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ON THE PRESCHOOLER'S PROBLEM WITH THE FALSE BELIEF TASK

by

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For Jerry, for all the music

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ABSTRACT

It has been argued that young preschoolers cannot correctly attribute a false belief to a deceived actor (Wimmer & Perner, 1983). Some researchers claim that the problem lies in the child's inadequate epistemology (Chandler & Boyes, 1982; Wellman, 1988); as such, it is specific to the child's theory of mind and no such problem should appear in reasoning about nonmental representations. This prediction is tested in the first paper below in the 'false photograph' task: Here an actor takes a photograph of an object in location x; the object is then moved to location y. Preschool subjects are asked: "In the picture, where is the object?" Results indicate that photographs are no easier to reason about than are beliefs. Manipulations to boost performance on the photograph task proved ineffective. Further, an explanation of the failure as a processing limitation having nothing to do with the representational nature of beliefs or photographs was ruled out. It is argued that young children's failure on the false belief task is not due to an inadequate epistemology (though they may have one) and is symptomatic of a larger problem with representations.

The second paper considers three possible sources of difficulty for the young child on the false belief task: first, the child may be unable to change the truth value of a representation as is required in the standard false belief task; second, the fact that the deceived actor's belief was acquired by visual experience, normally a reliable source of information, makes it harder for the child to consider it false; and third, the child's own visual experience of the object's true location, and therefore the certainty with which the child knows the object's true location, make it impossible to ignore. The present experiment tests these hypotheses by contrasting the standard false belief task with two testimony conditions. In both testimony conditions the false belief is stipulated as false from the beginning (the deceiver announces that he will tell a lie); no change of truth status is involved. The difference in the two testimony conditions is that in the 'seen' condition the subject sees the object's true location while in the 'unseen' condition, the subject is merely told the object's true location. Those 3-year-olds in the 'unseen' condition successfully attributed a false belief, while 3-year-olds in the two other conditions did not. This pattern of results supports the third hypothesis.

General Introduction

The research project reported here is grounded in a debate about the very nature of cognitive growth. Piaget argued that cognitive growth is domain-general, that the child's logical system changes in an invariant manner -- in a series of stages -- and that these changes ramify through the child's conceptual system, leading to improvement in a variety of reasoning tasks in different cognitive domains (e.g., number, language, morality).

The alternative domain-specific approach (Carey, 1985a) holds that cognitive development is largely a matter of domain-specific knowledge acquisition. On this view, the child is different from the adult not because the child has an inferior logic or representational system but simply because the child is a novice in so many domains in which the adult has already acquired expertise. This view suggests that the best research strategy is to focus on a single domain or 'theory', to try to describe its initial state, and to trace its development over time. This strategy is evident in the current literature on the child's understanding of number (Gelman & Gallistel, 1978), of

physical objects (Spelke, 1987), and of biology (Carey, 1985b).

The domain under investigation in the present work is the child's theory of mind. This domain was chosen for several reasons: first, it is obviously an important area of knowledge. It's very hard to imagine how the child could predict or explain the behavior of others without it, and such understanding must surely be a central goal of early childhood. Similarly, the child's concept of self would be radically different from our own if it did not include the understanding that people are intentional beings, thinking and feeling beings. For these reasons, a theory of mind has seemed a plausible candidate for a universal competence and even, according to Fodor (1987), an innate competence.

This was straightforwardly denied by Piaget (1929), who claimed that the physical and mental worlds were one undifferentiated whole to the young child:

"Let us imagine a being, knowing nothing of the distinction between mind and body. Such a being would be aware of his desires and feelings but his notions of self would undoubtedly be much less clear than ours. Compared with us he would experience much less the sensation of the thinking self within him, the feeling of a being independent of the external world. The knowledge that we are thinking

of things severs us in fact from the actual things. But, above all, the psychological perceptions of such a being would be entirely different from our own. Dreams, for example, would appear to him as a disturbance breaking in from without. Words would be bound up with things and to speak would mean to act directly on these things. Inversely, external things would be less material and would be endowed with intentions and will...We shall try to prove that such is the case with the child. The child knows nothing of the nature of thought..."

Piaget's claim now seems wrong for two reasons. First, young preschoolers have been shown to have an impressive understanding of physical causality. (Bullock, Gelman, and Baillargeon, 1982; Shultz, 1982). Second, there is a growing literature, most of it by Wellman and his colleagues, documenting the child's awareness of the domain of the mind. In a series of studies which investigated children's understanding of the brain (Johnson and Wellman, 1982), children were asked whether the brain was needed to perform a wide variety of activities. Among the activities mentioned were mental acts (such as knowing and remembering), sensory acts (such as seeing and hearing), school tasks (such as reading and writing), involuntary acts (such as coughing), and complex tasks (such as hopping on

one foot). Also included were three sets of 'feeling' items: physiological sensations (feeling hungry or sleepy), emotions (feeling happy or sad), and 'cognitive' feelings (feeling sure or curious). The results indicated that kindergarteners judged the brain necessary for such paradigmatic mental acts as remembering and thinking, for the school tasks of reading and writing, and for feeling sure. Wellman (1985) has argued from these results that young children view the brain as the locus of a number of different purely mental processes; in short, he has claimed, they have a concept of mind.

Similar studies with still younger children (Johnson & Wellman, 1982) revealed a similar picture for 4 year-olds; in fact, even for the 3 year-olds, paradigmatically mental acts were most frequently judged as requiring the brain. As Wellman points out, these results argue against Piaget's view cited above; the brain and its activities were seen as internal and nonbehavioral even by preschoolers.

Wellman and Estes (1986) invesigated the young preschooler's understanding of the ontological properties of mental states. They presented preschoolers with a number of contrasting characters (e.g., a boy who <u>had</u> a dog vs. a boy who was <u>thinking</u> about a dog). The child was then asked to make the following judgements for each dog: Can it be

seen, touched, and petted? Can someone else see it? Can the boy pet it tomorrow? Even 3-year-olds performed well on this task, understanding that real objects, but not mental entities, afford behavioral-sensory evidence (can be seen, etc.), have public existence (can be seen by anyone present), and have consistent existence (won't just dissolve or disappear in the way that thoughts or mental images can). Wellman (1988) has therefore claimed that 3-year-olds are in the same theoretical ballpark as adults with respect to the mental realm; they are, essentially, ontological dualists.

There is good evidence, then, that even 3-year-olds posit the existence of a domain of mental states, and that this domain is similar in many basic ways to the domain of the adult's theory. Still, one may ask just how well they reason about the mental realm; what kind of inferences are supported by their knowledge of this particular domain? It has been claimed, for instance, that although 3-year-olds believe in the existence of a mental realm, it is "divorced from the causal fabric of the world" (Leslie, 1987); that is, young children do not understand that beliefs can be the causes and effects of events in the material world.

Dennett (1978) has suggested that success on a task of the following form would constitute strong evidence of a theory of mind:

1) Child believes that Actor believes that p.

2) Child believes that Actor desires that q.

3) Child infers from his beliefs in (1) and (2) that Actor will therefore do x.

In an early paper not reported here (Zaitchik, 1986), Dennett's paradigm was used to test the ability of young preschoolers to make simple inferences of the following types: given information about an actor's beliefs and desires, to predict the actor's behavior; given information about an actor's belief and behavior, to infer the actor's desire; and given information about an actor's desire and behavior, to infer the actor's belief. Overall, 3-year-olds were quite successful on these tasks. Recently, Wellman and Bartsch (in press) and Bartsch and Wellman (in press) also addressed this issue using a similar methodology, but with several control conditions which attempted to rule out the possibility that the child's successful prediction of an actor's behavior may be acheived without any real understanding of mental states. Here too 3-year-olds were successful.

These successes stand in stark contrast to the failure of 3-year-olds on a task which has become the center of the entire debate about the child's theory of mind. In this task, the belief which the child must attribute to the actor

(step 1 of Dennett's syllogism) is false. This, Dennett (1978) has argued, is the best evidence that the child understands the concept of belief, because in this case only can we be sure that the child is not successfully predicting where the actor will look on the basis of other information, such as where the object really is.

In the false belief task, preschoolers are presented with stories with the following format:

1. Actor A sees an object in location x.

2. In his absence, the object is moved to location y.

Test Question: Where will Actor A look for the object?

In Experiment 1, below, we presented preschoolers with the false belief task. In addition to the test question above, children were asked three other questions. First, children were asked the Ignorance probe question: Does Actor A know where the object is? This question was included because it had been claimed to help some children make the correct inference on the Belief test question (Hogrefe, Wimmer, and Perner, 1986). This question was immediately followed by the Belief question: Where does Actor A think it is? This test question was included because it seemed plausible that using a mental state verb ("think") rather than an action verb ("look") might help some children to focus better on the actor's mental state. The Think

question was immediately followed by the Look question, the traditional question used to assess the child's ability to understand false belief. Finally, the Reality control question was included to make sure that children understood the events which transpired in the puppet skit; if not, their responses on the test questions would be uninterpretable.

Experiment 1

Method

Subjects

Thirty children from daycare centers in the Boston area participated in this study. There were ten subjects in each of the following age groups: 3.0-3.7 (mean age 3.3), 3.9-4.3 (mean age 4.0),and 4.4-5.0 (mean age 4.9).

Materials

A large cardboard box with its bottom removed served as a puppet theater. Props included four familiar Sesame St. puppets, some toy cookies, a doll's hat, and several empty boxes.

Procedure and Design

Each child was shown two skits (See sample story below). The order of presentation of skits was counterbalanced.

Story One

This is Big Bird's (BB) house. Over here is the door. This is the upstairs, and down here is the downstairs, where BB likes to watch t.v. One day Cookie Monser (CM) comes to visit BB. He knocks on the door.

BB: "Hi, Cookie Monster. What are you doing here?"

CM: "I came to play with you. I thought we could watch t.v. together."

BB: "Good idea."

CM sees a bag of cookies and a box.

CM: "Is that a bag of cookies?"

BB: "Yes."

CM: "May I have one?"

BB: "Well, okay."

CM: "Yum... could I have another one?"

BB: (less happily) "Okay. Come on, let's go down and watch t.v."

They go downstairs and what do you think they watch on t.v.? Sesame St! Cookie Monster is so excited to see himself on t.v.! Meanwhile, Big Bird is worried. He doesn't want Cookie Monster to eat all his cookies. He quietly sneaks upstairs. He hides the cookies in the shoebox. (Can you help him?) Then he closes everything up just like it was before. Meanwhile, Cookie Monster is so busy watching t.v.

that he doesn't even know Big Bird left the room.
[At this point in the session, children were asked the IGNORANCE QUESTION:] Does CM know where the cookies are now? Experimenter then continues: Pretty soon CM wants another cookie. He goes upstairs.

The Questions

The skit was immediately followed by three questions, in the order presented below:

THINK QUESTION: Where does CM think the cookies are?

LOOK QUESTION: Where will he look for them?

REALITY CONTROL QUESTION: Where are they really?

Results

All answers to the REALITY CONTROL question were correct. Table 1 shows mean scores for each age and question. Table 2 shows the distribution of scores by age and question. All incorrect responses to the THINK and LOOK questions consisted in pointing to the actual location of the object.

A 3-way ANOVA was run for effects of age, order of skits, and type of question. There was a significant main effect for age (F=27.32, df= 2,18, p<.001). Subjects in the middle group were significantly better than subjects in the youngest group (F=11.43, df= 1,18, p<.002, one-tailed) and subjects in the oldest group were marginally better than

subjects in the middle group (F=4.45, df= 1,18, p<.05, one-tailed). Effects of order and question type failed to reach significance.

Considering performance on the THINK question, the oldest group was perfect, while the middle group performed better than chance (t=7.86, df=9, p <.001 two-tailed). The youngest group performed significantly worse than chance (t=8.437, df=9, p<.001, two-tailed). Performance on the LOOK question was in line with these results, especially for the oldest group which was nearly perfect. Although mean scores on the LOOK question were similar to those on the THINK question, neither of the two younger groups was statistically different from chance on the LOOK question; for each, $t(9)$=1.5, p<.2, two-tailed. One might speculate that if children realized that the two test questions were addressing the same underlying question, the difference in performance might be due to pragmatic considerations. That is, some children might have concluded that their first answer (to the THINK question) must have been wrong; otherwise, why would the experimenter ask them the same (underlying) question again (in the form of the LOOK question). If some children made this assumption, performance on the LOOK question for the youngest group would have improved (since they performed poorly on the

THINK question) while performance for the middle group would have worsened (since they performed well on the THINK question). Given this pragmatic problem with the LOOK question, performance on the THINK question is probably a better indicator of children's understanding.

