However, provided the critical factor is not an increase in the demands on metarepresentational capacity, then comparison across interpretive diversity and false belief tasks has the potential to elicit a between-group difference in support of the present hypothesis.

A challenge for the present authors was to assess understanding of interpretive diversity in such a way that procedural bias would not be a factor in separating its measurement from performance on false belief tasks. In an attempt to answer this concern, we designed one of our interpretive diversity tasks to resemble, as closely as possible, Perner *et al.*'s (1989) "Smarties" false belief task. In the Smarties task, children are shown a familiar confectionery carton and asked what they think is inside. Once children have responded with "Smarties" (similar to M & Ms) or "sweets," the lid is removed from the carton to reveal the true contents—a pencil. The lid is replaced, and children are asked what another child, who has not seen inside the carton, will think is inside. To succeed on the Smarties task, children are required to understand that a classmate who is not aware of information to the contrary will be likely to assume that the carton contains Smarties.

In the "Cow" task, used in the present study, children were presented with a blurred picture that none of them were able to interpret meaningfully. Children were then given guided insight (see Procedure) into an alternative and more meaningful *interpretation* of this picture—that is, a different way of perceiving the stimulus—that enabled them to recognize the picture as a somewhat grainy portrait of a cow. Importantly, it was intended that participants who had been "trained" to interpret the stimulus in this way would henceforth find it difficult to perceive the picture simply as a blur in the way that they had done formerly. In this way, children experienced a change in their mental representation of a given stimulus similar to that undergone in the Smarties task. However, although the Smarties task concerned the possible misrepresentation of an objective (although concealed) item "out there," the Cow task referred only to subjective interpretation of ambiguous stimuli. To succeed on the Cow task, then, children were required to understand that what they saw when they looked at a given picture might be radically different from that seen by another child, who, nonetheless, was looking at *precisely the same* stimulus as themselves. An appreciation that the mind actively interprets a stimulus in this way is considered by Carpendale and Chandler to be the definitive feature of an understanding of interpretive diversity, distinguishing it from the "seeing-leads-to-knowing" principle that is sufficient for success on false belief tasks like the Smarties. The question of whether this distinction is one that might be found to characterize children's understandings at a particular stage in their development is an empirical matter that we set out to explore.

Full procedures for the Cow and Smarties tasks, as well as one further false belief task (Baron-Cohen *et al.*'s [1985] Sally-Ann task, introduced earlier) and two further interpretive diversity tasks are presented here. In an effort to forestall any complaint that the Cow task failed to adequately assess Carpendale and Chandler's notion of interpretive diversity understanding, we included an adaptation of the Duck/Rabbit task used by these authors. The third and final interpretive diversity task was the "Giraffe" task designed by Taylor (1988). Taylor proposes that the two-level scoring system used in the Giraffe task is effective at categorizing individuals according to their status either as someone who works on the basis of "seeing-leads-to-knowing" or as one who has a mature understanding of interpretive diversity. If Carpendale and Chandler (1996) are correct in arguing that success on false belief tasks requires only an understanding that "seeing-leads-to-knowing," then one might expect children who perform at the lower level of the Giraffe task to pass on false belief but fail on interpretive diversity.

Overall, it was anticipated that analysis of performances across the separate interpretive diversity tasks would inform us as to whether these tasks constituted a cohesive assessment, distinct from that offered by the two false belief tasks. To summarize, it was hoped that comparing the performance of children with autism with that of a group of children with a general cognitive delay on false belief tasks and on tests of interpretive diversity understanding would be of interest on two main counts: (1) we wanted to test Carpendale and Chandler's (1996) hypothesis that an understanding of interpretive diversity is more difficult than an understanding of false belief tasks for children who follow a typical path of development; the present study was the first time that both of these two types of understanding had been investigated in a single sample of children with cognitive delay; and (2) we hoped to test the hypothesis that children with autism perform on false belief tasks as a function of their capacity for metarepresentation (e.g., Roth & Leslie, 1998). This hypothesis would be supported if individual children with autism differed from those with cognitive delay by performing similarly across all of the tasks presented.

METHODS

Participants

Sixty-eight children were tested on five tasks. Of these, 34 had received a diagnosis of autism according to standard criteria (*DSM III-R* [American Psychiatric Association, 1987]; *DSM IV* [American Psychiatric Association, 1994]), and 34 were children with significant cognitive delay drawn from schools for children with "moderate learning difficulties." None of the children in the cognitive delay group had received a diagnosis of any Autism Spectrum Disorder or retardation-related syndrome. All children were drawn from educational establishments in Hertfordshire, Essex, and London, United Kingdom.

The two groups were matched on a measure of verbal comprehension. The Test for Reception of Grammar (TROG; Bishop, 1989) was chosen in preference to the British Picture Vocabulary Scale (BPVS; Dunn *et al.,* 1982) as an assessment of children's language comprehension. Although not a measure of verbal intelligence, the TROG differs from the BPVS in that it offers an evaluation of children's understanding of spoken sentences. Given the verbal nature of the tasks presented, it was considered important to establish that participants had adequate receptive language to cope with the demands made by test questions. Only children who scored an age equivalent of 4 years or above were included in the study. Chronological age (CA) and verbal comprehension age (VCA) characteristics for the delayed and autism groups are presented in Table I. Groups did not differ significantly for either CA or VCA (CA: $t = -.58$, $df = 66$, NS; VCA: $t = 1.29$, $df = 66$, NS).

