Children's Understanding of Representational Change and Its Relation to the Understanding of False Belief and the Appearance-Reality Distinction

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GOPNIK, ALISON, and ASTINGTON, JANET W. *Children's Understanding of Representational Change and Its Relation to the Understanding of False Belief and the Appearance-Reality Distinction.* CHILD DEVELOPMENT, 1988, **59**, 26–37. This research concerns the development of children's understanding of representational change and its relation to other cognitive developments. Children were shown deceptive objects, and the true nature of the objects was then revealed. Children were then asked what they thought the object was when they first saw it, testing their understanding of representational change; what another child would think the object was, testing their understanding of false belief; and what the object looked like and really was, testing their understanding of the appearance-reality distinction. Most 3-year-olds answered the representational change question incorrectly. Most 5-year-olds did not make this error. Children's performance on the representational change question was poorer than their performance on the false-belief question. There were correlations between performance on all 3 tasks. Apparently children begin to be able to consider alternative representations of the same object at about age 4.

As adults we change our ideas about the world, and we also know that we change them. We see what we think is a rock, but when we pick it up it turns out to be a painted sponge. We change our beliefs about the object; now we think the object is a sponge, but we also remember our past belief. We know that we used to think the object was a rock. Moreover, we can appreciate the difference between real changes in the world and changes in our beliefs about things in the world. We know now that the object really was a sponge all along. It did not change; our ideas about it changed.

We might capture this fact by saying that as adults we have representations of objects in the world, that those representations change, and that we represent the fact that those representations change. All creatures that represent the world at all change those representations. However, human adults have the additional ability to represent their past representations of the world and to contrast them with their present representations. They can understand the process of representational change itself.

The ability to understand representational change underpins many other important abilities. Acquiring new knowledge and, perhaps more important, acquiring strategies to acquire new knowledge often depends on an understanding of representational change. We say that we learn from our mistakes, but learning from our mistakes often requires that we know we were mistaken and can recognize the conditions that led us into error. Even machine learning systems must be able to represent their past representational states and retrace the path that led them to those states in order to modify their learning strategies (Newell & Simon, 1963). Moreover, our ability to understand and benefit from many

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types of instruction depends on our recognition that we were wrong in the past and may turn out to be wrong again in the future. It is hard to imagine teaching someone who was unable to recognize that they had been wrong.

In addition, an understanding of representational change is deeply involved in our everyday metaphysical assumptions about the relation between the mind and the world, the assumptions that philosophers sometimes call "naive realism." As adults we make a firm distinction between the world itself and our representations of the world. One important aspect of this distinction is that we believe that our representations of the world can change, and do change all the time, even when the world itself stays the same (Forguson & Gopnik, in press).

Finally, in addition to its intrinsic interest, representational change is also interesting because it is a metarepresentational ability, an ability that requires children to construct representations of their own representations (Pylyshyn, 1984). Some metarepresentational abilities may be present from a very early age. Very young children engage in pretend play, which suggests some ability to separate representations and realities (Leslie, in press; McCune-Nicolich, 1981; Piaget, 1962). Children seem to use terms such as "think" and "know" in their spontaneous speech from age 2 (Bretherton & Beeghly, 1982; Shatz, Wellman, & Silber, 1983). More compellingly, Wellman and Estes (1986) have found that even 3-year-old children could make some distinctions between mental events, such as dreams or images, and physical ones.

Although some metarepresentational abilities may be present at this very early age, there seems to be a particularly important change in children's understanding of representation somewhere between ages 3 and 5. Consider, for example, the metarepresentational ability to recognize that another person may represent an object differently than you do. Although Piaget (1926) claimed that young children are egocentric, in fact, even very young children, under age 3, can appreciate that under some conditions someone else might not perceive an object that they perceive (Flavell, 1978; Flavell, Everett, Croft, & Flavell, 1981). However, 3-year-olds have more difficulty in a more complex situation, one in which children must recognize that someone else's perception of an object is not like their own perception of it (Flavell, 1978; Flavell et al., 1981). For example, 3-year-olds have difficulty recognizing that a person who sees an object from a different angle than they do may perceive it differently. Flavell has described this as a difference between Level 1 and Level 2 perspective taking.