These results replicate the findings of Wimmer and Perner (1983). In a series of studies with preschoolers, they found that 4-years-olds generally succeeded on the false belief task, correctly claiming that the deceived actor would look in location x because 'that's where he saw it'. Most 3-year-olds, however, claimed that the actor would look in location y, because 'that's where it is'. This finding has now been replicated many times with many interesting variations in the task (Hogrefe, Wimmer & Perner (1986); Perner, Leekam,& Wimmer (1987); Gopnik & Astington, (1980). For instance, Hogrefe et al. maximized the salience of the false belief in the following way: they presented subjects with a box of Smarties, a popular brand of candy in England, and asked subjects what they thought was inside. All subjects responded that they thought it was Smarties (or candy). Subjects were then shown that the box contained only a pencil. The box was closed again. Subjects were then told that another child would soon be brought into the room. They were asked what this other child would think was in the

box when he or she first looked at it all closed up. Subjects responded, "a pencil". Even though they themselves had just been tricked with the same candy box, they nevertheless failed to attribute the same false belief to another child.

In another variation on the Smarties task (Gopnik & Astington), subjects were asked what they thought was in the closed candy box, then shown its contents. Instead of being asked what someone else would think was in the closed box, they were asked what they themselves had thought was in the box before they opened it. Remarkably, subjects claimed that they thought all along that there was a pencil in the box! In sum, the 3-year-old's difficulty with false beliefs is a robust finding.

The following two papers are investigations of the 3-year-old's difficulty on the false belief task. In the first paper, the focus is the issue of domain-specificity. Is the young preschooler's inability to attribute false beliefs just a species of his or her inability to understand misrepresentation in general; that is, does the child have a problem only with beliefs? In the second paper, the focus is on the generality of the child's problem with false beliefs; that is, does the child have a problem with all false beliefs. These questions address the scope of the

child's problem; knowing the boundaries of the phenomenon will help us to decide which proposed explanations are most likely.

Table 1

Mean scores by age and question

	Youngest: 3.1-3.7	Middle: 3.9-4.3	Oldest: 4.5-4.11
Ig Q	35%	90%	100%
Think Q	20%	80%	100%
Look Q	30%	70%	95%

Table 2

Frequency of S's getting both (100%), one (50%), or neither (0%) trial right, by age and question

	Youngest: 3.1-3.7			Middle: 3.9-4.3			Oldest: 4.5 -4.11		
	100%	50%	0%	100%	50%	0%	100%	50%	0%
Ig Q	3	1	6	8	2	0	10	0	0
Think Q	2	0	8	7	2	1	10	0	0
Look Q	2	2	6	6	2	2	9	1	0

When representations conflict with reality: The preschooler's problem with false beliefs and 'false' photographs

The adult's naive theory of mind involves the attribution to ourselves and others of intentional states such as beliefs and desires. Does the young child share this belief-desire framework for understanding human behavior? This question is important because a theory of mind is likely to be a universal competence. Furthermore, intentional concepts are crucially important to social cognition in general; one can scarcely imagine making sense of human behavior without them. Indeed, Fodor (1987) has argued that a theory of mind is innately specified, that the kind of social coordination which our species exhibits could not have evolved without this innate component.

In this vein, Wellman and Estes (1986) give convincing evidence that very young children share the adult metaphysics of mind. They presented preschoolers with a number of contrasting characters (e.g., a boy who <u>had</u> a dog vs. a boy who was <u>thinking</u> about a dog). The child was then asked to make the following judgements for each dog: Can it be seen, touched, and petted? Can someone else see it? Can the boy pet it tomorrow? Even 3-year-olds performed well on

this task, understanding that real objects, but not mental entities, afford behavioral-sensory evidence (can be seen, etc.), have public existence (can be seen by anyone present), and have consistent existence (won't just dissolve or disappear in the way that thoughts or mental images can). Wellman (1988) has therefore claimed that 3-year-olds are in the same theoretical ballpark as adults with respect to the mental realm; they are, essentially, ontological dualists.

While there is evidence that young children share the adult's metaphysical notions of the mind, one may still ask just how skillfully they can attribute beliefs to self and others. Premack and Woodruff (1978) argued that this ability is evidence of a theory of mind, "because such states are not directly observable, and the system can be used to make predictions about the behavior of others." Can the young child use information about beliefs and desires to predict the behavior of others? Dennett (1978) suggested the following paradigm to test this ability:

1) Child believes that Actor believes that p.

2) Child believes that Actor desires that q.

3) Child infers from his beliefs in (1) and (2) that Actor will therefore do x.

Wimmer and Perner (1983) adapted Dennett's paradigm to test the ability of young children to correctly attribute a <u>false</u> belief to a deceived actor. It was important that the beliefs be false because only then could one be sure that

the attribution was being made the right way-- not on the basis of the way the world is, but on the basis of the actor's exposure to the world. In a series of experiments, Wimmer and Perner presented preschoolers with two stories in which an actor places an object in location x; in his absence the object is moved to location y. The child is then asked to predict where the deceived actor thinks the object is. The results indicated that children do not acquire the ability to correctly attribute a false belief until about their fourth birthday.

Several researchers have recently claimed that the problem lies squarely in the child's theory of mind (Chandler & Boyes, 1982; Wellman, 1988; Flavell (1988); Pillow (in press). Chandler and Boyes (1982) have claimed that the younger child is a 'copytheorist' while the older child is, like the adult, a 'constructivist'. The copytheorist takes thoughts to be nothing more than mental copies of events in the world which somehow impress themselves on the mind of whoever is in their path. With this copytheory, the child can conceive of knowledge (just in case one was in the path) or ignorance (just in case one wasn't in the path); the child cannot, however, conceive of false belief. Wellman (1988) fixes the source of this misconception in the failure to conceive of the mind as an active interpretive, analytic machine--an information processor; instead, the mind is conceived to be merely a

bucket into which thoughts are dropped. Without a cognitivist view of the mind, the child posits no internal processes. The copytheory, then, specifies no mechanism by which a false belief, indeed any belief, could be acquired. If the copytheorist understands nothing of the role of perceptual mechanisms in acquiring information, then he or she is forced to look to the external world as the sole source of beliefs. Older children, on the other hand, appreciate the active role of the mind in fixing our beliefs about the world. Understanding that the mind interprets experience, they can use information about an actor's perceptual experience to predict his or her belief. Wellman's claim, then, is that children have the ontology straight before they understand the epistemology (Estes, Wellman, & Wooley, in press).

Leslie (1987) has further claimed that the child's problems with epistemology actually stem from his or her grasp of the ontology; that is, understanding that thoughts are immaterial, private, and not permanent, the child cannot imagine how the material world could cause them. Mental states thus remain divorced from the 'causal fabric' of the world. Development, on this view, involves coming to understand perception as the bridge between the world and the mind.

A recent study by Wimmer, Hogrefe, and Perner (1988) supports the claim that young children do not understand

that perceptual experience plays a causal role in belief formation. Here pairs of 3-year-olds, one of whom was designated as the subject, viewed the contents of a box. By and large, subjects correctly claimed that they knew the contents but failed to correctly attribute knowledge to the other child, even though the other child had the same visual access to the object that the subject had. These data support the view that the impressive development occurring between ages 3 and 4 is best characterized as conceptual change within the child's theory of mind.

If the child's problem lies in her inadequate theory of mind, then it is a problem limited to mental entities; the 'copytheory' account does not predict any problem with nonmental representations. That's just because what's hard about mental representations is that they're mental. If so, the child should have no problem with nonmental representations. To test this prediction of the copytheory hypothesis, we designed a task which posed the same problem for the child as the Wimmer and Perner task, but in which photographs take the place of beliefs. To see how this works, notice the similarity of the following two formats:

Belief format

1) Actor A places object in location x and then leaves.

2) Actor B moves object to location y.

3) Test question: "Where does A <u>think</u> the object is?"

Photo format

1) Actor A places object in location x and takes a photo of it.

2) Actor B moves object to location y.

3) Test question: "In the picture, where is the object?"

[Of course, the front of the photo will not be visible to the child.]

If young preschoolers succeed on the photo task while failing the belief task, this would support the view that the difficulty on the false belief task stems from the child's misunderstanding of belief. Those explanations for the problem which focus on demands of the task which are specific to the mental domain (e.g., an understanding of the mind as an interpretive device, an understanding that mental entities play a causal role in the physical world, etc.) would be supported. On the other hand, if children are no better at the photo task than they are at the belief task, then lack of knowledge about the mind per se is probably an inadequate explanation of the child's problem with false beliefs. This result would support the view that explanations should focus on those properties which beliefs share with photographs -- their representational status.

Experiment 1

Method

Subjects

Subjects were 14 3-year-olds (mean age 3.6, range 2.11-4.0), 18 4-year-olds (mean age 4.8, range 4.1-5.1), and 14 5 year olds (mean age 5.9, range 5.4-6.4). All the children attended daycare centers in the Boston area. Groups included roughly equal numbers of boys and girls.

Procedure

Each subject started the session with a pretraining period on the use of two cameras, a toy one and a real Polaroid camera. The subject was told that to use the toy camera you had to look through the little window until you saw the object to be photographed and you had to then push the button. After letting the child take a 'pretend' picture with this toy camera, the experimenter presented the Polaroid camera. The experimenter told the subject that this camera also had a window and a little button to push. The child was further told that when the button was pushed, there would be a flash of light (the flashbulb was pointed out) and a grinding noise, and that then the picture would come out of the camera. The subject was told that when the picture first came out, it would be all white, but that after a minute the colors would start to show, and that they would get brighter and brighter until the picture was done.

The child was then given the Polaroid camera and told to look through the little window until the puppet (which the subject was allowed to choose from a large selection of puppets) was visible in the middle. When the child had focussed the camera on the puppet and appeared to be ready, the experimenter checked with the child that he or she could see the puppet in the middle of the window. The child was then told to push the button. As promised, the child heard a grinding noise, saw the flash of light, and saw the blank photo emerge from the machine. Together the experimenter and child watched the photo develop. During this period, the experimenter pointed out the progress of the development with comments such as the following: "Look, there's Ernie! I can just begin to see Ernie. He'll get clearer and clearer. Soon the colors will come out better and you'll be able to see it more clearly." And a few seconds later, "Look, now I can see his hat!" When the photo seemed finished, the child was given it to take home, along with lots of praise for having taken such a nice picture. Subjects were then told that they would see some little puppet shows and that in some of them the puppets would get to take pictures.

Following the pretraining period, subjects in the two younger groups were presented with four puppet skits, two skits with the belief format and two with the photo format (see sample skits below). In one of the photo skits the experimenter used the Polaroid camera and took a real

picture; in the other, the experimenter used a small toy camera and took a 'pretend' picture. Within the photo condition, the real camera trial always preceded the toy camera trial, and within the belief condition Skit 1 always preceded Skit 2. The order of conditions was counterbalanced. The oldest group was tested only on the photo condition, since numerous studies have shown that even 4-year-olds succeed on the belief task (Baron-Cohen, Leslie, & Frith, 1985; Johnson & Maratsos, 1977; Perner, Leekam, & Wimmer, 1987).

Belief Skit 1

Walter (W) is a little boy puppet with a bag of marbles; he is 'upstairs' (on-stage) in his bedroom. His bedroom contains a bed and a toybox. His mother (M), an adult puppet, is seen 'downstairs' (off-stage).

W: Oh boy, I can't wait to play with my new marbles. I just got them yesterday.

M: (calling from downstairs): Walter, it's time for dinner; come wash your hands.

W: (disappointed) Oh, Mom; do I have to?

M: Yes, you do.

W: All right.

W: tells Subject: Well, I'll just leave my marbles here on my bed. I'll come back and get them after dinner. [Walter then leaves to wash his hands. In his absence, his mother enters his bedroom.

M: (complaining to Subject) Oh, that silly boy; he always leaves his toys lying around all over the place. I'll just put his marbles back in his toybox. (She does so.) There. Now his marbles are safe and sound inside his toybox.

Ignorance Probe Question: Does Walter know where his marbles are now?

Test Question: Where does Walter <u>think</u> his marbles are?

Belief Skit 2 differed from Skit 1 in that it involved intentional deception; Actor B was puposely hiding something from Actor A (see appendix).

Camera Skit 1

Bert [B] and Ernie [E] are on-stage with a camera.

B: Gee, Ernie, I'm so glad we bought a new camera. Let's take a picture of Rubber Duckie, okay? Here, I'll just take her out of her bathtub and put her here on the bed. (Bert looks through the window of the camera.) Okay, Ernie, I see her. (Bert snaps the button.) [In the real photo condition, he holds the picture up facing himself.] There, that'll make a nice picture!

E: Hmm, I'm really tired now. (He looks at his bed.) I guess I'll just pick Rubber Duckie up off the bed and put her back in the bathtub where she belongs.

