Realist Errors in Children’s Responses to Pictures and Words as Representations

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In three experiments we examined the judgments made by 3- to 4- year-old children about out-of-date physical representations which no longer matched their referents. The referent was a doll wearing a sticker, and the sticker was swapped for a different one after a picture had been drawn of the initial state of affairs (Experiments 1 and 2) or after the name of the doll and its original sticker had been written down (Experiment 3). We confirmed previous findings of realist errors in identity judgments for pictures and showed also that children tended to misidentify the name of a sticker in a written list to match a change to its referent. Thus, realist errors are not confined to representations which are iconically similar to their referents. Furthermore, children also judged incorrectly that the pictures and words had actually been changed, indicating that realist errors to external representations extend to operations performed on their referents as well as to their identities. © 1999 Academic Press

Key Words: false-picture task; iconic realism; pictorial representation; realist errors; symbolic representation; syncretism.

A crucial aspect of a mature understanding about any form of external representation is the reconciliation of two fundamentally opposed requirements. These requirements are to identify the representation with its referent and at the same time to recognize the distinction between these two entities. A picture, for
example, is both a thing in itself (e.g., marks on a piece of paper) and at the same
time a depiction of something else (its referent): Recognition of both identities of
the picture is needed for full understanding. While most adults have no difficulty
in grasping this, Piaget (1929) proposed that preschool children are unable to
differentiate successfully between symbols and the things they signify, display-
ing a confusion between the two which he termed “childhood realism.”

In what are now often described as “false-picture tasks,” many children up to
4 years of age appear to make such realist errors with respect to pictures (see also
Beilin & Pearlman, 1991). In the form of this task originally developed by
Zaitchik (1990), children witnessed a photograph being taken of a toy in Location
A. The toy was then moved to Location B, and the children were asked to say
what the picture would show. Many 3- to 4-year-olds replied as if they believed
the picture updated to match the changed reality. Robinson, Nye, and Thomas
(1994) confirmed the incidence of this kind of confusion among 3- to 4-year-olds
and were able to define more precisely the nature of the error and the conditions
under which it occurred. They adapted a procedure originally devised by Perner,
Leekam, Myers, Davis, and Odgers (1993) in which a child was introduced to a
doll wearing a distinctive sticker. A drawing of the doll with its sticker was then
made in front of the child. The picture was then turned facedown, and the sticker
on the doll was exchanged for a different one. The doll with its new sticker was
also turned facedown and the child was questioned about the identities of the
stickers on the real doll and on the doll drawn in the picture.

By using a drawing made by the experimenter in the presence of the child
rather than a camera and photograph, Robinson et al. (1994) ruled out children’s
possible misunderstanding of photography as a factor producing the confusion.
The instructions to the child established clearly that the drawing was a picture of
a particular reality. Furthermore, the test questions were accompanied by appro-
priate finger pointing by the experimenter to ensure that no children misinter-
preted the test question about the picture as referring to reality (see Perner et al.,
1993). In addition to the confirmation that some children appear to judge that a
picture would update to match a changed reality, it was found that some children
judge that a picture that was changed would “backdate” to restore its correspon-
dence with an (unchanged) real referent. The procedure also included a copy
control (see Perner, 1991) in which realist errors were significantly reduced when
the picture matched but did not represent the item that was subsequently changed.
Specifically, the picture in this control condition was described to the child as
being of a different toy from the one physically present with the picture, but
which just happened to be wearing a similar sticker. Furthermore, when either
two dolls or two pictures with initially the same stickers were presented as
matching but not representing each other, then there were again few errors when
one of them was changed. It seems that confusion errors arise principally when
one item is described to the child as representing the other.

What is the significance of the kind of realist error observed by Zaitchik (1990)
and by Robinson et al. (1994)? An interesting possibility is that in order to sustain the idea that a picture stands for its referent, 3- to 4-year-olds may have to suppress any recognition of the picture as a thing in itself. According to this view, realist errors would be a marker for an important step in children’s developing understanding of representations. This account suggests that not only should such children make errors about the identity of an item in a picture to match it to a changed referent, but they might also wrongly judge that the operation to bring about the change to the referent had also been performed on the picture. The present series of experiments was conceived to explore this possibility, to assess how robust the errors are, and to determine whether they occur only to pictures or also to other kinds of external representations such as words.

EXPERIMENT 1

The starting point for the present studies was the procedure reported by Robinson et al. (1994) in which many 3- to 4-year-olds judged that the identity of a sticker in a line drawing matched that of a changed real referent. In Experiment 1 we set out to examine whether children who made realist errors about the identity of the drawn sticker also made the related error of judging that the drawn sticker had been altered; thus, we would test whether realist errors about the identity of a referent and its representation extend to operations performed upon them.