Similarly, although very young children may sometimes be able to appreciate that other people do not know something they themselves know, they have more difficulty understanding that another person may represent an object differently than they do (Hogrefe, Wimmer, & Perner, 1986; Wimmer & Perner, 1983). For example, in one experiment children were shown a closed box that normally contained dominoes, and then the dominoes were removed and a glove was placed in the box. Three-year-olds were likely to say that another child would immediately think that there was a glove in the box, even before they opened it; 5-year-olds were more likely to say that the other child would think that there were dominoes in the box, though they themselves thought the box contained a glove. Three-year-olds are apparently unable to appreciate the fact that two people can have different representations of the same object. Five-year-olds can understand that two people could have different representations of the object.

Flavell and his associates (Flavell, 1986; Flavell, Flavell, & Green, 1983; Taylor & Flavell, 1984) have found a similar result in a different domain. Children begin to appreciate the difference between appearance and reality somewhere between 3 and 5. A 3-year-old who is given a deceptive object, such as a sponge painted to look like a rock, is likely to say either that the object looks like a sponge and really is a sponge or that it looks like a rock and really is a rock. These children are unlikely to say that the object really is a sponge but looks like a rock. This result may also indicate that 3-year-olds are reluctant to apply different representations to the same object. Although they may understand the difference between a rock and a pretend rock, or an image or a dream of a rock, they are unable to understand that the same object could be represented either as a sponge or as a rock depending on one's point of view.

From these findings it appears that 3-year-olds do not understand that there might be alternative representations of the same object (Flavell, 1986; Wimmer & Perner, 1983). If this is true, 3-year-olds should also have difficulty understanding the fact that their own representations have changed. When we change our ideas about an object, our previ-

ous representation differs from our present representation. To understand representational change children must be able to say "I once thought this was X but now I think this is Y." This ability is similar to the ability to understand another's false belief "he thinks this is X but I think this is Y," and the appearance-reality distinction "this looks like X but really is Y."

Shatz et al. (1983) report two instances in which a child aged 2-8 explicitly referred to a past mental state and contrasted this with a present mental state. There is, however, also some evidence that understanding representational change might be difficult for such young children. In an attempt to improve performance on the false-belief task, Hogrefe et al. (1986) showed children a typical container (e.g., a matchbox) that when opened turned out to have an unexpected content (e.g., chocolate), and routinely asked the children what they had originally thought was in the box. Several children answered this question incorrectly and had to be prompted to give the correct answer. Perner, Leekman, and Wimmer (1987) also reported that some children failed to answer a question about their own representational change correctly after they had been shown a candy box that turned out to contain pencils, though more children passed this control question than passed the false-belief question.

The form of the question in this experiment, however, gave the children a strong indication of what answer was expected. Children were asked, "Can you remember what's inside here?" and when they said "pencils," this question was immediately followed by the question, "But what did you think was in here?" Pragmatically, there is a strong presupposition in this question that the answer is something other than pencils. Thus it is not surprising that children did better on this question than on the false-belief question, which did not include this presupposition. Moreover, there was no control in this study to ensure that the children who did fail the task understood the representational change question itself. This experiment was, of course, not designed to investigate representational change, but these methodological problems make the results difficult to interpret. However, the results are consistent with the view that some children may have been unable to understand that they themselves had once had a different representation of an object, just as they were unable to understand that someone else had a different representation of the object. This is the possibility we explored systematically in the present study.

Empirical investigations of these issues raise particular methodological problems. The simple fact that a child fails to answer a question correctly may not necessarily indicate a cognitive deficit. The child may be unable to interpret the syntax of the question. Or the child may be unable to understand other concepts involved in the question. For example, children might be unable to answer questions about representational change if they could not understand the difference between past and present events. Or the child may be "perceptually seduced" by the present appearance of the object into giving the wrong answer (Bryant, 1974). For instance, if children see a box full of pencils in front of them, they may be tempted to answer "pencils" to any question about the contents of the box. In the present investigations, we have attempted to deal with these methodological problems. In particular, children were given a control task that was identical to the experimental task in all respects, except that it did not require the metarepresentational ability to understand representational change. Children were only included in the analysis of the results if they passed this control test.

The studies we will report were designed to accomplish three ends. First, the studies were designed to discover when children develop an ability to understand representational change. Second, we investigated the developmental relation between this problem and the appearance-reality and false-belief problems. Several different relations between these problems are possible. Children might solve all three problems at the same time, suggesting the development of a single more general metarepresentational ability at this point, or they might solve some of these problems before others. For example, we might expect that children would be able to understand representational change first and then apply this understanding to the false-belief problem; they might treat other people as if they were their own past selves. Alternatively, children might come to appreciate representational change by solving the problem of false belief; they might treat their own past selves as if they were other people. Similarly, understanding the appearance-reality distinction might be a cause or a consequence of understanding the other two problems. Finally, the study was designed to explore whether children's understanding of representational change varies in different task situations.