[Experimenter holds the photo up to focus subject's attention on it, but does not let subject see its front.]

Test Question: In the picture, where is Rubber Duckie?

Camera Skit 2 was identical to Skit 1 except for the following substitutions: a toy dinosaur replaced Rubber Duckie, a toyshelf replaced the bathtub, and other Sesame Street puppets were used.

The ignorance probe question. Notice that the belief condition included an ignorance probe question immediately before the belief question. This probe question was included because it had been shown to help subjects on the

belief test question that followed (Wimmer & Perner, 1985). Since cameras don't have minds, there is no exactly analogous probe question for the camera condition. Nevertheless, the probe question was included in the belief condition; since our intention was to test whether the camera condition was easier than the belief condition, we tried to optimize subjects' chances of success on the belief condition.

Results and Discussion

Belief Condition

Results are shown in Table 1. As in the literature, 4 year olds succeeded while 3 year olds did not (Baron-Cohen, Leslie, & Frith, 1985; Johnson & Maratsos, 1977; Perner, Leekam, & Wimmer, 1987).

INSERT TABLE 1 ABOUT HERE

The level of accuracy of the younger group (54% correct) was surprising; their performance was not different from chance (chance=50%), although several previous studies had shown them to be systematically worse than chance (Wimmer & Perner, 1983; Hogrefe, Wimmer, & Perner, 1986). A closer look at the data clarified the situation. For this analysis, the 3-year-olds were divided into two groups, 3.0-3.7 and 3.8-4.0. The percentage of correct responses was 10%

for the younger group (n=5) and 78% for the older group (n=9). This accords nicely with data from an earlier study (Zaitchik, 1984) using the same false belief paradigm; in this study, subjects were divided equally (n=10 in each) in 3 age groups: 3.0-3.7, 3.8-4.3, and 4.4-5.0. The percentage of correct responses were, respectively, 20%, 80%, and 100%. These data suggest that the switch from systematically incorrect to systematically correct responding comes just a few months before the fourth birthday, at least in the middle-class population of the present studies.

Five subjects got only one belief skit right; in every case, it was the skit involving intentional deception ($p < .05$, binomial, one-tailed). Subjects found the task easier when the false belief was explicitly motivated than when there was no such motivation.

Camera Condition

As can be seen from Table 1, both 3 year olds and 4 year olds performed at chance (chance=50%). Only the 5 year olds were, as a group, better than chance on the camera condition ($t = 3.2$, $df = 13$, $p < .01$ two-tailed).

Although the younger groups were not better than chance, subjects were not just guessing. Scores were bimodally distributed; for the most part, subjects were either systematically right or systematically wrong. Pooling the data of the two younger groups on the camera

condition, a contingency test over the two trials yielded a C =.59, chi-square (1)=17.7, p =<.001.

Six subjects got only one of the camera skits right; in every case, it was the real photograph condition that they succeeded on (p <.02, binomial, two-tailed). Since the real photograph trial was always presented first, it is possible that this was an order effect. Equally plausible, however, is that the presence of a real photograph, even one whose front could not be seen, served to help subjects on the test question.

An ANOVA for effects of age, condition (belief vs. camera) and order of presentation for the two younger groups showed a main effect of age only (F (1,30)= 5.4, p <.03). Our data do not show that the camera condition is harder than the belief condition, although they do hint at it. Still, the real surprise is that it is not easier. Pictures are, after all, more concrete than beliefs; they can be seen, handled, even torn into pieces. Nevertheless, simple photos, which seem to wear their representational nature on their sleeve, are no easier to reason about than are beliefs.

Before concluding that the representation of mental and nonmental events pose a similar problem for the preschooler, several other explanations for why the photo task was as difficult as the belief task needed to be ruled out. Experiments 2-5 were conducted in order to test the

following hypotheses: 1) that the there were greater inferential demands in the photo task (Exp. 2); 2) that the critical information was less salient in the photo task (Exp. 3); 3) that the difficulty in both tasks is a processing problem which has nothing to do with the representational status of beliefs and photos (Exps. 3 and 4); 4) that the problem on both tasks is in the timing of the inference, not the nature of the inference (Exp. 5).

Experiment 2

As mentioned above, it might be objected that the two conditions of Experiment 1 are not exactly equated in terms of their inferential demands. After all, the belief condition included the ignorance probe question which served to help the child make the first step toward the inference about the puppet's false belief. Perhaps the child could more easily make the inference about the photographic representation if she was helped to get halfway there. In Experiment 2, the following two probe questions were inserted into the photo condition immediately before the test question:

Probe 1: Where is (the object) now?

Probe 2: Where was (the object) when they took the picture?

Test Question: In the picture, where is the object?

Experiment 2 tests the hypothesis that 4-year-old children will succeed in the photo condition as well as the belief condition when the inferential demands are the same.

Method

Subjects

Subjects included 27 four-year-olds (mean age 4.7, range 3.11-5.1), with roughly equal numbers of girls and boys. One of these subjects was eliminated from the study because he answered a probe question incorrectly; he was the only child to do so.

Procedure

Except for the addition of the two probe questions in the camera condition, the procedure was identical to the procedure of Experiment 1. There were no changes in either the pretraining or the belief conditions; the skits themselves were identical to those in Experiment 1. The order of presentation of the new probe questions was counterbalanced as well as the order of condition type.

Results and Discussion

As mentioned above, all but one subject (whose data were not analyzed further) answered the two probe questions in the camera condition correctly. Although the probe questions were included in the task for another reason, they did in fact rule out the possibility that failure on the test question was due to a memory problem; that is, subjects

knew where the object was when the photograph was snapped, and where it was 'now'.

Results are shown in Table 2. The percentage of correct responses was 94% in the belief condition and 72% in the camera condition. Once again, performance on the belief condition for 4-year-olds was virtually perfect, and better than performance on the camera condition [F (1,24)=6.7, p <.02]. Once again, however, subjects were not answering randomly in the camera condition. A contingency test over responses on the two trials showed that subjects answered systematically (C =.47, chi-square (1)= 7.22 p <.01).

Of the five subjects who responded correctly on only one of the camera skits, all of them succeeded with the 'pretend' photo rather than the real photo (p =.06, binomial, two-tailed). Since Experiment 2 did not replicate the advantage of the 'real' photo that was evident in Experiment 1, we considered these to be spurious effects. In all subsequent camera studies, we used only the real camera in both pretraining and testing.

In sum, although subjects answered them correctly, the probe questions did not facilitate correct responses to the test question.

Although 4-year-olds, as a group, were nearly perfect in the belief condition, they were not better than chance on the camera condition.

Experiment 3

Perhaps one source of difficulty on the camera task is that the object's location is simply not a very salient aspect of the event for the child. Children may have performed better if they had been asked about an aspect of the event they were more likely to have attended to: the object's identity, rather than its location. In the camera condition of Experiment 3 there was only one salient location; one actor was at that location when the picture was taken but he was replaced by another actor before the test question was asked.

Information-processing problem?

Experiment 3 was designed to test another hypothesis as well, using a new procedure. Perhaps failure on the camera task reflects a general limitation in the young child's information-processing capacity. On this view the child's problem is an inability to track the different consequences for two different objects of a machine which operates over only one of them. To see what this means, consider the camera condition under the following description: object 1 is oriented toward the mechanism; the mechanism operates over object 1; this operation results in a certain consequence for object 1, namely a photographic representation of it; now object 2 is oriented toward the mechanism but the mechanism does not operate over object 2; therefore there is no consequence. In the camera task the

input to the machine consists in the object being placed before the lens, the single operation performed is the pressing of the button, and the consequence is the photo. It could be that keeping track of all this is just too hard for the child. The important point here is that the child's failure has nothing to do with the representational nature of photographs; that is, even where the consequence of the mechanism's operation is not a representation, the child will fail. If this is true, then all the arguments about the difficulty of representations, mental or pictorial, would lose much of their force.

To test this hypothesis a simple mechanical device was constructed, the "gizmo", illustrated in Figure 1. The gizmo was constructed by glueing an empty cardboard tube onto a larger piece of cardboard which supported it at roughly a 30 degree angle from the upright. Approximately 2 inches from the top of the tube, a red rod was inserted through the tube, thereby blocking the hole so that nothing could drop down the tube until the red rod was removed. On a given trial, one object was inserted and the rod was pulled, releasing the object into the concealed lower compartment. A second object was then placed into the tube, but the rod was not pulled, so the object remained in the upper part of the tube.

INSERT FIGURE 1 ABOUT HERE

To see how this gizmo is a nonrepresentational analog to the camera description given above, consider the following: it is a mechanism on which a single operation (pulling out the rod) can be performed, there are two objects which serve as input, one of which is operated on and one of which is not (although it is oriented with respect to the mechanism), and the operation has a consequence for the object -- this time not a representation, of course -- this time the consequence for the object is a change of location (the drop down the tube).

Mechanism	Operation	Input	Orientation	Consequence
Camera	push button	objects	in front of camera	photograph
Gizmo	pull rod	toys	placed into top	location change

Experiment 3 tests the hypothesis that failure on the camera task is due to information-processing demands which have nothing to do with the representational nature of photographs. The prediction is that children will perform just as badly on the gizmo task as they do on the camera task.

Method

Subjects

Subjects included 16 3-yr-olds (mean age 3.6, range 2.11-3.10) and 16 4- and 5-year-olds (mean age 4.9, range 4.2-5.6) from local daycare centers. Groups included roughly equal numbers of girls and boys.

Procedure for the camera condition

Each subject was presented with two puppet skits with the following format:

1. Actor A is photographed in location x and then moves away.
2. Actor B now moves into location x.
3. Test question: In the picture, who is in location x?

Camera Skit 1

Ernie and Bert are outside in the sun. Bert is lying on the mat and Ernie is taking Bert's picture.

E: Okay, Bert, I can see you through the little window; now I'll just press the button. (He does so). There, that'll make a nice picture.

Experimenter tells Subject that Bert is getting too hot lying in the sun.

B: Ernie, I'm really hot; let's go inside.

E: Okay, good buddy; I'm coming.

Experimenter says to Subject: Oh, look, here comes Big Bird.

BB: Hmm, look at that, someone left a camera here; well, I think I'll lie down on this mat for a while and have a rest.

[Experimenter holds the photo up to focus Subject's attention on it, but does not let Subject see its front.]

Test Question: <u>In the picture</u>, who is lying on the mat?

Camera Skit 2 was identical to Skit 1 except for the substitution of other Sesame Street puppets and a bathtub instead of a mat.

Procedure for gizmo condition

The experimenter presented the gizmo machine along with several small toys, all of which were small enough to slide down the tube of the gizmo when the red rod was removed, but large enough to remain stuck at the top when the rod was in place. (Examples of the stimuli include a tiny toy cow, a

marble, and a large die.) When an object was inserted into the tube, and the red rod pulled out, the object slid down to the bottom of the tube into a small trap; although the child could hear the object as it slid down the tube and into the trap, he could not see into the trap. The experimenter demonstrated the simple workings of the machine, making sure that the child saw the toy stuck at the top while the rod was in. She then invited the child to choose a toy and to operate the machine. Children did this several times with different objects to ensure their familiarity with the machine.

After this short pretraining, the test procedure followed: the child was asked to choose an object and insert it into the tube; the red rod was removed and the object slid down into the trap. The red rod was reinserted. The child was not allowed to remove the object from the trap as in the pretraining; rather, the child was asked to pick another object and place it in the tube. The red rod was not removed, so the object was stuck at the top. The child was then asked the test questions: Where is (object 1)? Where is (object 2)?. Each child was given two trials of the gizmo condition and two trials of the camera condition.

Results and Discussion

INSERT TABLE 3 ABOUT HERE

Camera condition

Results on the camera trials are shown in Table 3. Replicating Experiments 1 and 2, the performance of the older group (63%) was not better than chance (t=1.15, df=15). The younger group, which scored only 25%, was worse than chance (t=-2.7, df=15, p <.02 two-tailed). Clearly, asking about an actor's identity rather than his location did not help subjects of either age.

This new test question incidentally ruled out another possible objection to Experiments 1 and 2--specifically, that the test question, "In the picture, where is Rubber Duckie?" is ambiguous. Leslie (personal communication) has pointed out that the child may have taken the question to mean "show me the place in the picture where Rubber Duckie is now", as if the picture were a map. The camera format of Experiment 3 makes such a reading highly unlikely. Here the test question "In the picture, who is lying on the mat?" seems resistant to such an ambiguity. Children's failure in this camera condition support the claim that failure in

Experiments 1 and 2 was not due to a misinterpretation of the test question.

Gizmo condition

Results are shown in Table 4.