Procedures

Participants were individually tested in a familiar room within their school. Tasks were presented in random order within the space of one 20- to 30-minute session. Altogether, two false belief tasks and three tasks that set out to assess understanding of interpretive diversity were included. The procedures for these tasks are outlined here.

Table I. Sample Characteristics

Demographic variable	Autism (n = 34)	Delayed (n = 34)
Chronological age[a]		
Mean	11.11	11.6
SD	3.0	3.0
Range	6.4–16.2	7.0–16.1
Verbal comprehension age[b]		
Mean	7.7	8.5
SD	2.7	2.5
Range	4.3–11.0	4.3–11.0

[a] All ages are given in years and months.
[b] Verbal comprehension ages are given in accordance with age-equivalent scores on the Test for Reception of Grammar (TROG; Bishop, 1989).

False Belief Tasks

Two standard false belief tasks were administered; Baron Cohen *et al.*'s (1985) Sally-Ann and Perner *et al.*'s (1987) Smarties tasks. In the first of these, participants are asked to watch a scene acted out with puppets, one of whom is called Sally and the other is called Ann. Sally has a basket, and Ann has a box. Sally places a sweet inside her basket before leaving to go shopping. When she is gone, naughty Ann takes the sweet from Sally's basket and places it in her own box. Now Ann leaves to visit her friend. Sally enters and wants her sweet. Participants are asked:

Test question: Where will Sally look for her sweet first?
Reality question: Where is the sweet now?
Justification question: Why will Sally look in the basket/box?
Memory question: Where was the sweet at the beginning?

In the second task, children are shown a familiar Smarties (M & Ms) carton and asked to guess the contents. All participants replied appropriately with "Smarties" or "sweets." The lid is then removed from the carton, and a felt-tip pen is produced from inside and held up for participants to see. Children are asked to identify this. Again, all children answered correctly. The experimenter returns the pen to the Smarties carton and replaces the lid, before asking the following:

Test question: I'm seeing (classmate's name, e.g., James) after you. James hasn't seen inside this Smarties box before. If I show it to James all closed up like this, just like I showed it to you the first time, what will James say is inside?
Reality question: What's really inside the box?
Memory question: When I first showed you the box, before we opened it, what did you say was inside?
Justification question: Why will James say that there are Smarties inside?

Participants were required to answer all questions correctly on each task to score a pass. To achieve an overall pass for false belief understanding, children were required to pass both the Sally-Ann and the Smarties tasks.

Interpretive Diversity Tasks

Three tasks were used to look at children's understanding that the mind actively interprets sensory stimuli rather than passively receives it.

Cow Task. The first of these tasks was designed to resemble the Smarties task as closely as possible, differing in that the stimuli did not change throughout the task, but rather children's interpretation of it did change. Children were introduced to the picture shown in Fig. 1a and asked "What can you see in this picture?" In the 10 seconds participants were given to study the picture, none were able to identify its subject matter. A transparency was then placed over the picture, on which was drawn the outline shown in Fig. 1b. The outline was arranged so that it appropriately matched the shading in Fig. 1a. Children were again asked to identify the picture. All participants were able to recognize a domestic animal, although some of them identified it as a pig or a dog. The transparency was then removed, and children

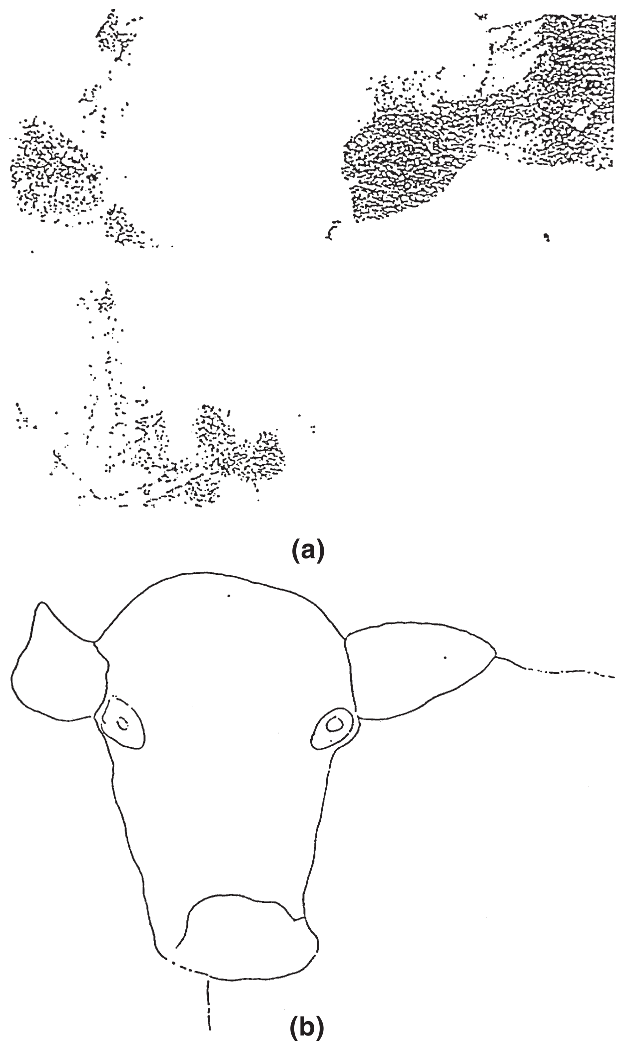

Fig. 1. (a) Stimuli for Cow task (from Darley, Glucksberg, & Kinchla, 1986, p. 117). (b) Transparency for Cow task (adapted from Darley, Glucksberg, & Kinchla, 1986, p. 118).