Experiment 1

Method

Subjects.—Subjects were 43 children attending local day-care centers. The subjects were divided into three age groups: 14 3-year-olds (mean age = 40.57 months, range = 34–48 months), 12 4-year olds (mean age = 54.67 months, range = 50–59 months), and 17 5-year-olds (mean age = 65.88 months, range = 60–75 months).

Materials.—Materials were designed to lead the child to represent an object in one way initially and then to change that representation, without there being an actual change in the object itself. Children received variants of the Perner et al. (1987) "smarties" task and the Flavell et al. (1983) "rock" task. In the "smarties' task, children were shown a box of the candy "smarties" that had pictures of smarties on it. ("Smarties" are a popular British and Canadian candy, and "smarties" boxes are highly familiar to British and Canadian children.) When children opened the box they discovered that there were small pencils inside the box instead of smarties. We assumed that the children would initially represent the box as containing smarties and then represent it as containing pencils.

In the "rock" task, children were shown a small sponge painted to look like a rock. (This sponge-rock deceived several adults who were shown it.) Children were initially shown the rock on the other side of a table and were then allowed to pick it up and squeeze it. We assumed that the children initially represented the object as a rock and then represented it as a sponge.

Procedure.—Children were all tested individually in a small screened-off area of the day-care center. Children were tested by two experimenters, one who administered the tasks and one who recorded the children's answers. Test sessions were audiotaped. Children were told initially, "We're going to play a game where we show you some things and ask questions about them." Children first received a control task (see below) and then received the materials described above. In each case, children were first shown the object in its deceptive form (i.e., the closed smarties box, or the rock at the other side of the table) and were told to look at it. The true nature of the object was then revealed (i.e., the children were told to open the box, and to pick up the rock and squeeze it). Then children were asked to identify the true nature of the objects. They were asked in the different tasks, "What's inside the box?" and, "What is it?" until they answered correctly. This ensured that the children did, in fact, represent the objects as containing pencils or as a sponge after the deception was revealed. The object was then returned to its previous deceptive state (i.e., the smarties box was closed, and the rock was placed away from the child). This ensured that the children were not "perceptually seduced" by seeing the pencils or by feeling the sponge. Children were then asked the test questions. At the end of the session, children were told not to talk about the tests with any other children.

Test questions.—Children were asked three sets of forced-choice questions investigating their understanding of representational change, false belief, and the appearance-reality distinction (see Appendix). The question concerning representational change for the smarties task was, "When you first saw the box, before we opened it, what did you think was inside it? Did you think there were smarties inside it or did you think there were pencils inside it?" The question was designed to be highly redundant and to stress the fact that we were asking about the child's past representation of the object.

All children received a control task that was designed to ensure that they understood the basic concepts involved in the representational change question. This task involved a real change in the world rather than a change in the child's representation of the world. In this task, children were shown a closed toy house. The roof of the house was then removed. Inside the house was an apple. The apple was then removed, a doll was put in the house, and the roof was replaced. Children were then asked what was in the house now. When they answered correctly they were asked, "When you first saw the house, before we put the man in there, what was inside it? Was there an apple inside it or was there a man inside it?" The two forced-choice alternatives were counterbalanced.

To answer this question correctly, that is to say, "the apple," children had to have understood the question, understood the concept of one event occurring before another, remembered the past event, and been able to ignore the present state of the object. In short, the only conceptual difference between answering this question and answering the representational change question is the metarepresentational element. In the control question, children are asked about the past state of the object, while in the test question they are asked about their past representation

of the object. Another way of putting this is that in the control question an object changes, while in the test question the object remains the same and the child's representation of the object changes. If the child answers the control question correctly but does not answer the change question correctly, it is likely that this failure is the result of an inability to understand *representational* change, in particular, rather than the result of a general inability to understand change or some more general cognitive or linguistic difficulty. Children always received the control task before they received the other tasks.

To control for possible effects of order of presentation, the four test questions (representational change, false belief, and the two appearance-reality questions) were presented in eight different orders, specified by eight different lists. Half the lists presented the representational change and false-belief questions first, and half presented the appearance-reality questions first. Within each half, order of presentation of questions in each pair was alternated, and within each pair the order of presentation of the forced choices was alternated, with the constraint that the order for the first and fourth questions was the same. Half of the children were asked first about the smarties box, and the other half about the rock. For each child, the order of questions and forced choice alternatives for one set of materials was exactly the reverse of the order for the other set.