INSERT TABLE 4 ABOUT HERE

In the gizmo condition, older subjects were perfect; younger subjects, with 70% right, were better than chance (chance=25%): (t=5.6, df=15, p<.001 one-tailed).

A two-way ANOVA for age and condition revealed main effects of both age (F=14.6, df=1,30, p<.001) and condition (F=31.9, df=1,30, p<.001). Children's superior performance on the gizmo condition makes it unlikely that they have a general information-processing problem in keeping track of the different consequences for two different objects of a mechanism which operates over only one of them. Instead, it supports the view that failure on the belief and camera tasks has to do with the representational nature of beliefs and photographs.

Experiment 4

In Experiment 3 the test questions asked in the gizmo condition (where is object 1? where is object 2?) were not ideal analogs to the test question asked in the camera condition (which object is in location x?). The closest

analog, presumably, would be: which object is at the bottom? To rule out the possibility that the difference in questions led to a difference in scores, we ran a new group of subjects on the gizmo condition only.

In Experiment 4, each subject was given two trials, each trial consisting of two questions:

Trial 1

Test questions: 1) Which toy is at the **bottom**?

2) Where is the (other toy)?

Trial 2

Test questions: 1) Which toy is at the **top**?

2) Where is the (other toy)?

Within trials, the order of questions remained the same. However, the order of presentation of the trials was counterbalanced.

Method

Subjects

Subjects were 16 3-year-olds from local daycare centers (mean age:3.6, range 3.0-4.0) with roughly equal numbers of boys and girls.

Procedure

The new questions required the child to name objects,

rather than simply to point at the top or bottom of the tube. To make sure the child knew the names of all the objects and understood that the 'game' required naming them even when they were hidden, the following procedure was added to the pretraining. The experimenter laid out the objects on the table and asked the child to name them, offering the information whenever needed; the experimenter then picked up each object individually, hid it in her closed fist, and asked the child which toy she was holding. The pretraining then continued as in Experiment 3. The test procedure was identical to that of Experiment 3 with the exception of the new test questions.

Results and Discussion

Results are shown in Table 4 above. Subjects responded correctly on 84% of the trials, compared with a chance rate of 25% ($t(15)=8.9$, $p<.001$). A one-way ANOVA on trial type ('top' or 'bottom' series) showed no significant effect ($F(1,15)=3.5$, $p<.08$).

Experiment 4 replicated the finding of Experiment 3 that children can keep track of the different consequences for the two objects of a physical mechanism which operates over only one of them.

Experiment 5

Perhaps the difference between the gizmo and photo/belief conditions is that in the former, the child

spontaneously draws the inferences as she goes along; that is, the child already has a mental representation of the location of the first object before the second object is put into the gizmo machine. In the photo/belief condition, this may not be so. Here the child might passively watch the puppet shows, making no spontaneous inferences at all about the contents of the photograph/belief. After the object has changed location, the child is asked the test question, but it is too late for the child to make the inference correctly. Rather than recalling what the world was like at the time that the belief/photo was formed and then making the relevant inferences, the child simply defaults to a strategy of reporting about the way the world is. The idea here is that it might be crucial to make the inference early on, at the time the belief/photo is formed; that is, having a mental representation of the contents of the belief/photo before any objects change location might help the child to understand the subsequent changes, to see what is and what is not relevant to the belief/photo.

This sort of effect has been seen before in the placement of the 'ignorance' probe question (Wimmer & Perner, 1983). When the ignorance question came directly after the act of deception rather than at the end of the skit, subjects scored higher on the belief question which always appeared at the end of the skit. If this is correct, we might ask what would happen if the child made the

inference as to the contents of the belief/photo early on, before the object changed location. Presumably the child would correctly identify the object or actor at that point, since there is no conflict between representation and reality, so one could be certain that the child had formed a correct mental representation of the contents of the photo. What would then happen after the object's location was changed, as in the original task, and the child was queried again as to the contents of the belief/photo?

If children succeeded on this version of the task, then one would have evidence that they know the belief is fixed when the object is observed and that the photo is fixed when it is taken. In this case the problem on the other versions of the task would lie in the child's failure to draw the inference spontaneously at the time of the original event.

Method

Belief Format

1. An actor sees object A in a box and then leaves.
2. Initial Query: Which [object] does A think is in the box?
3. In his absence, object A is removed from the box and object B is placed in the box.
4. Second Query

Photo Format

1. Actor A is photographed lying on a mat.
2. Initial Query: In this picture [holding it up, back toward the subject], who is lying on the mat?
3. Actor A moves off the mat and Actor B lies down on it.
4. Second Query

There is an obvious pragmatic problem in the form of the second query: if an experimenter asks a child the same question twice, the child might feel that the first answer must have been wrong -- that's why the experimenter is asking again (Rose & Blank, 1974; Siegal, 1988). To avoid this pragmatic problem, the second query did not involve asking the same question again. Instead, a 'little game' was introduced:

Belief Skit 1

Onstage is an open box with a little bag of trash in it.

Mr. Dog: I wonder what's in this box -- oh, a bag of trash. Yuch; that's stinky. I'm getting out of here; I'll go for a walk.

Experimenter asks Initial Query: What does Mr. Dog think is in the box? Experimenter then continues: Look, here comes Oscar the Grouch with a bag of marbles.

Oscar: Wow!!! A bag of trash!!! I love trash; I'm tired of these marbles. I'll just take this bag of trash and leave my bag of marbles instead.

Experimenter: Remember Mr. Dog who looked in the box and then left to take a walk? [Experimenter then continues with Little Game.]

LITTLE GAME: Well, Carl [second experimenter] didn't see our puppet show so he doesn't know which bag Mr. Dog thinks is in the box. Let's play a little game; I'll close my eyes and you give Carl the bag that Mr. Dog thinks is in the box.

Camera Skit 1

Grover (G) and Bert (B) are outside in the sun. Bert is lying on the mat and Grover is taking his picture. Big Bird (BB) is off-stage.

G: OK, Bert, I can see you through the little window. Now I'll just press this button. (Takes picture.) There, that'll make a nice picture.

Experimenter (holding up the picture) asks Initial Query: In this picture, who's lying on the mat? Experimenter then continues: Bert is getting bored lying down.

B: Grover, I want to get up now and get a snack. (He gets up and moves to side of stage.)

G: OK, good buddy. I'm going to get going now. Bye. (Takes camera and leaves.)

Experimenter to Subject: Oh, look, here comes Big Bird.

BB: I think I'll lie down on this mat for a while and have a rest.

Experimenter asks: Remember this picture? [Experimenter then continues with Little Game.]

LITTLE GAME: In this picture (holding it up) there's a doll lying on a mat. Carl didn't see our puppet show so he doesn't know which doll it is. Let's play a game -- I'm gonna close my eyes and you give Carl the doll that's lying on the mat in this picture.

The motivation for having the experimenter close her eyes was simply to make sure that the child didn't have to

answer the same question twice to the same person. The introduction of a second experimenter who hadn't seen the puppet show served to motivate the child's second response, while still ensuring that the child didn't have to give the same person the two answers.

Belief skit 2 is identical to skit 1 except that it involves different puppets, as well as the substitution of a carrot and cookie for the bags of marbles and trash. Camera skit 2 is identical to camera skit 1 except that it involves different Sesame Street puppets and a bathtub instead of a mat.

Subjects

Subjects included a group of 18 3-year-olds (mean age 3.7, range 3.1-3.10) and 20 4-year-olds (mean age 4.6, range 4.0-4.11) from local daycare centers, with roughly equal numbers of boys and girls.

Procedure

The pretraining session with the camera was identical to that of Experiment 3, but the test procedure was changed in one respect: in Experiment 5, the camera was removed from the scene before the actors changed location. This was done to make sure that subjects weren't considering the camera to be continuously operating on whatever it was pointing at.

Each subject had two trials on the belief condition and two trials on the camera condition. Half the subjects had

the belief skits first, while half had the camera skits first.

Results and Discussion

INSERT TABLE 5 HERE

Belief condition

As in Experiment 1, the 4-year olds succeeded in attributing a false belief (t=3.9, df=20, p<.001). The 3-year-olds, however, were worse than chance (t=2.4, df=18, p<.05).

Camera condition

As in Experiment 3, the 4-year olds were not different from chance in the camera condition (t=.52, df=20), while the 3-year-olds were significantly worse than chance (t=4.27, df=18, p<.001).

An ANOVA for effects of age, condition, and order of presentation yielded significant main effects of age [F(1,34)=20.6, p<.001] and question [F (1,34)=6.6, p<.015]. There was no interaction. Again, subjects were better in the belief condition than the camera condition.

Clearly their earlier correct responses to the first query did not help subjects make the inference again in the 'little game'. This attests to the robust nature of the child's difficulty and rules out the hypothesis that the

problem lay in the failure to spontaneously draw the inferences early on.

General discussion

The results of the studies above replicate earlier findings that right around their fourth birthday, children acquire the ability to correctly attribute a false belief. Further, they provide surprising evidence that the preschooler has an even harder time reasoning about photos than beliefs, at least the sort of reasoning demanded by our task (Exps 1-3). This problem with photographs is very robust; it doesn't disappear even when subjects are provided with inferential assistance (Exps. 2 and 5). The hypothesis that the problem with photographs is due to an inability to track the various consequences for different objects of different sorts of contact with the camera was not supported by parallel experiments with a nonrepresentational machine, the gizmo (Exps. 3 and 4). Nor is the problem caused by the child's failure to make the inference at the time the photograph is taken (Exp. 5).

Implications for the false belief task

These results bear on the interpretation of the false belief task, particularly the 'copytheory' account outlined

at the beginning of this paper. Recall that the copytheory view was proposed to explain the child's inability to consider conflicting beliefs, but clearly no claims about the child's theory of mind will explain the failure on the camera task. The camera studies suggest that the failure to correctly attribute a false representation may be more widespread than anyone thought--that is, the problem goes beyond mental representations, at least, it would seem, to pictorial representations. The results therefore suggest that mental representations may be hard not because they're mental but because they're representations. If this is true, then failure on the false belief task may have little to do with the fact that children lack an active cognitivist conception of the mind. (After all, the camera studies require no such understanding of the camera; to view the camera as a once and for all copymaker would be to succeed on the camera task.)

Indeed, there is reason to think that a copytheorist (on at least some version of the copytheory) would do just fine on the false belief task. Consider the copytheorist who knows nothing of perception and considers the mind to be just a bucket into which copies of events are dumped. Suppose this copytheorist knows one thing: she knows that you have to be correctly situated in space and time to get

hit with the information (Chandler & Boyes, 1982). This copytheorist should succeed on the false belief task, because this child knows the only facts you need to know: that if you are in the right place at the right time you will get the copy of the way the world is; if you aren't you won't. In the false belief task, the deceived actor is 'hit' with the information that the object is in location x; he therefore has a 'copy' of this event in his 'bucket'. He is never 'hit' with the information that the object has been moved to location y, so no copy of that event is acquired. Now when the child (the copytheorist) is asked what the deceived actor believes, he should correctly respond 'location x', since <u>that's</u> the event which the deceived actor has a copy of in his bucket. In other words, so long as this child can remember who was where when, he will succeed on this task. The point is that an active model of the mind as an internal processor is not needed to succeed on this task.

The claim that the child is a copytheorist can only explain the child's failure to correctly attribute a false belief when the false belief was caused by some internal processing problem, something the child would need to postulate an internal process for. It's very good then at explaining the child's problem in the appearance-reality task investigated by Flavell and his collaborators (1988). Here the child is faced with an object which looks like a

rock but feels like a sponge. The copytheorist-child has a dilemma here, since he has two conflicting 'copies' of the object being dumped into his 'bucket'. Since the copytheorist-child does not posit any perceptual processes, there is simply no way in which two copies of the same object could conflict. For the same reason, the claim that the child is a copytheorist is very good at explaining the child's problems in understanding individual differences, since the source of such differences is within the different minds. But it cannot explain problems representing false beliefs which have been caused by changes in the world.

Flavell has claimed that the young child doesn't really understand that seeing, hearing, feeling, and the like yield representations (1988). It's quite plausible that the mental representations engendered as a consequence of our experiences in the world are difficult for the child to understand. Perception, after all, is a complicated process; it does not occur in a discrete moment and it rarely calls attention to itself. The representations it engenders, beliefs, are immaterial and abstract. In the case of the photograph, however, it's hard to see the same argument being made; in this condition, the process of fixing the representation, focussing on an object and pushing the button, has none of the complexity of perception. Unlike the mind, the operation of the camera is behaviorally salient and temporally discrete. Furthermore,

the representations themselves, the photographs, can be seen and handled; indeed, in our pretraining period, each child sees, holds, and discusses the picture he or she took. From their reactions, it is clear that the children notice that it is a picture of the puppet.