were asked to point to the animal's ears, eyes, and nose. Where children were unable to comply, the transparency was replaced over the picture and the process was repeated until all participants were able to show that they could still see the animal when the transparency was absent. Next, children were asked the following:

Test question: I'm seeing (classmate's name, e.g., James) after you. James hasn't seen this picture before. If I show this picture to James like this, just like I showed it to you the first time, what will James say is in the picture?
Reality question: What's really in the picture?
Memory question: When I first showed you the picture, before I put this drawing on top of it, what did you say was in the picture?
Justification question: Why will James say there's nothing in the picture/the picture is just a blur?

Children needed to answer all of the questions correctly to pass the task.

The Cow task was specifically designed so that the demands placed by its solution on children's metarepresentational ability would be equivalent to those described earlier for the Sally-Ann or Smarties task according to the modular account of the theory of mind deficit in autism (Roth & Leslie, 1998). Thus, the "data structure" necessary for processing another's different interpretation of the Cow picture might be: James THINKS (that) "it is a blur" (is true of) the picture.

Giraffe Task. The second interpretive diversity task was an adaptation of one devised by Taylor (1988), who, like Carpendale and Chandler (1996), found that only children of 6 years and above were consistently successful. It was also similar to a task that Perner and Davies (1991) claimed 4 year-olds could pass. In the present task, children were shown the picture reproduced in Fig. 2a. All participants were able to identify the animals depicted. Four pieces of card had been prepared, with the same-sized square hole cut in each. Each differed in the position of the hole, and consequently the detail of the giraffe/elephant picture visible when the card was placed over it. The details visible in each case are shown in Fig. 2b. We excluded the "tiny edge" restricted view used in Taylor's study to limit the repetitive questioning that characterized the study as a whole. Participants were asked to look at the picture carefully. Their attention was directed to the fact that the giraffe was sitting down, and they were informed that his name was Gerald. Children were introduced to the task with the information, "Look, if we cover up the picture like this, then all that you can see is just this little bit of the picture here. All the rest is hidden under the paper."