Scoring.—Children were scored as having passed the representational change question if they correctly reported their initial representation of the object. All children who passed the control task gave some response to the questions. Children were only counted as having failed if they said that they had originally known the true nature of the object, for example, if they said, "I thought there were pencils in the box." Similar procedures were used to score the false-belief question. To pass the appearance-reality question, children had to answer both parts correctly; for example, they had to say both that the object really was a sponge and that it looked like a rock. Children were given a total score of 0–2 on each question depending on whether they answered the questions correctly on neither the smarties nor the rock task, on one of the tasks, or on both.

Results

Representational change.—Four of the children in the 3-year-old group and one in the 5-year-old group failed the control task and were excluded from further analysis. The new mean age of the 3-year-olds was 41.1 months and the range was 36–48 months. Children's mean scores were subjected to a 2 (task materials) × 3 (age) × 8 (list) analysis of variance, with task materials as the within-subjects factor and age and list the between-subjects factors. There was no effect of list, which had varied the order of task materials, questions, and forced-choice alternatives, and it did not enter into any interactions. There was a significant effect of age, with performance increasing across the three age groups, $F(2,15) = 5.38$, $p < .05$ (see Fig. 1). In particular, for both tasks, less than one-half of the 3-year-old group answered the representational change question correctly, while more than two-thirds of the 5-year-old group answered correctly. There was also a significant effect of task materials, with the rock task appearing to be easier than the smarties task, $F(1,15) = 5.92$, $p < .05$.

It may be noted that we did not ask the children, when they first saw the box, what they thought was inside it, and thus had no way of telling for sure whether they did think there were smarties in the box or that the object was a rock. This was done intentionally because we wanted to ensure that children were not simply reporting their previous statement rather than their previous mental state. However, there were seven instances in which children did in fact spontaneously identify the objects when they first saw them, suggesting that they did make these assumptions. Moreover, it is interesting to note that in five of these instances children who did explicitly identify the objects still gave the incorrect answer on the representational change question.

Relations to other questions.—A similar ANOVA performed on the false-belief and appearance-reality scores indicated that performance on these tasks also increased with age, replicating the findings of Flavell et al. (1983) and Hogrefe et al. (1986). However, a within-subjects analysis of performance on the three types of question indicated that performance on the false-belief question was significantly better than performance on the change question, $F(1,35) = 10.43$, $p < .01$. Performance on the appearance-reality question was intermediate between the other two questions but did not differ significantly from either question (see Fig. 1).

We also examined the pooled within-cell correlations between performance on the three questions for the entire sample. These correlations control for the effects of age. There were significant correlations between

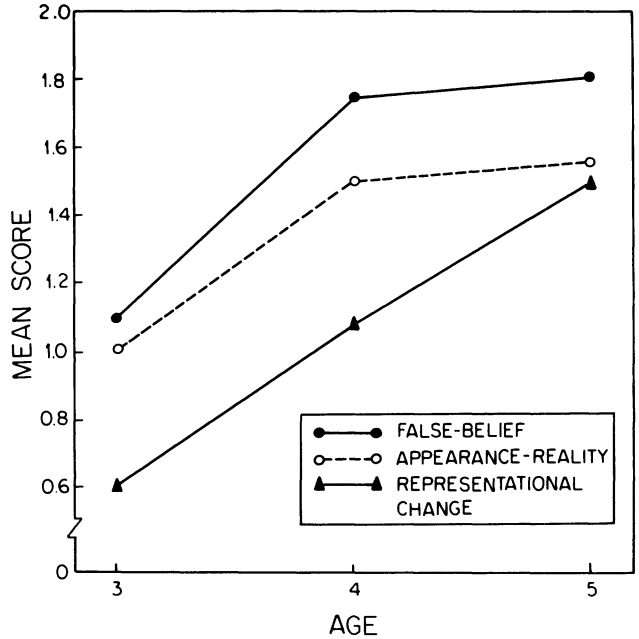

FIG. 1.—Mean scores on representational change, false-belief, and appearance-reality questions for three age groups in Experiment 1.

performance on the change question and the appearance-reality question ($r = .46$, $p < .01$) and between performance on the false-belief question and the appearance-reality question ($r = .49$, $p < .01$), although not between performance on the change question and the false-belief question ($r = .24$, $p > .05$).