Consider the photographs themselves; none of the properties of beliefs which have been taken to cause the child's problems apply to the photos. Photos are not immaterial, they are not intangible, they are not private and internal; in short, with the photos, children are faced with none of the problems in bridging the material and immaterial realms which, Leslie claims, lead to their failure with beliefs. Nevertheless, they fail.

The Camera Task

What is the source of the problem on the camera task, then? The first explanation that comes to mind is that the children don't know much about the mechanism of cameras, so they cannot possibly succeed on the task. We would argue, however, that there is probably nothing much they would have to know about the camera to get this task right except for what they probably know already and what our pretraining teaches them -- that is, that you aim the camera at the object, look through the window and push the button. Furthermore, it seems implausible that the difference between the children who succeed and the children who fail is that the former know something of the inner workings of

the camera. Children don't really have to know more about cameras to succeed on this task; what they do have to know about is photographs.

Specifically, what they have to know is that 1) the photo is a representation of whatever was in front of the little window when the photo was taken and 2) that it captures a moment in space and time and doesn't change after that. If the child kept that in mind, he could infer the correct answer so long as 3) he remembered how the world was when the picture was taken. We think it's reasonable to assume that subjects understand #1, that the photo will represent whatever was in front of the little window when the button was pushed; after all, we have explicitly told them just that in the pretraining and in fact each subject looked through the little window, pushed the button and then watched the image develop. Furthermore, it's clear from their correct responses to the probe questions in Experiment 2 that subjects have no problem with #3; they do remember the way the world was when the picture was taken. Apparently they don't use that information in reasoning about the photo's contents in our task.

One possible explanation for this is that the child has a problem with #2, the analysis of the temporal properties of photographs; in short, the child thinks photographs update, changing along with changes in the world. This view could be less wild than it seems at first blush. After all,

different sorts of representations differ in their fixedness. Photographs are spatiotemporally fixed, but other representations are not; mirrors and closed-circuit television, for instance, yield representations that do in fact change along with changes in the world. In the absence of specific knowledge to the contrary, the child might consider the photo to be dynamic.

A related possibility is that the child has no analysis by which photos can update; she simply has no analysis at all. It might be argued that this would lead to random responses, not systematically wrong ones, but the systematically wrong responding could be explained as the child's adopting some strategy (of reporting on the world) in her state of confusion.

These explanations locate the failure in the child's missing knowledge. If we consider how complicated the adult understanding of representation is, it is no surprise that learning about representations is a gradual process. In addition to the differences in ontological status and in fixedness mentioned above, there are many other properties which vary across different types of representations. To name just a few, there are the spatial properties -- pictures are 2-dimensional, sculpture is 3-dimensional, beliefs and words are nondimensional; there's the naturalness or conventionality of the representation -- words represent in virtue of convention while mirrors and

photos do not; there's the access of the representation -- beliefs are private, whereas photos and mirror reflections are public; finally, there's the directness of the cause -- in photos and mirrors, the input which determines the nature of the representation is in fact what the representation represents; not so for beliefs -- I can think about things that are not only not currently present, but things that don't even exist.

It could take quite a while to work all this out. It seems possible then that in the absence of a general theory of representation, of a single domain with causal principles which apply to all its members, the child must learn in a piecemeal fashion, one sort of representation at a time. Development, then, would consist in straightforward knowledge acquisition.

I would like to suggest, however, an entirely different explanation of the photograph results: that the child actually <u>has</u> the correct analysis of the temporal properties of photographic representations, but she does not or cannot use this knowledge <u>in the case where the photo conflicts with the true state of affairs</u>. In this case the child's reasoning collapses. In a similar vein, Perner, Leekam, and Wimmer (1987) have described the child's problem with <u>beliefs</u> as the inability to assign conflicting truth values to a single proposition. This ability is crucial in the false belief task where the child must represent both his

own knowledge of the world [THE OBJECT IS IN LOCATION X, NOT IN LOCATION Y] and the deceived actor's false belief [THE OBJECT IS IN LOCATION Y]. If the child takes the photograph to be making a claim about the world, she is faced with the same problem here: the photograph is at odds with the child's current perceptual representation of the world. The photograph assigns truth to a claim which the child's own perceptual representation denies. On this view, the young child's failure on the camera task suggests that the difficulty in assigning conflicting truth values to a proposition about the world is not specific to mental representations.

What kind of conceptual problem underlies this difficulty in assigning conflicting truth values? An interesting piece of the puzzle is that 3-year olds are successful at pretend play (Leslie, 1987) and at distinguishing between real and imaginary objects (Wellman & Estes, 1986). It is with representations which are supposed to reliably describe the actual world that children seem to run into trouble. This suggests that it is the assumption of veridicality of certain sorts of representations (among them beliefs and photographs) that is the problem. With respect to beliefs, this point has been made before and is, in fact, a central claim of the copytheory account. It is plausible that the same assumption of veridicality underlies the children's performance on the camera studies.

If children do assume that beliefs are veridical, then reasoning about them may be hard not, as Leslie claims, because they remain outside the causal fabric of the world; rather, they are hard because they are well within it -- they are seen to be determined by events in the world and as such, the child takes them to be veridical.

This does not mean, of course, that the ability to consider misrepresentation is an all-or-none competence. One might speculate, for instance, that children would have a somewhat easier time conceiving of a false drawing of a state of affairs than a false photograph, just in case they are sensitive to the directly-caused nature of photographs. There is evidence that 6-year-olds, at least, appreciate this special status of photographs. O'Connor, Beilin, and Kose (1981) presented children with either photographs or drawings of an incorrect solution to a conservation of liquid task. They found that subjects were more likely to choose the illogical outcome as the true outcome when it was represented in a photograph than in a drawing. The authors have argued from these results that children believe in the fidelity of photographs. Although children might perform better on a 'false' representation task using drawings, it still makes sense that they should have <u>some</u> difficulty; that is, to the extent that children understood the drawing to have captured a state of affairs in the world, it is

likely that they would take it to have some claim to the truth.

My claim, then, is that the child has all the causal knowledge she needs to determine the contents of a photograph; she understands that the picture will be of whoever was in front of the window when the button was pressed, and she has no mistaken ideas that the photo is a dynamic representation. The claim here is that this knowledge is either not accessed in our task or that the correct inference that it leads to is rejected because it conflicts with the child's own perceptual representation of the real state of affairs. Notice that this claim predicts that the child might reason very well about the contents of photographs so long as the conflict with reality is eliminated or possibly just sufficiently minimized.

There are several ways one might do this. For instance, if one asked "Who's in the picture?" rather than "Who's lying on the mat in the picture?", the child might succeed. That's just because the test question does not confront the child with the conflicting propositions 'X IS LYING ON THE MAT' and 'Y (AND NOT X) IS LYING ON THE MAT'. In the absence of this conflict, the child could use the knowledge he has about how the content of the photograph is determined -- and come to the right answer. Notice that success on this task is clearly not predicted by the alternative claim, considered above, that the child thinks

the photo is dynamic. This claim predicts failure on this task as well. The second alternative discussed above, that the child has no analysis of the temporal properties of photographs, is somewhat harder to make predictions from. Clearly, it would be consistent with this claim for the child to respond randomly. However, it is also possible that the child would answer correctly on the basis of her understanding that the photo is initially a picture of whoever was in front of the window when the button was snapped. That is, even without explicit knowledge that the photo is fixed, the child might choose the right actor simply because in this case, where the child is not faced with conflicting representations of who is on the mat, the actor who was in front of the camera when the button was pushed has a stronger claim than the other actors.

If children do in fact make an assumption of veridicality of beliefs and photos, how is it overcome? The most plausible story, and the one supported by the present findings, is that it doesn't happen all at once. The 4-year-olds, who are succeeding on the false belief task, are still failing the camera task. It's likely then that the veridicality assumption has to be discovered to be false for each type of representation independently. And how is this discovery made? Presumably, the inferences it supports will fail; the child will acquire sufficient counterevidence to cause the collapse of the assumption. Now we can see why

the child should succeed on the belief task before the camera task. Given the central importance of beliefs in the child's everyday predictions of behavior (and perhaps given the sheer volume of such inferences as compared to inferences about photographs), the consequences of his false belief about beliefs are likely to be more costly than those of his false belief about photographs. The counterevidence, then, will have a greater claim to the child's attention. The mechanism of development, on this view too, is domain-specific knowledge acquisition.

In any case, the present studies suggest that the child's problem with false belief should be seen in a broader context. To explain the results of the camera studies as well as the belief studies, we may need to cast a larger net.

Appendix

Experiment 1

Belief Skit 2

On stage are a bed, a grocery cabinet, groceries, a cookie jar, and a box of cookies. Two Sesame Street puppets, Bert (B) and Oscar the Grouch (OG) appear.

B: Hey, Oscar. Could you help me put the groceries into the cabinet?

OG: Sure, Bert.

[The puppets put various grocery items into the cabinet.]

OG: (picking up the box of cookies) Where should I put the cookies, Bert?

B: Put them in the cookie jar. Don't eat them! Just put them in the cookie jar.

OG: (regretfully) Okay.

B: Say, Oscar. Why don't you stay for dinner? Go put your coat away in the foyer.

[OG leaves the room].

B: (to Subject) If I leave those cookies in the cookie jar, Oscar will eat them all up. Hmmm. I know! I'll move the cookies from the cookie jar to underneath the bed. [He moves the cookies]. There. Now the cookies are safe and sound underneath the bed.

Ignorance Probe Question: Does Oscar the Grouch <u>know</u> where the cookies are now?

[OG comes back into the room.]

B: Oscar, you wait here; I'm going to get some tea in the other room.

[B leaves the room.]

OG: Now I'll eat those cookies!

Test Question: Where does Oscar <u>think</u> the cookies are?

Table 1

Experiment 1

Frequency of subjects getting neither (0%), one (50%), or both (100%) trials right, by condition.

		Belief				Camera			
	N	0%	50%	100%	Mean	0%	50%	100%	Mean
3s	14	5	3	6	54	6	3	5	46
4s	18	1	2	15	89	5	2	11	67
5s	14	-	-	-	--	2	1	11	82

Table 2

Experiment 2

Frequency of subjects getting neither (0%), one (50%), or both (100%) trials right, by condition.

		Belief				Camera			
	N	0%	50%	100%	Mean	0%	50%	100%	Mean
4s	26	1	1	24	94	5	5	16	72

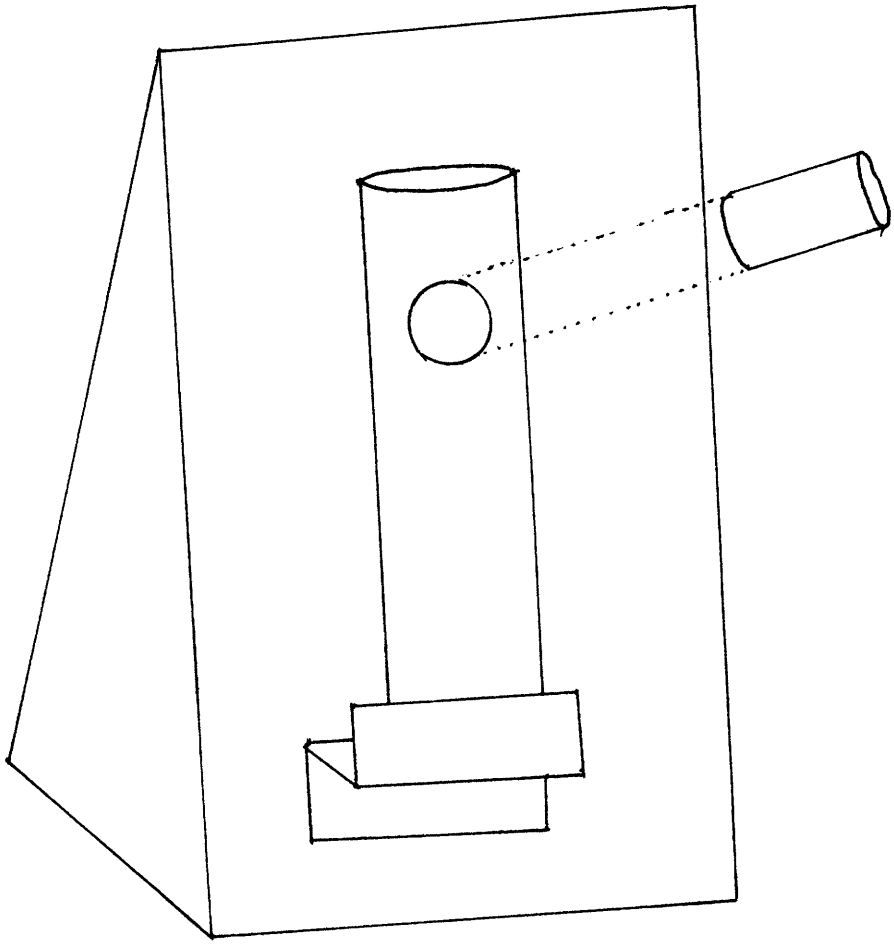

FIGURE 1: "GIZMO"

Table 3

Experiment 3

Camera Condition

	N	0%	50%	100%	Mean
3s	16	10	4	2	25
4/5s	16	4	4	8	63

Table 4

Experiments 3 and 4

Gizmo Condition

Frequency of subjects getting neither (0%), one (25%), two (50%), three (75%) or four (100%) questions right in the gizmo condition.