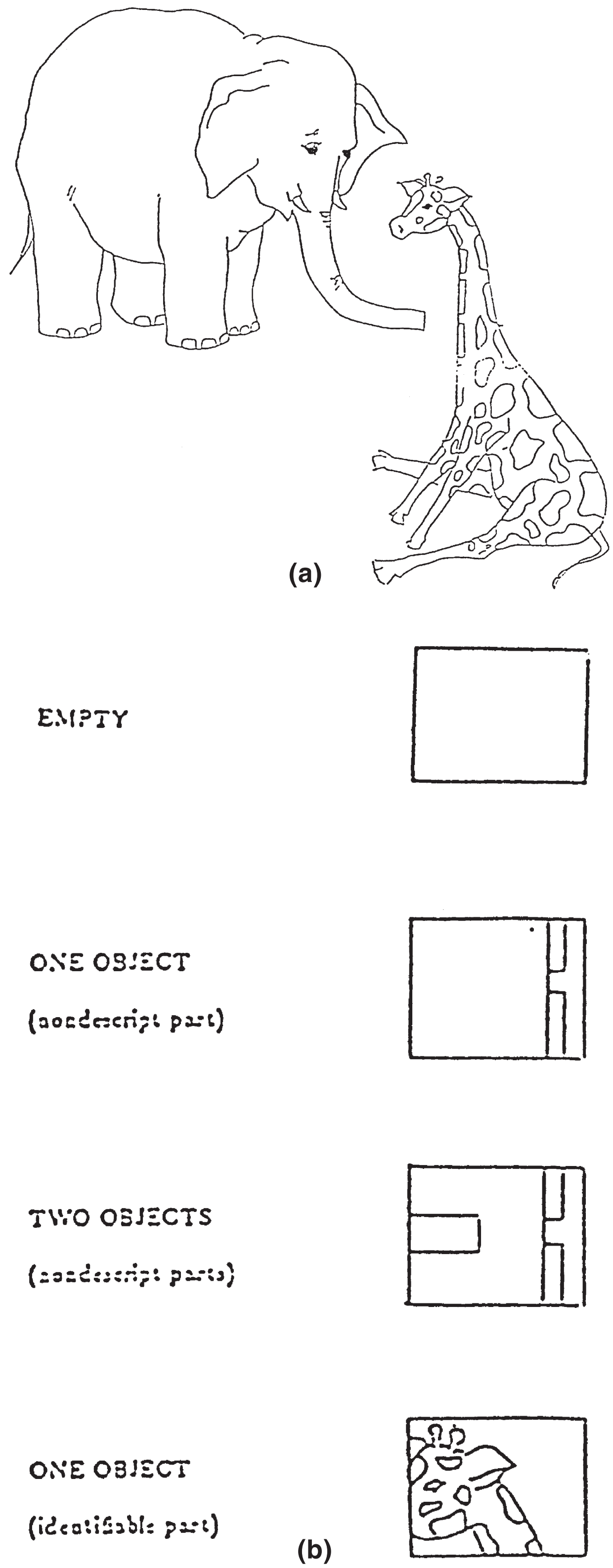

Fig. 2. (a) Stimuli for Giraffe task (taken from Taylor, 1988, p. 706). (b) Restricted views for Giraffe Task (adapted from Taylor, 1988, p. 707).

Children were asked to point to the part of the picture that was visible. Then the experimenter said, "I'm seeing (classmate's name, e.g., James) after you. James hasn't seen this picture before." On presentation of each view, children were reminded that their classmate had not seen the picture before. Participants were then asked the following two questions in randomized order:

Test questions: Will James know that there's a giraffe in the picture? Will James know that there's an elephant in the picture?

For restricted view 4 (identifiable part), two additional questions were asked:

Test questions: Will James know that the giraffe is sitting down? Will James know that the giraffe's name is Gerald?

Following Taylor, responses to questions were classified as characteristic of a level 1 or level 2 understanding, in accordance with Table II. Taylor suggests that level 1 responses to the Giraffe task can be achieved by following the simple principle of "seeing-leads-to-knowing." Level 2 responses, on the other hand, require an understanding that minds actively interpret the information they receive. This is because level 2 responses require an appropriate judgement concerning the likelihood that another person can reach an accurate interpretation of the picture based on incomplete information. This contrasts with level 1 responses, which require only an oversimplified appreciation that visual access *of any kind* is sufficient for knowledge concerning a given item. Scoring children on these two separate levels was of interest because of Carpendale and Chandler's (1996) contention that use of the "seeing-leads-to-knowing" principle (i.e., level 1 response) is sufficient to succeed on false belief tasks. In the present study, children were awarded a pass on the Giraffe task only where they performed at a level 2 understanding.

Duck/Rabbit Task. Last, we wanted to address Carpendale's and Chandler's (1996) complaint that not all tasks that claim to test for an understanding of the mind as active interpreter avoid a more parsimonious account of the level of understanding required to succeed. These authors suggest that a genuine test of interpretive diversity understanding should demand an appreciation that two persons presented with *precisely the same stimulus* may interpret this in quite different ways. In our adaptation of Carpendale and Chandler's task, children were presented with Jastrow's (1900) famous duck/rabbit picture and asked to identify what they saw in the picture. According to the interpretation chosen, the experimenter produced a transparency on which the rest of the duck or rabbit's body was outlined in ink. The experimenter placed the transparency on top of the picture so that the outline could be seen as a continuation of the duck's or rabbit's head shown on paper. The experimenter said, "That's right, it's a (duck/rabbit). There's his (ears/beak), and that's his eye. But look, it could also be a . . . ." Here, the experimenter produced a second transparency with the alternative interpretation in outline. The transparency was placed over the picture, and the experimenter paused to allow the participant to finish his sentence appropriately. He then said, "So this picture could be a (duck/rabbit), or it could be a (rabbit/duck)." As each was identified, the corresponding transparency was again placed over the picture. Children were then asked the following:

Test question: I'm seeing (classmate's name, e.g., James) after you. James hasn't seen this picture before. If I show this picture to James just like this (both transparencies concealed), like I showed it to you the first time, what do you think James will say is in the picture? Will James say that it's a duck or a rabbit, or don't you know what James will say?

Table II. Level 1 and Level 2 Responses to Restricted View Task[a]

	Level 1 responses		Level 2 responses	
Type of restricted view	Elephant	Giraffe	Elephant	Giraffe
Empty	No	No	No	No
One object (nondescript part)	No	Yes/no[b]	No	No
Two objects (nondescript parts)	Yes	Yes	No	No
One object (identifiable part)	No	Yes	No	Yes

[a] From Taylor, 1988, p. 708.
[b] There is no prediction for the answers to this question. Both yes and no answers could be interpreted as consistent with level 1 perspective taking.

The order in which the alternatives (duck, rabbit, don't know) were presented was randomized. As the three options were suggested, a card with each alternative written on it was produced and placed on the table.

Justification question: Why don't you know what James will say? The justification question was included to control for the possibility that children were simply answering "don't know" as a default option.

A pass was awarded on the Duck/Rabbit task when children showed an understanding that they could not know which interpretation another child would choose. To receive an overall pass mark for understanding of interpretive diversity, children were required to succeed on all three tasks.

RESULTS

For each group, the percentage of correct answers for each of the five tasks is given in Table III. Within each group, the percentages of correct answers for the two false belief tasks (i.e., Sally-Ann and Smarties)—apart from one exception—were higher than those for the three interpretive diversity tasks (i.e., Cow, Duck/Rabbit, and Giraffe).