One way to test for this possibility, and to assess the robustness of realist errors, would be to ask the children if the sticker in the picture had changed. There were two reasons for thinking that realist errors might be less likely in response to questions about the operations performed on a picture’s referent than in response to questions about its identity. First, children might fairly easily make realist errors about the identity of a sticker in a picture because of superficial confusion in memory but would, we thought, be less likely to be confused about whether that sticker had been changed to update it or, indeed, about the experimenter’s actions in changing the sticker on the doll but not in the picture. Second, a change question would be likely to direct children’s attention toward the picture as a thing in itself, which might also reduce realist errors. In Experiment 1, then, we asked children first whether the sticker (on the doll or in the picture) had changed, before we asked about the identity of the sticker. We expected that having answered correctly to a change question, children might then be much less likely to make realist errors about the identity of the sticker on the picture, so we included as a control a group of children who were asked only the identity but not the change questions.

Method

Design

The design involved two within-subjects comparisons. The two independent variables were the object referred to in the test question (doll and picture) and the
type of question asked (change and identity questions). There were three treatment conditions, varying in respect to which test questions were asked and the order of their presentation. In the two experimental groups, participants were presented with both change and identity questions, one group receiving test questions concerning the doll first, the other receiving the picture questions first. In both of these conditions the change question was always posed before the corresponding identity question for each object. The third group received only identity questions and thus acted as a control for any effects of experiencing the change questions first. The dependent variable was the participants’ score for their responses to each type of question summed across the two trials (1 point was given for each correct answer).

**Materials**

For the change pretest two teddies and three ribbons were used. Both the teddies and the ribbons used were distinctively different to avoid any confusion. For the experimental task, two dolls (one female and one male, approximately 12 cm tall) were used, along with six stickers (a sheep, a monkey, a star, a heart, a duck, and a pig sticker). Pieces of white paper (10.5 by 15 cm) were also employed, on which the dolls were drawn with a black ballpoint pen during the course of the procedure.

**Procedure**

The children were tested individually in a quiet room in their nursery. On successful completion of the warm-up trial, the children proceeded to the experimental trials.

**Change pretest.** This tested for each child’s understanding of questions about changes. Children were presented with a teddy bear and were asked, “What’s this?” Their answers were affirmed, “Yes, it’s a teddy.” Following their response, they were further questioned as to what the teddy was wearing. Most children said “scarf”; in subsequent questioning we adopted the actual term used by the child. Another teddy bear was presented and the child was similarly questioned as to what this bear was wearing. The experimenter then announced, “Let’s give this teddy a different scarf; let’s give him this one instead.” and one teddy’s scarf was replaced with an alternative. With both teddies placed on the table in front of the child, the experimenter asked rhetorically, “So the scarf this teddy’s wearing has changed, hasn’t it?” (the experimenter pointed to the altered teddy), immediately followed by the check question, “Has the scarf this teddy’s wearing changed?” (with the experimenter pointing to the second teddy). Only children who correctly answered the check question about the second teddy went on to complete the experimental task (see the Participants section for numbers of excluded children).

**Experimental trials.** The first (girl) doll was introduced with the three stickers she had brought with her (the sheep, monkey, and star stickers). Each child was
instructed, “This is a little girl called Anne, and we’ve got these stickers for her...” The child was then asked to name each sticker. When the child had answered, the experimenter placed the sheep sticker on the doll’s T-shirt and said, “Anne’s going to put this sticker on her T-shirt. Doesn’t that look nice. What is it?”

The experimenter then stated, “Anne wants us to draw a picture of her with her sticker.” The picture was drawn in front of the child by the experimenter, who talked about each part as it was drawn (“Here’s her face, and her arms...”). When it came to drawing the sticker in the picture, the experimenter drew the child’s attention to it by asking him/her to label it specifically. After a pause to allow the child to take in the completed picture, the picture was turned facedown (slightly out of the child’s reach) and the child was told, “Now let’s give Anne a different sticker; let’s give her this one instead.” The experimenter pointed to the monkey sticker, before replacing the sheep sticker with it. The child was asked, “Doesn’t that look nice? What is it?” and the experimenter affirmed the child’s answer with, “Yes, it’s a monkey.” The doll was then put facedown, again slightly out of the child’s reach.

The following test questions were then posed. Change doll question: “Remember Anne; has the sticker she’s wearing changed?” Identity doll question: “What sticker is she [Anne] wearing?” Change picture question: “Remember this picture; has the sticker drawn in the picture changed?” Identity picture question: “What sticker is drawn in the picture?”

The experimenter pointed at each object (doll or picture) while asking first the change question and then the identity question. Children in one of the experimental groups were asked the two questions directed at the doll first; children in the other group received the picture questions first. Children in the control group were asked only the identity questions (picture followed by doll).

The procedure was then repeated exactly for a second doll, named Paul, using the heart sticker (which was drawn), the duck sticker (which was used to replace the heart), and the pig sticker (the “distractor”).

Participants

The children tested were from two nursery schools in South Birmingham, situated in predominantly middle-class catchment areas. The data reported are from a sample which consisted of 60 children (31 girls, 29 boys) between 3;4 years and 4;5 years old (mean age 4;0), randomly assigned to one of the three treatment groups. A further 27 children were dropped from the study due to their failure in the change pretest.