It should be noted that two types of error are possible for appearance-reality; children may say that the rock both looks like a rock and really is a rock, the phenomenist error, or they may say that the rock both looks like a sponge and really is a sponge, the realist error (Flavell et al., 1983). Children in our study, like those in Flavell's study, made the realist error more frequently, though both these errors occurred. However, there was no connection between the type of appearance-reality error a child made and performance on the other two questions. Realists and phenomenists were equally poor on the representational change and false-belief questions.

Finally, we may investigate whether children erred consistently or simply responded at chance levels. If children were responding at chance we would expect the mean score to be about 1. In fact, the 3-year-olds' mean for the representational change question was considerably below this, suggesting that they *were* consistently making errors. Another way of investigating this question is to look at the patterns of responding across the two tasks. Only two of the 10 3-year-olds performed differently on the smarties task and the rock task. Moreover, both these children passed the rock task but did not pass the smarties task. The same pattern emerged among the older children. Only five out of 28 older children performed differently on the two tasks, and only one of these children did better on the smarties task than on the rock task. Apparently most of the divergences from consistency were due to the difference in difficulty of the two tasks rather than to chance responding.

Experiment 2

Given the results of Experiment 1, 3-year-olds do appear to have difficulty understanding representational change, and this difficulty is related to their difficulty in understanding false-belief and the appearance-reality distinction. Two issues deserve further investigation, however. First, we had some concerns about the linguistic form of the representational change question in Experiment 1. Some children may have had trouble understanding this complex question. Also, in the control task we had asked, "When you first looked in the house, before we put the man in there, what was inside it?" This may have indicated to the children that an answer other than "the man" was expected. Finally, in Experiment 1 there were some syntactic

differences between the form of the change question and the form of the false-belief question, and such differences might have led to the difference in performance on these two questions.

Second, we wanted to see whether children would show the same difficulties across a wider range of task materials, and whether some types of materials would be more difficult than others. In the second experiment, then, we included a wider range of syntactic forms of the question and of task materials.

Method

Subjects.—Fifty-eight children from local day-care centers were tested. Again, the children were divided into three age groups: 20 3-year-olds (mean age = 44.90 months, range = 37–48 months), 21 4-year-olds (mean age = 52.91 months, range = 49–59 months), and 17 5-year-olds (mean age = 65.59, range = 60–74 months).

Materials.—Three additional sets of materials, as well as the original "smarties" and "rock" materials, were used.

The first additional set of materials, based on a task used by Chandler and Helm (1984), were used to explore children's representation of the identity of an object but did so in a rather different way than the rock task. Children were presented with a small book with pictures of animals on the cover. When children opened the book they saw a restricted view of a picture of a dog, including its ears, through a peephole. When they turned the page, the full picture of the dog was visible. Similarly, on the next page, children saw a restricted view of a rabbit, including its ears, and when they turned the page saw the full rabbit. On the following page, children again saw a restricted view of what looked like ears through the peephole, but now when they turned the page they saw that the "ears" were actually petals of a flower. The assumption was that the children would initially represent the last picture as another animal and then represent it as a flower.

The next set of materials investigated the child's understanding of properties and was adapted from a task used by Taylor and Flavell (1984). Children were shown a green cat covered by a pink transparency, which made the cat look black. Children were then told to life the transparency, revealing that the cat was actually green. Again we assumed that the children would initially represent the cat as black and then represent it as green.

The final set of materials explored children's understanding of number. The materials consisted of two rag dolls that could be put together and covered with one dress. Children were initially shown the dressed doll, which looked like a single doll, and then the doll was undressed and the two dolls were revealed. Again the assumption was that the children would initially represent the doll as a single doll and then represent it as two dolls.

Procedure.—The procedure used was the same as that in Experiment 1. Children were given the control task first, and then the five other tasks. Children were shown the object in its deceptive form (the picture through the peephole, the cat with the transparency over it, and the dressed doll), and the true nature of the object was then revealed (the page was turned, the transparency was lifted, and the doll was undressed). Children were asked to identify the true nature of the object, and the object was then returned to its original deceptive state and the children were asked the test questions.