When comparing the proportion of correct answers displayed in Table III between autistic and delayed children, significant differences were found only for two of the five tasks: the Smarties task [$\chi^2(1)$: 3.85, $p <$ .05] and the Cow task [$\chi^2(1)$: 8.47, $p <$ .01]. Both differences were in favor of the delayed group.

To also compare overall performance on false belief and interpretive diversity by these two groups, a simple pass/fail criterion was introduced for each kind of task. Children were awarded an overall pass on each task type only if they were successful on both tasks, in the case of false belief, and on all three tasks, in the case of interpretive diversity. Consistent with findings from previous studies, the group of children with autism had a significantly [$\chi^2(1)$: 6.01, $p <$ .01] lower proportion of overall pass scores on false belief (autistic group, 44%) than did children with a general delay (delayed group, 73.5%). By contrast, no significant difference [$\chi^2(1)$: 1.31, NS] was found between these groups for the proportion of correct answers on all three interpretive diversity tasks (autistic group, 29%; delayed group, 18%).

Furthermore, within-group comparisons regarding the level of overall performance between the two types of tasks revealed that both groups were better on false belief tasks than on interpretive diversity tasks. The difference in percentage between the two types of tasks was 14.7% for the autistic group (false belief, 44.1%; interpretive diversity, 29.4%) and just failed to reach significance (exact p value for McNemar's test, .06). For the delayed group, this difference amounted to 55.9% (false belief, 73.5%; interpretive diversity, 17.6%) and was highly significant (exact p value for McNemar's test, $<$.001).

To investigate the degree of consistency of answers to either type of task, *Phi* correlations among the respective tasks were computed for each group separately. Also, *Phi* correlations between different types of tasks were computed to assess the amount of discriminant validity (Table IV).

The correlation between the two false belief tasks (Sally-Ann and Smarties) was moderate and significant in the autism group but weak and nonsignificant in the delayed group. All three correlations among the interpretive diversity tasks were high in the autistic group, but in the delayed group, only two moderate correlations

Table III. Percentage of Correct Answers for Each Task by Group of Children

Task	Autism group (%) (n = 34)	Delayed group (%) (n = 34)
Sally-Ann	64.7	91.2
Smarties	47.1	76.5
Cow	32.4	67.6
Duck/Rabbit	32.4	41.2
Giraffe	32.4	41.2

Table IV. *Phi* Corrections Among False Belief and Interpretive Diversity Tasks

	Smarties	Cow	Giraffe	Duck/rabbit
Autism group				
Sally-Ann	.57[c]	.51[b]	.51[b]	.51[b]
Smarties	⋯	.73[c]	.73[c]	.73[c]
Cow	⋯	⋯	.87[c]	1[c]
Giraffe	⋯	⋯	⋯	.87[c]
Delayed group				
Sally-Ann	.32	.01	.26	.05
Smarties	⋯	.65[c]	.46[b]	.46[b]
Cow	⋯	⋯	.45[b]	.45[b]
Giraffe	⋯	⋯	⋯	.27

[a] $p <$ .05.
[b] $p <$ .01.
[c] $p <$ .001.

were found, and the correlation between Giraffe and Duck/Rabbit tasks was nonsignificant. These findings suggest that there was a certain amount of disparity between the groups regarding the degree of convergent validity of the tasks representing false beliefs and interpretive diversity respectively. Only the autistic group showed a high degree of consistency in their answers to both type of tasks.

Similar results were obtained for the across-type-of-task correlations (Table IV). The three correlations involving the Smarties task with the interpretive diversity tasks were significant in both groups, but those for the Sally-Ann task were generally lower and in part nonsignificant. Again, all six across-type-of-task correlations were moderate to high and significant only in the autistic group. Interestingly, no significant across-type-of-task correlations were found for the Sally-Ann task in the delayed group. Overall, the amount of discriminant validity for the two sets of tasks appeared to be rather limited.

A correlational analysis between performances on false belief and interpretive diversity tasks was also of interest with regard to the hypothesis that some children might have succeeded on false belief tasks by applying a principle of "seeing-leads-to-knowing." Taylor (1988) suggested that children who perform at level 1 of her Giraffe task may be demonstrating an understanding of this kind, without a full understanding of the mind as active interpreter. If this is the case, then one might expect there to be a significant correlation between level 1 performance on the Giraffe task and success on false belief, accompanied by failure on interpretive diversity. Contrary to this hypothesis, overall pass on false belief in attendance with overall fail on interpretive diversity did not correlate significantly with level 1 performance on the Giraffe task in either the autism group (*Phi* = .19, NS) or the cognitive delay group (*Phi* = .16, NS).

A weak and only marginally significant association between the two overall percentage rates for the two kinds of tasks was found for the MLD group (*Phi* = .31, p = .08), but a high and significant one was found for the autistic group (*Phi* = .73, p = .001).