Results and Discussion

Our first concern was the relatively large number of children who had to be dropped from the study after failing the change pretest. Given that approximately one quarter of the children screened failed the test question, a specific concern
was that some of the children who had passed the pretest and were included in the study may actually not have understood the change question and may have passed only because they replied correctly by chance. In order to evaluate this possibility we tried a slightly modified version of the pretest (but not the rest of the procedure) on a further 21 children. In this modified pretest, each child received two trials each with a different pair of dolls/teddies. We found that approximately 40% of the children failed, thus confirming our previous result that many children fail this pretest. More importantly, however, we found that all but 2 of the children gave the same answer on each of the two trials, indicating that performance on the pretest was not based on chance, but really was discriminating between children on the basis of their ability to answer correctly to questions about changes. Twelve of the children who responded consistently were correct on both trials; 7 made errors on both trials. The 2 children who responded inconsistently made errors on the first trial but were then correct on the second trial. All errors took the form of asserting incorrectly that the unchanged teddy had changed too. Consequently, we can be fairly confident that our pretest efficiently excluded children who misunderstood the test questions or who simply tended to respond by answering “yes.”

Returning now to the main part of the study, each child in the two experimental groups was given a score of 1 for each correct answer, giving a total score out of 2 for each of the four test questions (change picture, identity picture, change doll, identity doll). Similarly for the control group, responses were summed across both trials for each identity question (doll and picture). Parametric tests were used throughout the present studies, despite the narrow range of scores, because it is widely held that such tests are robust where there are equal sample sizes and an $N > 40$ in each condition (as in our experiments). Furthermore, repeating the analyses with a conservative adjustment for violations of the sphericity assumption (Greenhouse & Geisser, 1959) confirmed all the within-subject significant effects. Similarly, applying a correction for violations of the homogeneity assumption to the between-subjects effects (Welch, 1938) also confirmed the original decisions. An alpha level of $p < .05$ was used throughout.

It was necessary first to establish whether realist errors to the identity questions were reduced by having a preceding change question. Performance on the identity questions across all three treatment groups was compared using a two-way mixed analysis of variance (ANOVA). This analysis revealed that the main effect for group and the interaction between group and question topic (doll or picture) were not significant. Thus, performance on the identity questions did not differ significantly between the experimental and control groups, indicating that answers to identity questions in the experimental groups had not been influenced by preceding them with a change question. Data from the control group were not analyzed further.

A three-way ANOVA on the experimental groups’ scores revealed that there
was no significant main effect for order of question topic (doll first or picture first) and that there were no significant interactions of order with either object (doll or picture) or type of question (change or identity). The mean scores for type of question and object presented in Table 1 were, therefore, collapsed across order conditions.

There was a significant main effect for object ($F(1, 38) = 10.81$), reflecting superior performance on questions about the doll compared to those about the picture. There was no significant main effect for type of question nor a significant interaction between type of question and object. A Pearson correlation (two-tailed) was calculated to examine whether children responded similarly to the change and identity questions about the pictures. A significant association was found ($r = .41$), which persisted when age was partialled out ($r = .37$). Thus, many children made errors when asked about the sticker in the picture; these realist errors consisted of stating both that the sticker in the picture had changed and that it had the same “identity” as the new sticker on the doll.

This pattern of results indicates that realist errors about the identity of the sticker in the picture extend to operations performed on the doll but not on the picture. It is important to note, however, that the lack of any significant difference between performance on change and identity questions to either doll or picture challenges our initial supposition that it might be easier for children to recall correctly the operations performed on an item than to recall its identity. Nevertheless, the relevant change to the doll had been carried out in full view of the children only moments before the questions were asked. It does seem improbable, moreover, that children would assert incorrectly that the picture had changed if they had been thinking about it as a thing in itself with physical properties that were independent of the properties of the doll that the picture represented. Before we definitely drew this conclusion, however, it seemed worth trying to facilitate correct answers with a change of question wording which would focus the children even more firmly on the doll and on the picture as discrete objects.

**EXPERIMENT 2**

The procedure in the second experiment was similar to that of the first, but with three amendments. First, for half of the sample of children the change

<table>
<thead>
<tr>
<th>Question</th>
<th>Doll</th>
<th>Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change</td>
<td>1.55 (0.82)</td>
<td>1.15 (0.89)</td>
</tr>
<tr>
<td>Identity</td>
<td>1.75 (0.59)</td>
<td>1.10 (0.87)</td>
</tr>
<tr>
<td>Identity (control)</td>
<td>1.85 (0.37)</td>
<td>0.95 (0.76)</td>
</tr>
</tbody>
</table>

*Note. Maximum score is 2. Standard deviations are in parentheses.*
question was modified so that the child was asked, “Did we change the sticker [on the doll or in the picture]?” instead of “Has the sticker . . . changed?” This modification, we thought, would direct attention particularly to what the experimenter did with each of the doll and the picture, drawing attention to the picture as a distinct entity in itself. The revised change question should also be easier to answer correctly for any children who might have made errors in response to the original form of the change question because of a belief that pictures might magically and spontaneously update to match their referents (cf. Harris, Brown, Marriott, Whittall, & Harmer, 1991).

Second, the procedure of the change pretest was made more comparable to that employed in the experimental trials to provide greater opportunity for the children to familiarize themselves with the experimental procedure.