Questions.—The control task question was changed to avoid the pragmatic problems of the question in the first experiment. One form of this question read, "When you first saw the house, before we took the roof off, what was inside it?" All children received a representational change question and false-belief question for all tasks. Appearance-reality questions would not have been appropriate for all the new tasks, and we were slightly concerned about the naturalness of the appearance-reality question in the "smarties" task. Therefore, these questions were asked only for the "rock" task and the "cat" task, the two tasks most closely analogous to Flavell's tasks. Twenty-one of the children received questions analogous to the questions in Experiment 1, 17 children received questions of Form A, such as "When you first saw the box, all closed up like this, what did you think was inside it?" and the remaining 20 children received questions of Form B, such as "What did you think was inside the box before we opened it?" (see Appendix). In each case children received the same form of the question in the control task, the change task, and the false-belief task. In Experiment 1, many children answered the representational change and false-belief questions immediately before the forced-choice part of the question could be administered. Therefore, in this experiment, children were given an open-ended question first. If children did not

respond they were asked the forced-choice question.

Tasks and questions were presented in six different orders specified by six different lists. The three tasks that did not have appearance-reality questions were presented equally often in first, third, or fifth position, and the two tasks that did have appearance-reality questions were presented equally often in second or fourth position. The representational change and false-belief questions were always asked first; within the pair, each type of question appeared first at least twice, and first not more than twice in succession, on each list. In addition, on each list the order of questions for appearance and reality was alternated for the two tasks that had appearance-reality questions.

Scoring.—Scoring procedures were generally the same as those used in the previous experiment. Children received a score of 0–5 on the representational change and false-belief questions and a score of 0–2 on the appearance-reality question, depending on how many times they answered each question correctly. To compare scores on the three questions, the appearance-reality score was transformed to a comparable scale to that used for the other two questions by multiplying each appearance-reality score by 5/2.

Results

Representational change.—Five 3-year-olds failed the control task and were not included in the analysis of the results. The new mean age of the 3-year-old group was 45.0 months and the range was 40–48 months. Children's mean scores were subjected to a 5 (task materials) × 3 (age) × 6 (list) × 3 (syntactic form of question) analysis of variance, with task materials as the within-subjects factor, and age, list, and syntactic form between-subjects factors. The three-way interaction and the interaction of list and syntactic form were suppressed and pooled with the within-cell variance. There were no effects of list, or syntactic form, and no interactions of either with age, suggesting that the results were not due to the order of presentation of the questions or to the particular syntactic form of the question.

There was a significant effect of age, which was similar overall to the age effect found in the first experiment, $F(2,30) = 6.39$, $p < .01$ (see Fig. 2).

There was also a significant effect of task materials, $F(4,120) = 5.85$, $p < .001$. Children's performance on the "smarties" and "rock" tasks was comparable to their performance in Experiment 1. However, the "book" and "cat" tasks appeared to be somewhat eas-

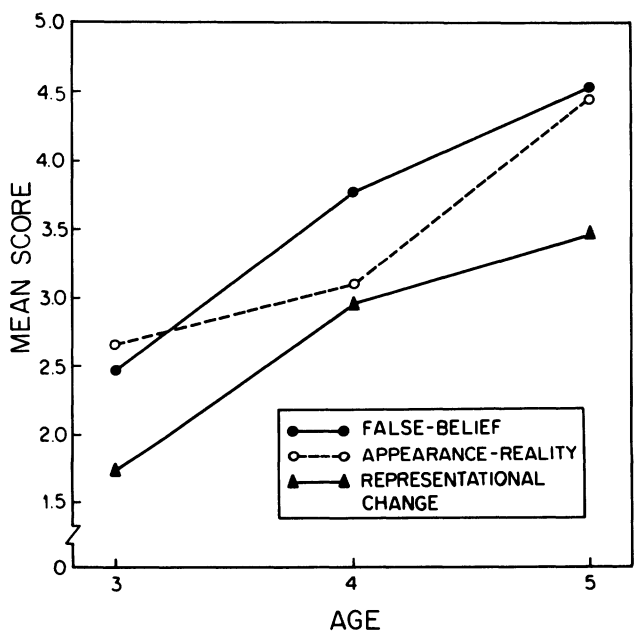

FIG. 2.—Mean scores on representational change, false-belief, and appearance-reality questions for three age groups in Experiment 2.

ier than the other two tasks, and the "doll" task appeared to be more difficult. Across all three age groups, the proportion of children who answered the representational change question correctly was .69, .66, .52, .49, and .39 for the "book," "cat," "rock," "smarties," and "doll" tasks, respectively. For the 3-year-olds, the proportion of correct answers on each task ranged from .47 to .27. Thus, even the easiest of the tasks was still failed by more than half of the 3-year-olds.