Table V. Results for the Cross-tabulation Analysis Between the Overall Percentage Correct of False Belief and Interpretive Diversity Tasks

	Fisher's exact test	*Phi* correlation
Autistic group	$p < .001$	.73 ($p < .001$)
Delayed group	$p > .10$	.31 (NS)

Of the 15 autistic children who succeeded on the false belief tasks, 67% also solved the interpretive diversity tasks, but only 28% of the 25 delayed children who were successful on the false belief tasks managed to solve the interpretive diversity tasks. Hence, there was a considerable difference between the two groups in their conditional probabilities of also solving the interpretive diversity tasks if the false belief had been passed successfully.

Finally, the relation between verbal comprehension age and the probability of correctly solving all tasks of either type was examined for the autistic and delayed groups using logistic regression analysis. A first model investigated the influence of verbal comprehension age and group membership on the probability of correctly solving both false belief tasks. This model yielded a significant improvement over a baseline model (likelihood ratio, 34.46, $df = 2$, $p < .001$) with both predictors reaching the level of significance ($p < .05$). The adjusted odds ratio between group membership and success or failure on both false belief tasks was 4.06 (95% *CI,* 1.06–15.62) in favor of the delayed group, confirming that after controlling for possible differences in verbal comprehension age, delayed children were four times more likely to solve both false belief tasks than were autistic children. The relation between verbal comprehension age and the predicted probabilities of success on both false belief tasks is shown in Fig. 3 for both groups. As can be seen, delayed children are expected to reach the 50% pass rate at around 6 years, whereas autistic children need 2 additional years more to reach that rate.

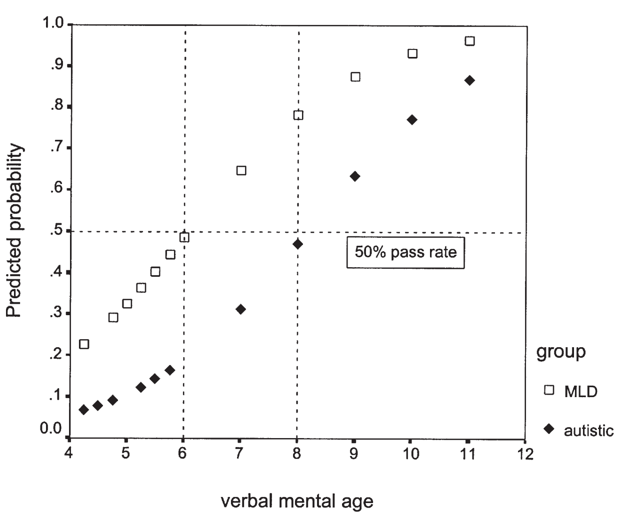

Fig. 3. Expected probability of correctly solving both false belief tasks for autistic and MLD children.

The same analysis was repeated for the probability of passing all three interpretive diversity tasks. As before, verbal comprehension age proved to be a significant predictor ($p < .001$), but the adjusted odds ratio representing the size of the difference between the groups in obtaining a pass on all three tasks was not significant (odds ratio, 3.3; 95% *CI,* .81–13.3). Thus, the verbal comprehension age at which children were expected to reach a 50% pass rate was fairly similar for the two groups (autistic group, 8.7 years; delayed group, 10 years); this time, however, at a slight advantage for the autistic group.

DISCUSSION

We set out to examine performances across five theory of mind tasks by children with autism and children with cognitive delay. The results provide tentative support for Carpendale and Chandler's (1996) assertion that an understanding of false belief is developmentally precedent to an understanding of interpretive diversity. Consistent with this hypothesis, the group of children with developmental delay in our sample performed significantly better on an overall measure of false belief understanding than on three tasks aimed at assessing understanding of interpretive diversity. However, the weak or moderate nature of correlations found between tasks in each of these categories suggests that caution is needed before interpreting these results as supportive of a general distinction between understandings of false belief and interpretive diversity. We consider the possible implications of such inconsistencies in performance by children with cognitive delay further in the discussion.

As in many previous studies, the children with autism in the present investigation performed significantly worse on an overall measure of false belief understanding than did children with a general delay matched for verbal comprehension age. Indeed, this difference between groups persisted even after variation in verbal comprehension had been statistically controlled for. This finding is of special interest because of the current discussion concerning the relationship between language and theory of mind competence in children with autism (e.g., Happe, 1995; Tager-Flusberg, 1999). The present study supports previous evidence for an association between language abilities and performance on false belief tasks, not only for children with autism but also for children with cognitive delay (Frith, Happe, & Siddons, 1994; Kazak *et al.,* 1997; Yirmiya *et al.,* 1996, 1998). However, as in a previous study by Happe (1995), the language competence at which we found children with autism to achieve a 50% success rate on false belief tasks was somewhat higher than that found to characterize children in the comparison group (although, in fact, the TROG age equivalent of 8 years recorded in the present study was slightly lower than the 9 years 2 months scored by children with autism on Happe's more comprehensive language assessment). Taken together, these findings suggest that language ability may have played an important role in false belief task performance by children from both groups, and especially by children with autism. At the same time, however, it seems that this factor alone did not account for the difference in success rates between the two groups.