Finally, after responding to the test questions in the second trial, each child was asked if the picture was of the doll (which had been altered by exchanging its sticker). This check question was included to discover whether children responding correctly to the previous test questions had simply switched focus to the picture as an object in itself and no longer considered it a representation of the doll.

\section*{Method}

\textit{Design}

The experiment employed a three-way mixed design. The two within-subjects independent variables were the topic referred to in the test question (doll or picture) and the type of question asked (change or identity). The between-subjects independent variable was the phrasing of the change question, either the original phrasing used in Experiment 1 (“Has the sticker changed”) or the modified phrasing (“Did we change the sticker”).

\textit{Materials}

For the change pretest two teddies and three badges (attachable to the teddy with a small piece of Velcro) were used. Both the teddies and the badges used were distinctively different to avoid any confusion. Other materials were exactly as in Experiment 1.

\textit{Procedure}

The general procedures were similar to those in Experiment 1.

\textit{Change pretest}. The initial procedure was the same, except that badges were employed instead of ribbons and the teddies were placed facedown during the check question. The form of this question matched the wording of the change questions that the child would subsequently receive in experimental trials.

\textit{Experimental trials}. Children given the original version of the change question were asked the same change and identity questions as in Experiment 1. Children given the modified version of the change question were asked, for the change doll
question, “Remember Anne; did we change the sticker Anne’s wearing?” and, for the change picture question, “Remember this picture; did we change the sticker drawn in the picture?” After the experimental trials, the children were asked a final check question, “Now that we’ve nearly finished, tell me again, is this is a picture of [the doll]?”

Participants

The final sample consisted of 80 children (48 girls, 32 boys) between 3;9 and 4;8 years of age (mean age 4;3), drawn from two nursery schools in predominantly middle-class catchment areas of Birmingham. A further 30 children failed the change pretest and were dropped from the study. The children who went on to complete the experimental task were randomly assigned to either the original or the modified version of the change question and to one of the two order groups (doll or picture questions first).

Results and Discussion

Scoring was exactly as in Experiment 1. The mean scores out of 2 for each test question by group (modified and original) are presented in Table 2.

A three-way mixed ANOVA was calculated to examine the effect of change question wording (original/modified), question topic (picture/doll), and question type (change/identity) on performance. There was a significant main effect for question topic \((F(1, 78) = 46.74, \text{confirming that performance on doll questions was superior to that on picture questions. A significant main effect of question type} (F(1, 78) = 10.41) \text{indicated more correct responses to identity questions than to change questions. The only significant interaction was the three-way interaction} (F(1, 78) = 6.12).\) Interpretation of this interaction proceeded by examining differences between scores on doll and picture questions for each of the four combinations of the other two variables (change/identity question and original/modified form of the question). With the modified form of questioning, doll and picture differences were significant both on change questions \((F(1, 78) = 28.20)\) and on identity questions \((F(1, 78) = 11.16)\). With the original

### Table 2

<table>
<thead>
<tr>
<th>Question</th>
<th>Doll</th>
<th>Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original change</td>
<td>1.50 (0.78)</td>
<td>1.15 (0.92)</td>
</tr>
<tr>
<td>Original identity</td>
<td>1.80 (0.46)</td>
<td>1.15 (0.84)</td>
</tr>
<tr>
<td>Modified change</td>
<td>1.83 (0.45)</td>
<td>0.75 (0.81)</td>
</tr>
<tr>
<td>Modified identity</td>
<td>1.78 (0.42)</td>
<td>1.25 (0.84)</td>
</tr>
</tbody>
</table>

*Note.* Maximum score is 2. Standard deviations are in parentheses.
question wording, doll and picture differences were significant on the identity question ($F(1, 78) = 17.10$), but not on the change question.

As in Experiment 1, when the above analyses were repeated with Greenhouse–Geisser and Welch corrections all the decisions on significance were confirmed. The results therefore show that performance in identifying the sticker in the picture was significantly poorer than that in identifying the sticker on the doll, irrespective of whether the identity question was preceded by a change question in the original or modified form. Furthermore, performance on the modified form of the change question was significantly poorer when the question was about the picture rather than about the doll. Only the original form of the change question did not produce a significant difference between doll and picture, although the difference was in the expected direction. Furthermore, performances on the change and identity picture questions in the modified version of the task were significantly associated, even when age had been partialed out ($r = .29$, one-tailed test). Thus, even when the change questions explicitly referred to actions by the experimenter to try to emphasize the separate identities of the picture and doll, the results of Experiment 1 were essentially replicated. That is, children who make updating errors with respect to the identity of picture contents are likely also to state incorrectly that the picture contents have been changed.

There are two superficial processes that might be entertained to account for these realist errors: misunderstanding of the questions about the pictures as questions about their referents, and confusion or interference in memory. Given the explicit finger pointing that accompanied the questions, however, it seems unlikely that children really had misinterpreted questions relating to the picture as questions relating to its referent. Furthermore, in a subsequent unpublished study we tested a sample of 5-year-olds on the procedures of Experiment 2 and found that they were essentially at ceiling on both change and identity questions, indicating that there was no general ambiguity in the questions that would lead participants of any age to make mistakes. The change question (“Did we change the sticker drawn in the picture?”) is possibly more susceptible than the identity question (“What sticker is drawn in the picture?”) to interpretation as a question about the referent (the sticker on the real doll). It seems unlikely, however, that the realist errors made by our participants were the result of such an interpretation specifically of the change question because realist errors in response to the change and the (unambiguous) identity questions were positively correlated, and in Experiment 1 there was no significant effect of having a change question before answering an identity question.