Relation to other questions.—As in Experiment 1, the false-belief question proved to be significantly easier than the change question, $F(1,50) = 24.02$, $p < .01$ (see Fig. 2). Moreover, this difference was consistent across the five tasks. For each individual task, children performed better on the false-belief question than on the change question. As in the previous experiment, the results on the appearance-reality question appeared to fall between the other two results. In this experiment, however, appearance-reality performance was significantly better than change performance, $F(1,50) = 7.16$, $p < .01$, but was not significantly worse than false-belief performance.

The pooled within-cell correlations of performance on the three types of question were also examined. There were significant correlations between performance on all three types of question. The correlations between the change question and the appearance-reality question ($r = .49$, $p < .01$) and between the false-belief question and the appearance-reality question ($r = .44$, $p < .01$) were comparable to those in the previous experiment. In the present experiment, however, there was also a significant correlation between performance on the change and false-belief questions ($r = .62$, $p < .001$).

Again, as in the previous experiment there were 40 instances in which children spontaneously identified the objects when they first saw them. Children explicitly said "smarties," "a rock," and "a doll" and identified the flower as an animal, though they did not explicitly identify the color of the cat. As before, in 14 of these cases children who explicitly identified the objects answered the representational change question incorrectly.

Again as before, realist answers to the appearance-reality questions predominated. This was true even in the "cat" task, where Flavell et al. found a predominance of phenomenist errors. However, as in the previous experiment, there was no clear relation between the type of appearance-reality error and the results on the other two questions.

As in the previous experiment, the fact that the 3-year-olds' mean score on the representational change question was less than 2.5 suggests that these children were not responding at chance. The task differences in this study made it difficult to use children's consistency across tasks to indicate whether they were guessing or choosing a particular incorrect answer. However, a reliability coefficient (Cronbach's alpha = .69) across the five tasks also suggests that children were not performing at chance.

General Discussion

Children's understanding of representational change seems to develop between ages 3 and 5. In particular, 3-year-olds are likely to behave as if their present representation of an object was always their representation of it. They are unable to appreciate that their past representation of an object was different from their present representation.

However, performance on this task may vary depending on what kinds of task materials are used. A possible, though speculative, explanation for this fact is that it is easier to construct metarepresentations of representations that are more perceptually based than those that are more abstract. For example, the Level 2 visual perspective-taking ability, which involves perceptually based claims about the appearance of objects, seems to arise somewhat earlier than the solution of the false-belief task, which involves more abstract propositions about relations between objects. It seems plausible that it is more difficult to metarepresent more abstract and sophisticated representations, such as the representations of number in the "doll" task, than more perceptually based representations, such as the representations of color in the "cat" task.

There also are interesting relations between understanding representational change and understanding false belief and the appearance-reality distinction. All three of these tasks involve the ability to consider two alternative conflicting representations of the same object. All three of these abilities seem to develop at about the same point, between 3 and 5, and all three abilities are correlated even when age is controlled. These three abilities may reflect some more general ability to consider alternative representations of reality that develops at about this time.

However, it appears that, for each particular task, children consistently understand the false-belief question before they understand the representational change question. There are a number of possible interpretations of this finding. One possibility might be that children are less willing to attribute errors to themselves than to other people and are therefore motivated to conceal their own ignorance. According to this account, some children know about their past representation, but they lie about it to the experimenter, or somehow suppress their own knowledge of their past representation. Notice that this explanation will not work as an explanation of the change effect in general. When children are incorrect on both the false-belief question and on the change question, it seems implausible to attribute both these errors to motivational or emotional factors. To do so, we would have to assume that these children are motivated to lie to the experimenter about both their own state and the state of other children.

This explanation of the difference between these two questions seems implausible on several grounds. First, it assumes that 3-year-old children have the ability to formulate metarepresentational propositions and then have the further metarepresentational ability to deceive another person (or themselves) about those propositions. Second, and most significant, this explanation fails to account for the effect of task materials. We would have to assume, on this model, that while 5-year-olds were not motivated to deceive the experimenter or themselves about their representations in the other tasks, they were so motivated in the "doll" task.

An alternative, more promising explanation is that children actually learn to understand changes in their own mental states by appreciating the difference between their own mental state and that of another. Although this may at first seem counterintuitive, it might be consistent with a Vygotskyan view of cognitive development. Such a view would claim that certain concepts are learned first in a social setting and are then internalized. In particular, because children and other people use the same language, children's own states will often conflict explicitly with the states of others. Although it may be easy to ignore your own contradictions, it is less easy to ignore, say, the vociferously repeated contrary claims put forward by your older brother.