Interestingly, an equivalent difference in language comprehension levels between autistic and delayed children was not found to characterize successful overall performance on interpretive diversity tasks, despite the fact that verbal comprehension was a significant predictor of performance by children on this kind of task. In passing, it should be noted that the comprehension level at which the group of children with delay reached a 50% success rate on interpretive diversity tasks was about 3 to 4 years higher than that suggested by Carpendale and Chandler for typically developing children. Needless to say, this discrepancy might simply have been a function of the difference between assessments used by the present authors and Carpendale and Chandler. Perhaps more important was the lack of significant difference between the autism and comparison groups' performances on interpretive diversity tasks when based on an overall pass/fail criterion. To some extent, these findings seem supportive of Carpendale and Chandler's suggestion that these task types differ in difficulty, at least with regard to our sample of delayed children.

Interestingly, children in the autism group also seemed to find interpretive diversity tasks somewhat easier than false belief, albeit not to the same degree as children in the delayed group. In fact, the results collected for children with autism are somewhat confusing in that despite the fact that false belief was found to be generally easier, performances on false belief and interpretive diversity tasks were related both on an individual basis and in terms of overall scores. In fact, children with autism performed more consistently across tasks than did children with delay in the following four ways: (1) overall scores for understanding of false belief and interpretive diversity were significantly associated, (2) performances across all three interpretive diversity tasks were significantly correlated,

(3) performances on all five tasks were significantly correlated, and (4) performances were significantly correlated across the Sally-Ann and Smarties false belief tasks. These consistencies—but not the near-significant difference between overall performances on false belief and interpretive diversity tasks—seem to be in line with the prediction we offered on behalf of the modular theory: namely, that children with autism would perform similarly on tasks that make the same metarepresentational demands. How might this contradiction be reconciled?

One way to make sense of these results is to recognize a number of subgroups within the autism sample. In the first subgroup, children with autism failed all of the tasks, regardless of whether they were false belief or interpretive diversity. This group's performance, then, seems consistent with the hypothesis that some children with autism might fail all of the tasks presented due to an absolute impairment in metarepresentational capacity. In a second subgroup, children with autism succeeded on all of the tasks presented, again regardless of whether they were interpretive diversity or false belief. This subgroup may have achieved sufficient metarepresentational ability to pass all of the first-order tasks we gave them (although not necessarily, of course, to succeed on second-order tasks that we did not give them). Third, however, there was a smaller subgroup, responsible for the near-significant difference between overall false belief and interpretive diversity task performance, who passed tasks of the former kind but failed on the latter. In no instance did a child with autism succeed in any of the three interpretive diversity tasks if he or she failed either of the false beliefs. How might we account for performance by this last subgroup if not by reference to metarepresentational capacity?

The idea that some children with autism may "hack out" unconventional routes to solving false belief tasks is now commonplace within the literature concerned with social understanding in able individuals with autism (e.g., Bowler, 1992; Frith, Morton, & Leslie, 1991; Happe, 1995; Leslie & Roth, 1993; Leslie & Thaiss, 1992). The "hacking" hypothesis has been put forth largely to account for the finding that children with autism who pass false belief tasks do not always show a corresponding understanding in everyday situations. Persistent difficulties with everyday social understanding suggest that the competence that enables such children with autism to pass false belief tasks does not always extend to the classroom or playground (Frith, Happe, & Siddons, 1994; Hadwin *et al.,* 1996; Ozonoff & Miller, 1995). Although no direct evidence exists concerning the methods that might be used by children in this subgroup, the high language skills that frequently accompany success on false belief tasks by children with autism have led to speculation that some autistic children may use a language-based approach to solving false belief paradigms (e.g., Tager-Flusberg & Sullivan, 1994). In support of an "artificial" and rule-based approach to social situations in autism are the first-hand reports from high-functioning adults on the Spectrum, which commonly report a need for "reasoning out" aspects of human relations to which the rest of us seem intuitively "tuned in" (e.g., Sacks, 1995; Williams, 1994). These individuals frequently report the need to take an explicitly rule-based approach to coping with even the more superficial features of social engagement. In perhaps the most striking illustration, Segar (1997) offers that the single most important feature separating individuals with autism from those without is the need for "autistic people to understand scientifically what non-autistic people already understand instinctively" (p. 24). Unfortunately, however, the efficacy of this kind of "scientific" approach to social interaction may often be compromised by the poor generalization skills so commonly observed by professionals concerned with pedagogy for children in this clinical group. It is this lack of generalizing ability that may explain the finding that some children succeed in only a narrow range of tasks, without wider application to either real-life situations, or in tasks of subtly different kinds.

Unfortunately, without data regarding social understanding in more naturalistic settings, we cannot be certain whether the more able children with autism in our sample were showing a genuine understanding about minds or were simply demonstrating effective strategies for success on formal tasks of one or both kinds. However, it may be that certain qualitative differences between responses offered by autistic and comparison groups offer some clue with regard to this question. More specifically, responses given by the children with autism on all tasks were nearly always brief and "to the point," without embellishment or qualification until this was asked for. In contrast, answers to test questions given by the delayed group were frequently imaginative and often contained elements of narrative in their explanations. For example, when asked which interpretation another child might choose of Jastrow's duck/rabbit picture, responses included "a monster with horns" and "I've got a rabbit at home." At the same time, children's justifications of both correct and incorrect responses referred to what appeared to be irrelevant facts or events, such as, "because I was outside" or "she's playing hide and seek." Responses of this nature evoke the interpretive approach to social scenarios espoused by Nelson, Henesler, and Plesa (1998). On this account, seemingly bizarre answers may make sense when considered within the context of children's references to their prior experiences. This is because, according to Nelson *et al.,* children do not normally approach social situations by applying a rule-based theory as some have suggested (Bartsch & Wellman, 1995) but rather interpret each individual situation by responding to features that have increased salience due to prior experience.