It also seems implausible that realist errors concerning changes made to doll and picture could be due only to confusion in memory, although the better performance on identity than on change questions in Experiment 2 challenges our earlier assumptions that confusion in memory might be more likely with identity than with change questions (cf. the results of Experiment 1). We consider this issue further in the discussion of Experiment 3. Nevertheless, it seems unlikely
that simple interference in memory could lead children to misrecall events that
took place moments before, unless there was also a deeper problem concerning
external representations.

All but one of the children responded affirmatively to the final question of
whether the picture was of Paul. As expected, children who claimed that the
picture had changed also said that it was still of the referent. However, children
who had answered the test questions correctly also maintained that the picture
was still of Paul. (These affirmative answers were correct in that only Paul’s
sticker was mismatched.) The important point, however, is that we cannot
explain correct responding to change and identity questions as a consequence of
children’s switching focus and ceasing to consider the unchanged picture as of
the now changed doll. We consider further implications of this finding in the
General Discussion.

EXPERIMENT 3

Given that realist errors to “out-of-date” pictures seem robust and not easily
explained as a superficial mistake, a further question is whether such errors are
made only to pictures or whether they would occur to other kinds of external
representation such as written names. One reason for thinking that realist errors
might be more likely to pictures than to names concerns the supposed resem-
blance between a picture and the real thing it represents. If young children have
come to believe that pictures “look like” the things they depict, then this belief
might lead such children into making realist errors on our tasks. In contrast,
written and spoken names generally lack any physical similarity with their
referents, and thus young children might be less disposed to make realist errors
by stating that names have changed to match changes to their referents.

The third experiment examined whether realist errors would be as likely to
occur to representations in the form of written names as they are to pictures.
There are several studies which indicate that children 3 to 4 years of age have
begun to understand the representational nature of words, so that the use of words
with the present procedures would be justifiable. Sorby and Martlew (1994), for
example, showed that 3- to 4-year-olds can use letters to convey meaning in tasks
that had a communicative goal. Thus, in the appropriate condition of the next
experiment, the names of the doll and sticker were written down on a piece of
paper instead of the doll and sticker being drawn.

In this third experiment we also included a second doll, which did not change
its sticker. There were two main experimental conditions. In the “representa-
tional” condition, the names or pictures represented the first doll (which changed
its sticker) as in the first two experiments. In the “nonrepresentational” condition,
the child was told that the names or pictures on the paper were of the second doll
and thus did not represent the to-be-altered first doll. The inclusion of this
“nonrepresentational” condition allowed us to test whether realist errors occurred
only when the name or picture was a representation of the doll whose sticker
changed (see Robinson et al., 1994). If simple confusion in memory of the various items presented in a trial were the only factor producing realist errors then there should be no difference in error rates between the representational and nonrepresentational conditions.

**Method**

**Design**

Responses to names and pictures were investigated in separate groups of children. Each investigation was based on a three-way mixed design. The two within-subjects independent variables were the question topic (altered or unaltered doll, picture/word) and the type of question asked (change or identity). The between-subjects independent variable was whether or not the picture or word represented the altered doll (representation/nonrepresentation).

All participants received the test questions in the same order: Change questions were presented before the corresponding identity questions for each object. This pair of questions was directed first to the altered doll, then to the word/picture, and finally to the unaltered doll.

**Materials**

For the change pretest two teddies and three badges were used (as in Experiment 2). For the experimental task, four dolls (two female and two male) were used, together with six stickers (a sheep, a monkey, a lion, a crocodile, a rabbit, and a bird sticker). Pieces of white paper (10.5 by 15 cm), on which the pictures or names of the dolls (and stickers) were represented during the course of the procedure, were also employed.

**Procedure**

The general procedure was as before.

*Change pretest.* The procedure was an exact replication of that used in Experiment 2, with the test questions about change in the modified form.

*Experimental trials.* The procedure here was the same as before, but with the addition of a second doll, whose sticker was not changed. Thus, the first doll was presented and a sticker placed on it. A second doll was presented and a similar sticker placed on it. Either the first or the second doll (with sticker) was represented in pictorial or written form. The sticker on the first doll was then changed. Thus, the picture (or name) either represented or did not represent the doll whose sticker was subsequently changed. All children were then asked change and identity questions about the first (altered) doll, name or picture on the paper, and second doll, always in that order. The change question always preceded the identity question for each object.

When the experimenter presented the second doll and placed a sticker on the second doll’s T-shirt, she said, “I’ve got somebody else for you to meet here
now. . . . This is a little boy called Paul and Anne wants to give him a sticker too. That looks nice, doesn’t it. What is it of?"

On representational picture trials the name or picture was stated to be of the first doll; on nonrepresentational trials the name or picture was stated to be of the second doll. Then the sticker on the first doll only was exchanged for a new one, and both dolls and the paper bearing the names or picture were turned facedown. The piece of paper was placed closer to the doll it represented than to the other doll.