	Age	N	0%	25%	50%	75%	100%	Mean
Exp. 3	3s	16	1	1	5	2	7	70
Exp. 3	4s	16	0	0	0	0	16	100
Exp. 4	3s	16	1	0	3	0	12	84

Table 5

Experiment 5

	Belief				Camera			
	0%	50%	100%	Mean	0%	50%	100%	Mean
3s	9	7	2	30	12	5	1	19
4s	2	4	14	80	6	6	8	55

Is Only Seeing Really Believing?: Sources of the true belief in the false belief task

The last decade has seen a surge of interest in the young child's developing understanding of mental states such as beliefs and desires. This interest is motivated by the realization that our everyday theory of human action rests on some understanding of such mental states; that is, when we want to predict or explain Mary's behavior, we appeal to her beliefs and desires. Indeed, some understanding of human intentionality seems crucial to the growth of social cognition in general. For these reasons, a theory of mind seems a likely candidate for a universal competence and, according to Fodor (1987), an innate competence.

This claim is in striking contrast to the view espoused by Piaget (1929) that the child does not even differentiate the physical and mental realms until around age 7. Piaget's view, however, has undergone a strong attack. For instance, Wellman and Estes (1986) have found that even 3-year-olds clearly distinguish the mental from the physical along the same intuitive criteria that adults use: they understand that physical entities, but not mental entities, are

tangible, public, and continuous from one moment to the next.

Dennett (1978) has suggested that strong evidence that a child has a theory of mind would come from success on a task of the following format:

1) Child believes that Actor believes that p.

2) Child believes that Actor desires that q.

3) Child infers from his beliefs in (1) and (2) that Actor will therefore do x.

Wimmer & Perner (1983) adapted Dennett's paradigm to develop what has become a litmus test for the 'theory of mind' literature, the 'false belief' task. In this task, children are given stories with the following format:

1. Actor A sees an object in location x.

2. In his absence, the object is moved to location y.

Test Question: Where will Actor A look for the object? It is important that the Actor's belief is false; otherwise, the child might succeed on the task even without an understanding of mental states, simply by pointing to the object's actual location.

In a series of studies Wimmer and Perner tested 3-, 4-, and 5-year-olds on stories with the format above. They found that 4-years-old correctly pointed to location x, explaining that the actor would look there because that's

where he saw it. Most 3-year-olds, however, claimed that the actor would look in location y, because 'that's where it is'. This finding has been replicated many times with many interesting variations in the task (Hogrefe, Wimmer & Perner (1986); Perner, Leekam,& Wimmer (1987); Gopnik & Astington, 1988). For instance, Hogrefe et al. maximized the salience of the false belief in the following way: they presented subjects with a box of Smarties, a popular brand of candy in England, and asked subjects what they thought was inside. All subjects responded that they thought it was Smarties (or candy). Subjects were then shown that the box contained only a pencil. The box was closed again. Subjects were then told that another child would soon be brought into the room. They were asked what this other child would think was in the box when he or she first looked at it all closed up. Subjects responded, "a pencil". Even though they themselves had just been tricked with the same candy box, they nevertheless failed to attribute the same false belief to another child.

In another variation on the Smarties task (Gopnik & Astington, 1988), subjects were asked what they thought was in the closed candy box, then shown its contents. Instead of being asked what someone <u>else</u> would think was in the closed box, they were asked what they <u>themselves</u> had thought

was in the box before they opened it. Remarkably, subjects claimed that they thought all along that there was a pencil in the box! In sum, the 3-year-old's difficulty with false beliefs is a robust finding.

The question arises, however, whether the false belief task may not provide too conservative a measure of children's understanding of beliefs and their causal role in behavior: It could be that children would successully attribute beliefs and predict behavior in a task which maintained Dennett's format, above, so long as the task did not involve <u>false</u> beliefs. Of course one would have to control for the possibility mentioned above that the child might succeed simply by pointing to the object's actual location.

In a series of studies, Wellman and Bartsch (1988) attempted to do just this. They presented children with information about a protagonist's belief and desire and then asked subjects to predict the protagonist's action. Even 3-year-olds were successful on this task. To ensure that this success was not due to the subject's own belief consistently coinciding with the protagonist's belief, subjects were also presented with the 'not-own' control condition:

"Sam wants to find his puppy. His puppy might be hiding in the garage or under the porch. Where do you

think Sam's puppy is? [Here the child answered with, let's say, 'under the porch'.] But Sam thinks his puppy is in the garage. Where will Sam look?"

Even the 3-year-olds were 84% correct in this condition. This condition, however, does not provide the necessary control for the strategy mentioned above, that the child might just take information about where Sam thinks his puppy is to be information about where the puppy really is, or where anyone would look for the puppy. Recently, however, Leekam and Perner (1988) have rerun the 'Not-Own' condition, adding the necessary control question: "Where would YOU look for the puppy?" Subjects correctly answered that they would look 'under the porch' whereas Sam would look 'in the garage'.

In another condition, the Inferred-belief control condition, subjects were presented with stories like the following:

"There are magic markers in the desk and there are magic markers on the shelf. This morning Fred saw the magic markers in the desk, but he did not see the magic markers on the shelf. Now Fred wants magic markers. Where will he look?"

The authors argued that if children used the strategy of responding with the object's true location, subjects should

answer randomly, since the magic markers are truly in both locations. This, however, did not happen. Instead, subjects succeeded in constraining the puppet's behavior to his perceptual experience.

In another task, the 'discrepant belief' task, the child was shown drawings of a cupboard and a refrigerator with paper-flap doors. The child was told "Look, there are bananas in the cupboard and there are bananas in the refrigerator." Both flaps were then shut and the child was shown a picture of a story character and told, "This is Jan. Jan wants a banana. Jan thinks there are only bananas in the cupboard; she doesn't think there are bananas in the refrigerator. Where will Jan look for a banana?" Once again, a strategy of reporting the object's true location should lead to random responding. Instead, subjects were overwhelmingly correct in this task.

The work of Wellman and his colleagues, then, seems to show that 3-year-old children have a theory of mind in the following important senses:

1) They see the role of perceptual experience in belief formation (inferred-belief-control task).
2) They understand that people can hold conflicting beliefs (not-own task).

3) They appreciate that people's behavior is predictable from their beliefs (discrepant-beliefs and not-own task).

4) They understand the ontological differences between mental entities and material entities; that is, they take mental entities but not material entities to be private, internal, intangible, and impermanent (Wellman & Estes, 1986).

Given all this knowledge about the mind, the robust failure of 3-year-olds on the false belief task is very mysterious. One thing, however, seems clear: the child's problem is not an inability to attribute beliefs, but an inability to attribute <u>false</u> beliefs. Now it might be objected that both the Discrepant and the Inferred-belief tasks involve the attribution of a false belief. Still, there does seem to be a difference between the standard false belief tasks and these tasks: in the Discrepant and Inferred-Belief tasks the actor's belief (that the object is in location x) is actually true. It is an incomplete representation of reality, of course -- it captures only part of the truth. Still, it is true as far as it goes.

What, then, is the source of the child's difficulty on the standard false belief tasks? The present study considers three hypotheses.

Hypothesis 1:

Children cannot imagine that perceptual experience, an extremely reliable source of information, could lead an actor to a false belief. In fact, children in the false belief task might reason like this: the actor has seen the cookies in location x, so he knows where they are. Later, when asked "where does the actor think the cookies are?", the child recalls that the actor knows where they are; the child then points to the cookies' current location. Essentially, this would be to claim that the child translates information about seeing into information about knowing. There is some evidence that children do confuse seeing with knowing in certain cases. Taylor (1988) presented children with three pictures, each of which had a drawing of two animals. After showing the subject a picture of a giraffe sitting down next to an elephant, for instance, she covered the picture with a piece of cardboard which had a small open window such that only a tiny uninformative piece of the drawing beneath it was visible. She then asked subjects whether another child, who had not seen the full drawing and who could see only the tiny part that was visible through the window, would know that there was an elephant in the drawing. Her results were surprising: a large number of 4-year-olds and even 5-year-olds assumed

that seeing any part of the drawing, no matter how uninformative adults would consider it (even just an edge of a line), would lead to knowledge on the part of the viewer. Although 3-year-olds on Taylor's task showed no systematic response pattern at all, it could be that her task was so difficult in some other respect that it masked the same 'seeing is knowing' assumption among 3-year-olds.

If Hypothesis 1 is right, then the child's problem in inferring false beliefs is specific to visually acquired false beliefs. If children, like adults, consider verbal reports less trustworthy than visual experience, they might succeed in attributing a false belief which was acquired by testimony. To reiterate, the child might think that 'seeing that x is knowing x' but not that 'being told that x is knowing x'.

This hypothesis can account for the pattern of successes and failures discussed above. In the standard false belief tasks, the deceived actor's belief is acquired by seeing the object in question (even in the Smarties task, the deceived actor will be brought into the room to see the box). On all these tasks the child fails. Conversely, all but one of the Wellman & Bartsch tasks on which the child succeeds avoid this problem all together; with the exception of the Inferred-belief task, the child doesn't infer the

actor's belief from information about what the actor has seen. Instead, the child is explicity told the actor's belief. In the Inferred-belief task, of course, the child does make the inference from what the actor saw to what he thinks, but in this case the inference leads to the correct response: 1) Sam saw the set of markers that were in the desk; 2) therefore Sam knows the location of those markers; 3) therefore Sam will look for those markers where they are --in the desk.

Hypothesis 2:

The difficulty in the standard paradigm is that the false belief was once true. Changing the truth status of the representation may be hard for the young child. If this is so, then young children might successfully attribute a false belief which has been stipulated as false from the beginning. Consider that all the false belief tasks described above require changing the status of a proposition from true to false while none of the tasks on which they succeed requires this (since none of these involves false beliefs). As remarked above, the actor's beliefs in the Discrepant and Inferred-Belief tasks are probably represented as true, if incomplete, rather than as false.

Hypothesis 3:

It does not matter whether the deceived actor's <u>false</u> belief was generated by visual experience or testimony, but

it may well matter how the subject's true belief was generated. The claim is that the child is unable to attribute a belief which conflicts with his or her own visually acquired true belief, because these sorts of beliefs are marked as certain; in the case where the child is certain of the object's true location, he or she will not attribute to anyone else a belief that the object is somewhere else. In the standard false belief task, the child sees the object in its actual location and is therefore certain it is there. Hypothesis 3 predicts that the child will perform better when his or her true belief has been acquired by a less reliable source of information--by testimony-- and is therefore less certain.

This was suggested by an early finding of Johnson and Maratsos (1977). They too presented subjects with stories where one actor deceives another actor by lying about the location of a hidden object. Half the subjects saw (while the other half were only told) the object's true location before the deceiving actor tells the lie. Subjects were then asked where the deceived actor would look for the object. If Subjects answered incorrectly, the skit was repeated, reemphasizing the main events. [This was done because correct responses to this question were criterial to going on to the main test questions which were the real aim

of this study.] Table 1 below shows the results for 3- and 4-year-olds in both the 'told' and 'shown' conditions. The table provides scores tabulated in two ways -- after an initial hearing of the story (T1) and after either an initial hearing or after retelling (T1 or T2).

TABLE 1

Johnson and Maratsos (1977)

		NUMBER OF TRIALS	
Group	N	1	1 or 2
3s			
Told	9	.53	.86
Shown	7	.29	.39
4s			
Told	9	.78	.92
Shown	7	.82	.93

As usual, there is improvement with age and 4-year-olds as a group succeed in attributing a false belief. More interesting, however, is the difference in 3-year-olds' scores between conditions. In the T1 tabulation, 3-year-olds performed better in the 'told' condition than in the 'shown' condition. In the T1 or T2 tabulation, this difference is even more marked. As Johnson and Maratsos pointed out, children in the 'told' condition were likely to improve with

the second telling of the story, while children in the 'shown' condition were likely to repeat their incorrect response.