Of course, we cannot rule out the possibility that procedural bias might have contributed to the poor consistency shown across tasks by the comparison group. But exactly why these biases should have affected the different groups differently is not readily apparent. The same problem does not beleaguer an interpretive account of the kind offered by Nelson *et al.,* because it presupposes that responses will vary radically between individuals according to personal experience. In particular, the idea that children in the comparison group may have taken an intuitive approach to tasks presented may help to explain the otherwise unaccountably low correlation found between false belief tasks in the delayed group. During the past 15 years, the Smarties and Sally-Ann tasks have become two of the most established research instruments in theory of mind research (although this is not the first time that reliability across these tasks has been reported to be less than good [Charman & Campbell, 1997]). Yet, in the case of present findings relating to the delayed group, choosing between these tasks as a canonical measure of false belief understanding essentially determines whether this was distinct from an appreciation of interpretive diversity. On the interpretive account offered by Nelson *et al.,* answers to these two tasks may have been driven more by experiential knowledge—for example, about hide-and-seek games or the urgency of making good someone else's deceptive act—than by attention to a common denominator concerning misrepresentation. If making sense of a given situation occurs via negotiation rather than via the tenets of a theory, then responses are bound to differ between situations that those of us initiated into the causal relations of theory of mind concepts consider to be of the same kind.

Interestingly, it appears that it was the Sally-Ann task that bore a large part of the responsibility for low intertask correlations found among performances by children in the cognitive delay group. In contrast, performances by this group on the Smarties task were found to correlate highly with all three interpretive diversity tasks. In particular, the especially high correlation found between performances by the delayed group on the Smarties and Cow tasks might suggest that children in this group found these tasks somewhat comparable in the demands they made—perhaps due in part to the efforts we made in equating their designs. On this point, it seems feasible that children in the delayed group may have succeeded on the Cow task without genuinely understanding the mind as active interpreter. Instead, it may have been sufficient for participants to infer from their own experience (in accordance with the "seeing-leads-to-knowing" principle) that if their classmate had not *seen* the transparency containing the outline, he or she might not *know* that the picture was of a cow. In this way, participants in the delayed group may have bypassed the need to appreciate that different people might offer alternative interpretations of a stimulus that remained unaltered in itself. On the other hand, the fact that the Smarties and Cow tasks correlated with both the Duck/Rabbit and Giraffe tasks—but not with the Sally-Ann task—seems to suggest that performance on the Smarties task more closely resembled an interpretive diversity task than did the Cow task a false belief.

Unfortunately, the present findings cannot shed further light on this question, nor can they reveal the method by which a subsection of children with autism managed to pass the false belief tasks but fail on interpretive diversity. The absence of significant correlation between this profile and level 1 performance on Taylor's (1988) Giraffe task does not support the hypothesis that children in this subgroup may have been using a principle of "seeing-leads-to-knowing." Rather, it may be that interpretive diversity and false belief tasks differed in some other property, which one hopes to identify through future research.

To summarize, it seems that the higher consistency, unembellished response format, and higher verbal comprehension ability that characterized successful performance by children with autism may be in accord with a less-intuitive, more rule-based approach to tasks than that used by children with cognitive delay. In explaining our results, we have made reference to two theoretical viewpoints: the modular account of theory of mind difficulties in autism proposed by Leslie and colleagues (e.g., Roth & Leslie, 1998) and the interpretive approach to theory of mind development in nonautistic individuals offered by Nelson *et al.* (1998). As Astington and Olson (1995) suggest, accounts of both cognitive and interpretive kinds have an important role to play in characterizing the development of social understanding. Unfortunately, in the case of autism, the role that atypical sociocultural development may play in poor understanding about minds has been almost entirely neglected in favor of a focus on the mechanics of underlying cognitive deficits. Whether processes that permit causal theories about mind and behavior follow interpretation, or vice versa, may never be resolved, but it seems likely that where a clinical group is impaired in one, it will also present with difficulties in the other. In reporting the findings from a study that looked at narrative ability in high-functioning children with autism, Loveland *et al.* (1990) wrote that, "The 'social deficit' of autism is not limited to an impaired understanding of other people's thoughts and feelings: rather, a human cultural perspective seems also to be lacking" (p. 20). One such perspective may correspond with a tendency to take an interpretive approach to social situations.

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Annotations from 367937.pdf

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Annotation 1; Label: IPC; Date: 1/23/2002 2:24:38 AM
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Author: Is "Phi" okay?

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was found after a course of intra-arterial procaine infusions. for	cap	Capitalize
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patients with peptic ulceration. This investigation was in direct relationship to our own, and	no ¶	Run into same paragraph
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