A final interesting aspect of these results is their implications for studies of children's memory. The representational change question tests one aspect of the child's memory as well as testing metacognitive skills. Apparently, 3-year-old children can easily remember states of the external world, but they may have more difficulty remembering internal psychological states such as their previous representations of the world. This is consistent with some of the findings in the naturalistic investigation of early event memory (Nelson & Ross, 1980).

More generally, there is a growing consensus that there are significant and profound changes in children's concept of the mind between 3 and 5 (Astington, Harris, & Olson, in press). Developing an understanding of representational change appears to be one of these changes.

Appendix

Question Forms

EXPERIMENT 1

Control

When you first looked in the house, before we put the man in there, what was inside it? Was there an apple inside or was there a man inside?

Smarties

Representational change.—When you first saw the box, before we opened it, what did you think was inside it? Did you think there were pencils inside it or did you think there were smarties inside it?

False belief.—X hasn't seen inside this box. If X sees the box all closed up like this, what will [s]he think is inside it? Will [s]he think there are pencils inside it or will [s]he think there are smarties inside it? [Note: X is another child in day care, not yet tested.]

Appearance.—Does it look like this box has pencils in it or does it look like it has smarties in it?

Reality.—What's really inside this box? Are there really pencils inside it, or are there really smarties inside it?

Rock

Representational change.—When you first saw this, before you touched it or squeezed it, what did you think it was? Did you think it was a rock or did you think it was a sponge?

False belief.—X hasn't touched this, [s]he hasn't squeezed it. If X just sees it over here like this, what will [s]he think it is? Will [s]he think it's a rock or will [s]he think that it's a sponge?

Appearance.—What does this look like? Does it look like a rock or does it look like a sponge?

Reality.—What is this really? Is it really a rock or is it really a sponge?

EXPERIMENT 2

Form A

Control

When you first saw the house at the beginning, what was inside it?

Smarties

Representational change.—When you first saw the box, all closed up like this, what did you think was inside it?

False belief.—X hasn't seen inside this box. When [s]he first sees the box, all closed up like this, what will [s]he think is inside it?

Rock

Representational change.—When you first saw this, over here like this, what did you think it was?

False belief.—X hasn't touched this, [s]he hasn't squeezed it. When [s]he first sees it, over here like this, what will [s]he think it is?

Book

Representational change.—When you first saw the picture, through the peephole like this, what did you think it was?

False belief.—X hasn't seen these pictures. When [s]he first sees the picture, through the peephole like this, what will [s]he think it is?

Cat

Representational change.—When you first saw the cat, all covered up like this, what color did you think it was?

False belief.—X hasn't seen this. When [s]he first sees the cat, all covered up like this, what color will [s]he think it is?

Doll

Representational change.—When you first saw this, all dressed up like this, how many dolls did you think there were?

False belief.—X hasn't seen this, [s]he hasn't played with it. When [s]he first sees it, all dressed up like this, how many dolls will [s]he think there are?

Form B

Control

What was in the house before we took the roof off?

Smarties

Representational change.—What did you think was inside the box before we opened it?

False belief.—X hasn't seen inside this box. What will [s]he think is inside it before [s]he opens it?

Rock

Representational change.—What did you think this was before you touched it or squeezed it?

False belief.—X hasn't touched this, [s]he hasn't squeezed it. What will [s]he think it is before [s]he touches it or squeezes it?

Book

Representational change.—What did you think this was before we turned the page?

False belief.—X hasn't seen these pictures. What will [s]he think it is before [s]he turns the page?

Cat

Representational change.—What color did you think the cat was before we uncovered it?

False belief.—X hasn't seen this. What color will [s]he think the cat is before [s]he uncovers it?

Doll

Representational change.—How many dolls did you think there were before we took the dress off?

False belief.—X hasn't seen this, [s]he hasn't played with this. How many dolls will [s]he think there are before [s]he takes the dress off?

Forms A and B (Appearance-Reality)

Rock

Appearance.—What does this look like? Does it look like a rock or does it look like a sponge?

Reality.—What is this really? Is it really a rock or is it really a sponge?

Cat

Appearance.—What does this look like? Does the cat look black or green?

Reality.—What is this really? Is the cat really green or really black?

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