The following test questions were then administered in the picture condition in the following order:

“Remember Anne; did we change the sticker she’s wearing?”
“What sticker is she wearing?”
“Remember this piece of paper; did we change the sticker drawn in Anne’s picture?”
“What is the sticker drawn in the picture?”
“Remember Paul; did we change the sticker he’s wearing?”
“What is the sticker he is wearing?”

On name trials the procedure was the same as that for the picture trials except that the names (rather than the pictures) of the relevant doll and his/her sticker were written down on the paper. Thus, when the dolls and their stickers had been presented the experimenter stated, “Anne wants us to write down her name, and the name of her sticker.” Anne’s name was written as well as the word “sheep.” The child was shown the written names and told the meaning of each one. The test questions were also modified to refer to names rather than to pictures.

For each of the experimental conditions the procedure was repeated with a different set of dolls and stickers, giving two trials in all.

Participants

The final sample consisted of 80 children (36 girls, 44 boys) between 3;5 and 4;9 years of age (mean age 4;2). The children were tested from three nursery schools in Staffordshire, situated in predominantly middle-class catchment areas. A further 38 children were dropped from the study due to failure in the change pretest.

Results and Discussion

Each child obtained a score out of 2 for each of the six test questions according to the number of correct answers given. A three-way mixed ANOVA was calculated separately for names and for pictures to examine the effects on correct responding of representation (representation vs nonrepresentation), question type (change/identity), and question topic (first doll, paper, second doll). As in the previous experiments, the validity of the ANOVAs was checked by incorporating
Greenhouse–Geisser and Welch corrections, which confirmed the original decisions.

The mean scores for each question type and for each question topic for the name condition are presented in Table 3. The ANOVA revealed that there was a significant main effect of question topic, $F(2, 76) = 15.08$. Examination of Table 3 indicates that performance on questions about names was significantly worse than that on questions about the two dolls. There was no significant difference between performance on the change and identity questions. Only one interaction was significant, that of level of representation × question topic, $F(2, 76) = 8.20$. Performance on doll and name questions differed significantly on representational trials ($F(2, 38) = 18.62$), but not on nonrepresentational trials. Performance was worse on names than on the dolls on representational trials only.

The mean scores for each question type and question topic for the picture condition are presented in Table 4. There was a significant main effect for representation ($F(1, 38) = 4.82$) and for question type ($F(1, 38) = 6.83$). There was also a representation × question topic interaction ($F(2, 76) = 8.76$). More important, however, was the significant three-way interaction ($F(2, 76) = 3.71$).

### Table 3

<table>
<thead>
<tr>
<th>Condition/question</th>
<th>Doll 1</th>
<th>Name</th>
<th>Doll 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Representation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change</td>
<td>1.80 (0.62)</td>
<td>0.95 (0.95)</td>
<td>1.65 (0.75)</td>
</tr>
<tr>
<td>Identity</td>
<td>1.85 (0.37)</td>
<td>1.05 (0.83)</td>
<td>2.00 (0.00)</td>
</tr>
<tr>
<td>Nonrepresentation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change</td>
<td>1.85 (0.49)</td>
<td>1.50 (0.83)</td>
<td>1.75 (0.64)</td>
</tr>
<tr>
<td>Identity</td>
<td>1.65 (0.59)</td>
<td>1.80 (0.52)</td>
<td>1.85 (0.49)</td>
</tr>
</tbody>
</table>

*Note. Maximum score is 2. Standard deviations are in parentheses.*

### Table 4

<table>
<thead>
<tr>
<th>Condition/question</th>
<th>Doll 1</th>
<th>Picture</th>
<th>Doll 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Representation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change</td>
<td>2.00 (0.00)</td>
<td>1.45 (0.69)</td>
<td>2.00 (0.00)</td>
</tr>
<tr>
<td>Identity</td>
<td>1.95 (0.22)</td>
<td>1.90 (0.31)</td>
<td>2.00 (0.00)</td>
</tr>
<tr>
<td>Nonrepresentation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change</td>
<td>1.55 (0.69)</td>
<td>1.75 (0.55)</td>
<td>1.60 (0.60)</td>
</tr>
<tr>
<td>Identity</td>
<td>1.70 (0.47)</td>
<td>1.85 (0.37)</td>
<td>1.75 (0.44)</td>
</tr>
</tbody>
</table>

*Note. Maximum score is 2. Standard deviations are in parentheses.*
Further analysis was directed at the effects of level of representation and question topic on performance on change and identity questions separately. There was a significant interaction between question topic $\times$ representation for the change question only ($F(2, 76) = 7.34$). Whereas performance on the change picture question was better on nonrepresentational than on representational trials, the reverse pattern was true for the change question about the two dolls.