Hypothesis 3, too, is compatible with the experimental results discussed above. In the standard false belief tasks, the child sees the object in its actual location and is therefore certain of the true state of affairs; in this case, the child cannot attribute a belief which conflicts with what he or she has seen. In the one Wellman & Bartsch task in which the child actually sees bananas in both locations, the child is able to ignore his or her own visual experience and correctly predict where the actor will look for a banana. But in this condition, as mentioned above, the actor's explicitly stated belief does not deny what the child has seen; it only partially captures it.

Notice that the Johnson and Maratsos results not only provide support for Hypothesis 3; they also provide counterevidence to Hypotheses 1 and 2. That is, in their seen condition, the false belief was not visually acquired, nor was it once true; still, children failed the task. While these findings are suggestive, they need replicating. For one thing, as mentioned, they were not the main findings of the study; they were merely the results of a preliminary task where correct responding was criterial to going on to

the real test questions. As such, they were not reported in great detail or with a full statistical analysis. Furthermore, there is some counterevidence to Hypothesis 3 as well. In addition to the tasks described above, Wellman and Bartsch presented preschoolers with an Explicit False Belief condition. Here children were told that the object was really in location x, but that the actor thought it was in location y. Children were then asked where the actor would look for the object and where it really was. Three-year-olds were worse than chance on this task (16% correct) while even 4-year-olds were not better than chance (31% correct). These data suggest that having the actor's true belief stem from testimony rather than visual experience may be a necessary but not sufficient condition for success.

It seems clear that, given the conflicting sources of evidence, a direct comparison of the 'seen', 'told', and standard false belief task is needed to decide among Hypotheses 1,2, and 3. Furthermore, since the Johnson & Maratsos task is the first in which a majority of 3-year-olds succeed in attributing a false belief, it is worth replicating children's success in the 'told' condition. The present experiment was designed to address these needs.

All three hypotheses were tested in the present study. Consider the three formats below.

Format of standard version:

1. Actor A sees object in location x.
2. In his absence, Actor B moves object to location y.
3. **Test Question:** Where does Actor A think it is?

Format of unseen testimony version:

1. Actor B tells Subject that object is in location y but that he will tell Actor A that it is in location x.
2. B tells A it's in location x.
3. **Test Question:** Where does Actor A think it is?

Format of seen testimony version:

1. Actor B tells and shows Subject that object is in location y but that he will tell Actor A that it is in location x.
2. B tells A it's in location x.
3. **Test Question:** Where does Actor A think it is?

Based on the previous literature (Johnson and Maratsos, 1977; Wimmer & Perner, 1983), it is expected that all groups of 4-year-olds will succeed on the task. As for 3-year-olds, the predictions which follow from our three hypotheses are as follows:

1) If Hypothesis 1 is true, then subjects in both the seen and unseen testimony conditions should succeed on the

task, because Actor A's false belief was generated by testimony, not visual experience. Subjects in the standard condition, however, will fail.

2) Similarly, if Hypothesis 2 is correct, 3-year-olds in both testimony conditions should succeed because the false belief never was a true belief. Rather, the claim that the hidden object was in location x was stipulated as false from the beginning. Subjects in the standard condition, however, will fail. Clearly, if our youngest subjects in both testimony conditions performed well, while 3-year-olds in the standard version did not, we would need an additional experiment to determine which factor was responsible for their success. This would be easily done by having a testimony version where the false belief was once true, as in the standard task.

3) If Hypothesis 3 is correct, then 3-year-olds in the unseen testimony version should succeed while subjects in the seen testimony and the standard version will fail, because only the subjects in the unseen testimony condition will not suffer from having seen the object's true location.

Method

Subjects

Subjects were 96 preschoolers from the Boston area, 48 3-year-olds (2.11-3.11, mean 3.6) and 48 4-year-olds (4.0-5.3, mean 4.6). Subjects in each age group were equally

divided among three conditions: the standard belief condition, the 'seen' testimony version and the 'unseen' testimony version.

Procedure

Stories were presented to subjects in the form of puppet skits. (See sample skit of each condition below; for second skit of each condition, see Appendices A and B.) Each subject was individually presented with two trials within a single condition. Following each skit, the subject was asked the four questions, as shown below.

Sample skit for standard condition

Big Bird (BB): I just got a new toy airplane. I love to play with my toy airplane. It's here in my toybox. Wanna see it?

Frog: Yeah.

BB: Here it is (he shows Frog the airplane in the box.)

Frog: That's nice, Big Bird. Well, I have to go home now to eat lunch, but I'm going to come back later, after lunch, to play with your new toy airplane. Bye.

(Frog leaves)

BB: Hmm... when Frog comes back, he'll want to play with my airplane. But I'll want to play with it; I don't want him to play with it. I know; I'll hide the airplane. Frog saw the airplane here in the toybox but I'll hide it here in the closet.

(BB hides the plane in the closet.)

Experimenter: Frog is at home now eating his lunch. Before, when Frog was here with Big Bird, he saw the airplane in the toybox.

Reality Control Q: Well, where is the airplane now?

Deceived Actor's Ignorance Q: Does Frog know that?

Deceived Actor's Belief Q: Where does he think it is?

Deceiving Actor's Knowledge Q: How about Big Bird? Does he know the toy airplane is in the closet?

Sample skit for testimony conditions

Big Bird (BB): I jut got a new toy airplane. I love to play with my toy airplane. Frog is coming over soon to play with me. If he finds out that I got a new toy airplane, he'll want to play with it. But I want to play with it. My toy airplane is here in my toybox (in seen condition, child is shown the toy airplane in the toybox) but I won't tell Frog that. I'll make something up. I'll tell him that my toy airplane is in my closet. Yeah, that's what I'll say. Really my toy airplane is in my toybox, but I'll tell Frog that it's in my closet.

Frog: Hi, Big Bird! Can I play with your toy airplane?

BB: Yeah... it's in my closet.

Frog: Oh, thanks for telling me.

Experimenter: Big Bird told Frog that his toy airplane is in the closet.

Reality Q: Where is the toy airplane really?

Deceived Actor's Ignorance Q: Does Frog know that?

Deceived Actor's Belief Q: Where does Frog think it is?

Deceiving Actor's Knowledge Q: Does Big Bird know that the toy airplane is in the toybox?

The Questions. The reality control question served to ensure that correct answers to the belief question were meaningful. The deceived actor's ignorance question was

included as a probe because it had been claimed to help the child make the inference about the false belief (Hogrefe, Wimmer, & Perner, 1986). Since the same authors have also claimed that the ability to attribute ignorance appears earlier than the ability to attribute false belief (that's why it's helpful in answering the latter question), it is hard to see any straightforward predictions of Hypotheses 1-3 with respect to the ignorance probe question. If ignorance attribution is indeed easier and earlier than false belief attribution, it could be the case that children who fail the false belief question will nevertheless succeed on the ignorance question. What would be expected, however, is that children who succeed on the test question, the belief question, will also succeed on the ignorance question. Following the ignorance question came the test question itself: the false belief question. This question, of course, is crucial, since it is this question that directly taps the ability to attribute a false belief. Finally, the child was queried about the knowledge of the deceiving actor. This question is less central than the ignorance question since it is quite possible that subjects in this task are not really tracking the deceiver's epistemic state. Still, the question was included to have some measure of how robust an understanding subjects had that the deceived actor was

ignorant, while the deceiver was knowledgeable, about the object's location.

Results

All answers to the reality control question were correct.

The deceived actor's belief question

Table 2 shows the percentages of correct reponses to the test question by age and condition. As predicted, 4-year-olds performed better than 3-year-olds: $F(1,90)=14.9$, $p<.01$. The older subjects were better than chance (chance = 50%) in the unseen testimony condition ($t(15)=5.7$, $p<.001$ one-tailed), the seen testimony condition ($t(15)=2.23$, $p<.025$ one-tailed) and the standard condition ($t(15)=7.0$, $p<.001$ one-tailed).

As for the 3-year-olds, only subjects in the unseen condition were better than chance: $t(15)=2.15$, $p<.025$ one-tailed. These 3-year-olds were also better than 3-year-olds in the seen condition ($t(30)=1.87$, $p<.05$ one-tailed) and the standard condition ($t(30)=1.79$, $p<.05$, one-tailed).

Table 3 shows the distribution of scores by condition for the 3-year-olds. Notice that subjects in the two chance groups were not just guessing; scores were bimodally

distributed. For the most part, subjects were either systematically right or systematically wrong. A contingency test over the two trials revealed a C=.36, chi square(df=1)=17.8, $p<.001$, two-tailed.

Two contrast analyses were computed, one to test Hypotheses 1 and 2, and the other to test Hypothesis 3. In the first contrast, the prediction is that 3-year-olds will do better in both the seen and unseen conditions than they will in the standard condition, so lambda weights were assigned as follows: 3's in the unseen and seen conditions, +1; 3's in the standard condition, -2; all 4's, 0. This contrast analysis failed to reach significance {$F(1,90)=1.3$, $p>.2$, two-tailed.}

The second contrast analysis tests the prediction that 3-year-olds will do better in the unseen condition than in either the seen or standard condition. Lambda weights were assigned as follows: +2 to the 3's in the unseen condition, -1 to the 3's in both the seen and standard conditions, and 0 to all the groups of 4-year-olds. This contrast proved significant {$F(1,90)=5.36$, $p<.025$, two-tailed.}

The Ignorance and Knowledge Questions

4-year-olds

In every condition the older preschoolers were correct in claiming that the deceived puppet was ignorant (ignorance

question) while the deceiving puppet was knowledgeable (knowledge question; see Table 4). Correct responses to these questions support the claim that the older subjects succeeded in attributing a false belief for the right reason, because they understood the central deception of the plot.

3-year-olds

The Ignorance Question: Only subjects in the unseen condition performed better than chance on the ignorance question (see Table 5). Of the 10 subjects in this condition who were consistently right on the false belief questions, all were consistently right on the ignorance questions as well.

The Knowledge Question: Only subjects in the standard condition were better than chance on the knowledge question. Presumably, the fact that the puppet actually hid the object in this condition led children to infer his knowledge -- even those children who failed the false belief question itself (see Table 6).

The Unseen condition:

Although subjects in the unseen condition were not, as a group, better than chance, they were not simply guessing.

Again scores were bimodally distributed, with 11 subjects (69%) consistently right and 5 subjects (31%) consistently wrong (see Table 6).

The odds of getting both the ignorance and knowledge questions right on both trials simply by guessing is only 6% (.5x.5x.5x.5=.0625), yet 50% of the subjects in the unseen condition showed this pattern of results. Furthermore, every one of these children was consistently correct on the false belief question as well. The chance of responding correctly to all six questions approaches zero, yet fully half the youngest subjects in the unseen condition did so.

It is important to see that in all conditions correct responding on the belief question reflects genuine understanding of the deception that is central to the plot. Evidence for this claim comes from the fact that consistently correct responding to the false belief questions (across all three conditions) was accompanied by consistently correct responding to the ignorance and knowledge questions. Of the 22 3-year-old subjects who answered both false belief questions correctly, 21 (95%) answered both ignorance questions correctly as well, while 19 (86%) were consistently right on the knowledge question.

An ANOVA for age, condition (seen, unseen, standard) and question type (ignorance, knowledge) yielded the

expected main effect of age (F=29.9, df=1,90, p<.001). Clearly, 4-year-olds are better at these questions than 3-year-olds. The ANOVA also revealed a two-way interaction of condition by question (F=3.8, df=2,90, p<.03) and a three-way interaction of age by condition by question (F=6.4, df=2,90, p<.003). These interaction effects seem to be due to the superior performance of 3-year-olds in the standard group on the knowledge question. In this condition virtually everyone answered the knowledge question correctly, presumably, as mentioned above, because here the knowledgeable puppet has actually hidden the object.

With respect to this, and to the meaning of children's performance on the ignorance and knowledge questions (both of the form 'does the actor know x?'), there is some recent evidence that children use the term 'know' in several ways, much as adults do. One way is to refer to an epistemic state and it is this sense which studies hope to tap when they query children about what an actor knows. However, Perner (1988) has recently claimed that children sometimes take the question to be asking how 'familiar' an actor is with, say, the location of an object. If this is true, then children are simply answering a different question than the one we are asking them -- and all bets are off with respect to our hypotheses. This suggests that we should remain

somewhat skeptical about the ignorance and knowledge questions as indicators of the child's understanding of epistemic states.

Discussion

With respect to Hypothesis 1, it seems clear that the source of the Frog's false belief had no effect on children's responses. Subjects did not perform better in the seen condition of the testimony task than on the standard task.

With respect to Hypothesis 2, it is also clear that failure on the standard false belief task is not due to the change in truth status of Frog's belief. Again, subjects performed no better in the seen condition of Experiment 2 where no such change is required than in the standard task.