As in Experiment 2, there was a tendency for fewer errors to be made in response to identity questions than in response to change questions. This difference, however, was significant only on the picture condition of Experiment 3, not in the name condition. It is difficult to evaluate the meaning of this result for children’s understanding about representations because superior performance on identity questions compared to change questions was evident on questions about the dolls themselves as well as on questions about pictures. Possibly, questions about the current state or properties of any tangible item are generally easier than questions referring to the history of that item and the operations previously performed upon it. This suggestion would also go some way to account for the relatively large numbers of children who were excluded because they failed to answer correctly to the change question in the pretest.

To conclude, however, performance on questions about names was worse than performance on questions about the dolls on representational trials but not on nonrepresentational trials. This pattern of results was replicated for the change question in the picture condition. Hence, we can conclude that children were more likely to assert that either a name or a picture of a sticker changed if it had initially represented the referent that had been altered than if it had once matched but never represented that referent. This result rules out simple memory confusion as the sole cause of realist errors, because such confusion among the items on a trial should be the same in both representational and nonrepresentational conditions. The occurrence of such realist errors to names as well as to pictures indicates that these errors may be a feature of young children’s response to external representations generally, and not just of their responses to pictures.

We did not test for differences in realist errors to words and to pictures, because we had no way of accounting for any differences that might be found. Children of this age, for example, may have varied in the extent that they recognized a written word as a representation, or the iconicity of a picture may have played some role. What we considered important was that there were realist errors to words that appeared broadly similar to those occurring to pictures, thus indicating that realist errors were made to external representations generally, and not just to iconic ones.

**GENERAL DISCUSSION**

An important initial point is that the present study has confirmed that realist errors may occur to a symbol (picture or word) that represents a changed reality. In the present Experiment 3, for instance, updating errors were significantly
fewer when the picture or name of the sticker initially matched but did not represent that on the doll whose sticker was subsequently changed (see also Robinson et al., 1994). We can also be confident that the pretest excluded children who were likely to make errors because they did not understand the test questions or simply had a yes bias. Furthermore, the near-ceiling performance on the change question about the second doll (answer “no”) in Experiment 3 showed that poor performance on the change picture questions cannot be explained as resulting from a yes bias.

Following this confirmation, an important further conclusion from the present series of experiments is that some 3- to 4-year-olds make realist errors not only about the content of pictures and words but also about operations performed on the referents of these external representations. The errors in response to the change questions, in particular, are hard to reconcile with a simple memory-confusion account. Specifically, children who made updating errors about the content of pictures also reported incorrectly that the picture itself had changed (Experiment 1) or that we had changed it (Experiment 2). The fact that children were apparently claiming that the experimenter had changed the picture in front of them (when, of course, she had not) makes it implausible that the children imbued the pictures with some kind of magic, allowing them to change spontaneously to match their referents (see Woolley, 1997). Furthermore, the fact that the question phrasing and the accompanying pointing were completely unambiguous rules out the possibility that children had simply misunderstood the test questions. The tendency to make realist errors seems to be closely linked to age. In an unpublished study we have found that 5-year-old children had no difficulty when tested on the procedures used in the present Experiment 2; this result additionally reassured us that there was no general ambiguity about the change or identity questions which would lead anyone regardless of age to make “errors” like those reported here.

How common is it for 3- to 4-year-olds to make realist errors in the ways that we have described? Our present results confirm earlier indications that up to half of a sample of children of this age may make realist updating errors to pictures (Robinson et al., 1994; Zaitchik, 1990). Nevertheless, the high number of children who were excluded from the present studies due to failure in the change pretests means that our data may underestimate the true incidence of realist errors in 3- and 4-year-olds’ understanding of pictures. Recall that it was necessary in each of the three experiments to test approximately an additional 30 children in order to obtain sample sizes of 60 and 80 in the main task. These children were dropped from the experiments because of their failure on a question to test their understanding of changes, but it is possible that they would have made realist errors concerning the identity of stickers represented by the pictures or names. As far as we are aware, no previous studies of realist errors to pictures have incorporated a pretest such as the one in the present experiments. As noted above, however, most 3- to 4-year-olds who make realist errors to pictures will come to
answer correctly by the age of 5 years. Robinson et al. (1994) reported that a sample of 5-year-old children were essentially at ceiling on a false-picture task like that used in the present experiments and that they made virtually no updating errors to questions about picture contents.

It is important to note the results of Experiment 3, using names instead of pictures as the representation. The finding that realist errors were also likely to be made to written names as well as to pictures suggests that the source of realist errors is a general difficulty in understanding external representations, and not some specific feature of pictures (such as their supposed physical resemblance to their referents).

What could be the general difficulty that children 3 to 4 years of age might have in understanding external representations? We propose that these children understand that a picture or a name which represents a real referent should convey the identity of that referent. Crucially, they tend not (or are unable) to simultaneously attend to the physical properties of the picture as a thing in itself. Thus, they would be unaware that their statements about the pictures or names contradicted their physical state and history. According to our account, when children making realist errors are asked about the picture or the name, they immediately think of the referent that the picture or name stands for, and reply as if the picture or name accurately represents that referent. It seems certain that there must be some limits to this tendency to overlook the physical identity of a picture or name as a thing in itself. We have still to test whether realist errors would persist if, for example, the picture with its out-of-date sticker were faceup in front of the child. It is hard to imagine, however, that children would then still make errors about the identity of the sticker in the picture. Possibly, when faced with the discrepancy they would treat the picture or name as no longer a representation.

The position set out also has some further implications for children’s behavior toward external representations. Would children’s supposed neglect of the physical properties of pictures and writing leave them unable to comment on the color of the paper or on its position on the table? This seems unlikely, though it might be worth testing. We think that the neglect would arise only for properties of the representation that potentially conflict with the child’s knowledge about the referent.

Confirmation that children are more likely to find interpretation difficult when there are conflicts between the properties of referent and representation comes from studies of children’s understanding and judgments about maps (Liben, 1999; Liben & Downs, 1989). Children are able, for example, to identify correctly a river on a map because “it is blue,” but become confused by (nonrealistic) coloring of main roads as red and built-up areas as yellow. With maps, of course, the conflict between representation and referent stems from the (more or less) arbitrary nature of the symbolic relationship, whereas in the present experiment the conflict occurred because the picture had become out-
dated. Nevertheless, it seems reasonable to suggest that these errors of interpretation have a common basis in children’s developing grasp of external representations.

While in the present study we have conceptualized children’s confusion over representations as realist errors, it is interesting to discover that a strikingly similar error can be observed in studies of children’s emerging concepts of writing. Using a “moving word” task, Bialystok (1997) showed children a card with a word printed on it which was then placed next to the named object. Children were asked to say what the word said both when it was in its correct position and after it had “accidentally” been moved so that it was next to a different object. Many monolingual English-speaking 4-year-olds reported as if they believed the word on the card changed to correspond to the object it was beside. Bialystok (1997) conceptualized this result as possibly an attentional problem; children must focus on textual features and not be distracted by conflicting information from the position of the name card next to the wrong object. Clearly, there are potential correspondences between this attentional account and the present suggestion that 4-year-olds might have difficulty in simultaneously apprehending a symbol both as a representation of something else and as an entity in its own right.

There are also interesting comparisons to be made between the present results and the occurrence of realist errors in the domains of mental representation and of spoken utterances. Children 4–5 years of age, for example, make a related error with oral language: Robinson, Goelman, and Olson (1983) found that once children knew which of a set of objects an ambiguous utterance referred to, they tended to accept the suggestion that a disambiguated version of an utterance had actually been given. For example, once they knew that the ambiguous utterance “I’ve chosen the one man with the red flower” referred to the man with the big, rather than the small, red flower, children were inclined to agree that the speaker had actually said “the man with the big red flower.” They correctly rejected suggestions that were not consistent with the intended referent. The children who made this error were those whose performance on other tasks suggested that they failed to hold in mind the distinction between the words spoken and the intended referent and failed to understand that the words might only partially represent the real referent. These children apparently assumed that the spoken message shared features of the intended referent which it represented, just as the children in this experiment tended to assume that written words matched the real object which they represented (see Apperly, 1999, for a more recent analysis of this phenomenon).

Realist errors are also common in children’s responses to questions about mental representations (Wimmer & Perner, 1983; Gopnik & Astington, 1988). The tangible instantiation of external representations may make them easier than mental representations for children to understand (see Vygotsky, 1934/1962). For research purposes, the possibility of manipulating the physical properties of
external representations allows examination of the determinants of realist errors more easily than with mental representations. The examination of responses to change questions carried out in the present experiments, for example, would not be possible if mental representation were the object of study.

What is not yet clear is whether a tendency to think about a name or a picture of something only as a representation marks a necessary stage in the development of understanding about external representations or is simply a consequence of a general difficulty in simultaneously grasping two interpretations of the same entity (see Flavell, Green, & Flavell, 1986; Thomas, Nye, & Robinson, 1994). However that may be, it seems likely that the occurrence of realist updating errors could be a marker for an important step in the development of understanding about representation. Such errors might then be a useful test in researching young children’s understanding of other forms of external representation such as maps, plans, and diagrams.

If realist errors are considered to constitute a recognition that a symbol conveys information about its referent, then we should note that that stance need not imply that children regard external representations as substitutes for their referents. Children making realist errors, for example, might know that a picture of ice cream could not be eaten, but might nevertheless state incorrectly that the ice cream in a picture had changed its appearance once its real referent had done so (see Beilin & Pearlman, 1991). Similarly, children making realist errors about names might still know that the word “ice cream” need not feel cold and wet.

What of the developmental sequence in which realist errors might be located? According to DeLoache and Burns (1994), an understanding that a picture may convey information about its referent may be present in some 2- to 3-year-olds. If this is the case, then 3- to 4-year-olds such as those we tested may be emerging from a stage in which they can apprehend the picture only as a representation to one in which they can grasp both its identities, as a representation and as a thing in itself (see Thomas et al., 1994). An implication of this account is that we would find that realist errors are even more frequent in the responses of children rather younger than the 3- to 4-year-olds we tested in the present studies. A further implication is that yet younger 2-year-olds might respond correctly to the picture questions, not because they have better understanding of pictures than older children have, but because they do not yet understand at all that the picture could be a representation of the doll. Testing such young children would present practical problems but would be an important step toward exploring further the development of understanding about pictures and other external representations.

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Received June 10, 1998; revised April 21, 1999