Hypothesis 3 is confirmed. For 3-year-olds, the difference in the source of the subject's true belief had a significant effect on responses to the test question. Performance on the unseen condition confirms the suggestion found in the Johnson & Maratsos data that 3-year-olds can successfully attribute a false belief to a deceived actor.

It is important to recall that all responses to the reality control question were correct. This ensures that 3-year-olds who succeeded on the false belief question were not pointing to the closet because they mistakenly believed

the airplane to be hidden there. On the contrary; they claimed that the plane was really in the box, but that Frog believed it to be in the closet.

Clearly, the older children performed better on the task. Nevertheless, performance on the unseen condition of the present study affords genuine evidence of the ability of most 3-year-olds to conceive of and successfully attribute false beliefs.

These results have implications for the accounts which have been proposed to explain children's failure on the standard false belief task. Perner (1988), for instance, has claimed that young subjects in the false belief task claim that the deceived actor will look for the object in its actual location because they consider where the actor would fulfill the goal -- locating the object in the real world in which the deceived actor is operating, not in the counterfactual world of the false belief. Wellman and Bartsch (in press) make a related claim that the child uses desire-reasoning rather than belief-reasoning when considering where the actor will look or what he thinks: if he wants to find the object, he will look for it where it is. Neither of these strategies, however, would predict children's success in the unseen condition.

Children's failure on the standard and seen tasks is best understood as the result of a one-way correspondence

principle which states that beliefs correspond to reality. In representational terms, this leads to the child's inability to mark as true (for anyone) any model of reality which conflicts with his or her own model of reality (Perner, 1988).

If children fail the standard false belief task because they use an erroneous correspondence rule, why do they succeed in the unseen condition of the present study? In terms of 3-year-olds' performance, the unseen condition is similar to the tasks of Wellman and Bartsch discussed above. To see what all these tasks have in common, a brief summary reminder of these tasks is in order.

Task 1) Inferred belief control. Here subjects were told that there were marbles in locations x and y, but that the actor had seen the marbles only in location x, not location y. They were asked where the actor would look for the marbles.

Task 2) Discrepant belief. In this condition subjects saw that there were objects in both locations x and y, but were told that the actor thought the object was only in location x, not location y. They were asked where the actor would look for the object.

Task 3) Not-own. Here subjects were told that the object might be in location x or in location y. They were

then asked where they thought it was. Whichever location they chose, they were told that the actor thought it was in the other location. They were then asked where the actor would look for the object. (Recall that in Perner and Leekam's control study, subjects were also asked where they themselves would look for it; they succeeded on this control question as well.)

Task 4) Unseen condition of present study. In this condition subjects were told that the object was in location y, but that the actor was told it was in location x. They were asked where the actor thinks the object is.

These four tasks differ from the standard false belief tasks in terms of the child's representation of the <u>true</u> state of affairs. Consider the following: in Tasks 1 and 2 above, the object is truly in both locations; in Task 3, the object's true location is unspecified; and in Task 4, the salience of the object's true location is minimized. On all these tasks the child succeeds. This pattern of results is sensible if we accept a slight revision of Perner's constraint above:

> So long as children are (reasonably, to some threshhold) certain about their model of reality, they will not mark as true (for anyone) any model of reality which conflicts with it.

In other words, when the child is certain of the truth, he or she will reject all conflicting beliefs. When uncertain, the child will evaluate them. In the standard false belief task, the child has seen the object in location x and is certain it is there, so the actor's false belief is rejected out of hand. In the Wellman and Bartsch tasks summarized above (Tasks 1-3), the child is not constrained by his or her own true model of reality. Why? In Tasks 1 and 2, the actor's reality model is not false (the object really is in the location he thinks it's in), so it needn't be rejected out of hand. In Task 3, the child doesn't know the object's true location, so the constraint is not operative. In Task 4, the unseen condition of Experiment 1, subjects do of course know the single correct location; we are assured of this by their uniformly correct answers to the reality control question. Nevertheless, they know it in a different way, a less reliable way. In the absence of <u>certainty</u> about the true state of affairs, children reason out the answer. (It's of interest here that several children asked to look inside the box, while another whispered to me conspiratorially "is it <u>really</u> in there?") In the unseen condition, then, the child seems to accept the puppet's statement as only <u>provisionally</u> true. It's worth pointing out that not all verbal reports would be accepted as only

provisionally true; presumably, most verbal reports would be considered trustworthy. In our experiment, it may have been not only the source of the child's information, but the fact that better information was available (the closed container was on the table, in easy reach for opening--yet not opened) which led the child to only provisional acceptance. Whatever it was that caused the information to be accepted as only provisionally true, however, the important point remains: in this case, the correspondence rule is not invoked -- and something else is. What is it?

To answer this question, notice that even if the correspondence rule is not used, as in the unseen condition, this is no guarantee of success; the child still needs to use belief/desire causal reasoning in order to succeed on the task. That's just because the possibility of representing a false belief does not guarantee the ability to figure out what it <u>is</u>. Clearly, the child in the unseen condition still needs to make the inference from what the puppet was told to what the puppet will think. That 3-year-olds do so is evidence that they do in fact understand the causal link between testimony and belief; that is, the young child has a causal principle that being told that x leads to believing that x. This result is in keeping with recent evidence that 3-year-olds understand the causal relationship

between seeing that x and believing that x. (Pillow, in press; Pratt and Bryant, 1988; Wellman and Bartsch, in press).

The claim that 3-year-olds have some understanding of false belief is also supported by a recent study of Bartsch & Wellman (in press). They presented preschoolers with stories in which a deceived actor is shown searching for an object in the wrong place. Subjects were asked to explain why the actor was searching in the wrong place. Although these same 3-year-olds could not attribute false beliefs in the standard prediction task, they were quite impressive in explaining the actor's search by appealing to his false belief. In this task, then, children were able to reason backwards from a character's action to a false belief which might have sensibly caused it.

'False' photographs and false beliefs

A series of recent studies (Zaitchik, in press) on the child's understanding of photographs suggests that the early correspondence rule may not be specific to beliefs. In these tasks, preschoolers are presented with a problem similar to the false belief task: An actor takes a photograph of an object in location x; the object is then moved to location y. Subjects are asked: "In the picture, where is the object?" Preschoolers typically answer

incorrectly, pointing to the object's actual location. This mistake, so similar to the mistake on the false belief task, suggests a common source. As suggested above about beliefs, I think the child has enough understanding of the causal processes involved to correctly determine the contents of the photograph, but this knowledge is not accessed in the task or else the inference it leads to is rejected. Why? Possibly the most salient aspect of photographs is just the way they differ from drawings. Drawings do represent possible states of affairs -- but they need not ever have represented true states of affairs. Photos may be special in that they directly reflect the states of affairs that caused them. As such they have a hold on the world that most other representations don't have. That is, the child takes the photograph to be true to reality. There is evidence that 6-year-olds, at least, appreciate this special status of photographs. O'Connor, Beilin, and Kose (1981) presented children with either photographs or drawings of an incorrect solution to a conservation of liquid task. They found that subjects were more likely to choose the illogical outcome as the true outcome when it was represented in a photograph than in a drawing. The authors have argued from these results that children believe in the fidelity of photographs. Once again, it seems, the child's belief in

the correspondence of the representation to reality leads to error.

The False Belief Task

Recall that Bartsch and Wellman (in press) have evidence that young children can explain action by appeal to false belief before they can correctly predict action by appeal to false belief. Considering children's failure on the prediction tasks, the authors claim that the problem stems from the tendency to predict action on the basis of an actor's desires. Specifically, they claim that although 3-year-olds can reason about beliefs as causes of action, 2-year-olds cannot. Two-year-olds can, however, reason about desires as causes of action. The problem in the false belief task, they argue, is that desire reasoning conflicts with belief reasoning. In this case, most 3-year-olds will opt for the more entrenched desire reasoning. Although there is considerable evidence that 2-year-olds can in fact predict action on the basis of an actor's desires (Wellman, 1989) it seems unlikely that it is solely the child's reliance on desire reasoning which accounts for failure on the false belief task. First, notice that this account predicts no problem in inferring the false belief itself; it is only in predicting where the actor will look that the child is faced with a conflict. The test question used in

both the seen and standard conditions, however, does not require predicting action -- only inferring belief. Still the child fails. Second, if the conflict for the child is between the desire and the belief, one should find no such problem with photos. Here there are no desires at play. There is only the representation and the reality -- and still the child fails. Third, in the present study, the difference between the seen and the unseen condition did not involve a change in the actor's desires, so there is no reason why the child should use desire reasoning in the seen condition and belief reasoning in the unseen condition. It was clearly the subject's own representation of reality that was changed from one condition to the other. It seems then that the child's problem is not in the conflict of beliefs and desires, but beliefs and reality.

To conclude, I would agree with the claim that the 3-year-old is in a state of conceptual tension, but the source of the tension is this: the child is making the transition from reasoning in accordance with an early one-way correspondence rule about beliefs and reality--an assumption of the veridicality of beliefs-- to causal reasoning about beliefs, that is, to reasoning from an actor's perceptual experience to his or her belief. For the most part, of course, these two principles live harmoniously, leading to

the same inference; it is only in the case of false beliefs that the child must choose between them. In a way, the claim that the child has principles which sometimes lead to contradictory inferences is not surprising. It is clear that the child's theory of mind is undergoing change. There is no reason to expect this change to be neat, no reason to think that at any given moment the child's theory will be perfectly coherent and non-contradictory. We may expect this of our best scientific theories, perhaps, but it is probably too much to hope for in our developing naive theories.

By the time the child is 4 years old, the understanding of the causal determinants of belief is firmly in place and is evident in a large variety of tasks. The present study, however, provides some evidence of this understanding even in 3-year-olds. In conjunction with the results of Johnson and Maratsos (1978) cited above, it offers evidence that, under some conditions, even 3-year-olds can represent and reason about false beliefs and their effects on human action.

Appendix A

Second skit for seen and unseen conditions

Dog: I just got a new watch. I love to wear it on my arm. Ernie is coming over soon. If he finds out about my new watch he'll want to wear it. But I want to wear it. My watch is in this box, but I won't tell Ernie that; I'll make something up. I'll tell him that my watch is in this bag. Yeah, that's what I'll say. Really my watch is in this box, but I'll tell Ernie it's in the bag.

Ernie: Hi, Dog. Where's your watch?

Dog: Here, in this bag.

Ernie: Oh, thanks for telling me.

Experimenter: Dog told Ernie that his watch is in the bag.

Reality Q: Where is the watch really?

Deceived Actor's Ignorance Q: Does Ernie know that?

Deceived Actor's Belief Q: Where does Ernie think the watch is?

Deceiving Actor's Knowledge Q: Does Dog know that the watch is in the box?

Appendix B

Second skit for standard condition

Dog: Look, Ernie; I just got a new watch. I love to wear it on my arm. It's here in my box. Wanna see it?

Ernie: yeah, that's nice, Mr. Dog. Well, I have to go buy some milk now, but when I come back I'll wear your watch.

Dog: Hmm, when Ernie comes back, he'll want to wear my watch. But I'll want to wear it myself; I don't want him to wear it. Hmm, I know; I'll hide the watch. Ernie saw my watch here in this box, but I'll hide it here in this bag. Dog hides the watch in the bag.

Experimenter: Ernie is out buying milk. Before, when Ernie was here with Dog, he saw the watch in the box.

Reality Q: Well, where is the watch now?

Deceived Actor's Ignorance Q: Does Ernie know that?

Deceived Actor's Belief Q: Where does he think it is?

Deceiving Actor's Knowledge Q: How about Dog? Does he know that the watch in this bag?

Table 2

The deceived actor's belief question

Percentage of correct responses

3-year-olds	
unseen	72
seen	44
standard	44
4-year-olds	
unseen	84
seen	75
standard	94

Table 3

The deceived actor's belief question

Number of S's who got zero, one, or both trials correct

	2	1	0
3's unseen	10	3	3
3's seen	5	4	7
3's standard	7	0	9

Table 4

The deceived actor's ignorance and the deceiving actor's knowledge questions

Percentage correct

	ig	kn	both qs	all 4*
			(% trials)	
chance=	50	50	25	6
3s unseen	81	69	56	50
seen	72	59	43	33
standard	50	97	46	43
4s unseen	94	97	93	86
seen	88	100	87	87
standard	100	100	100	100

*(% of Subjects correct on 2 trials)

TABLE 5

Ignorance questions

Number of S's who got zero, one, or two correct

	2	1	0
3's unseen	12	2	2
3's seen	11	1	4
3's standard	8	0	8

TABLE 6

Knowledge questions

Number of S's who got zero, one, or two correct

	2	1	0
3's unseen	11	0	5
3's seen	7	5	4
3's standard	15	1	0

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