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Children's Ability to Make Tentative Interpretations of Ambiguous Messages

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Consistent with prior research, 5- and 6-year-old children overestimated their knowledge of the intended referent of ambiguous messages. Yet they correctly revised their interpretations of ambiguous messages in light of contradicting information that followed immediately, while maintaining their initial interpretations of unambiguous messages (Experiment 1). Children of this age were able to integrate information over two successive ambiguous messages to identify the intended referent (Experiment 2). However, unlike 7- and 8-year-olds, they were no more likely to search for further information following ambiguous messages compared with unambiguous ones (Experiment 3). We conclude that although 5- and 6-year-olds' interpretations of ambiguous messages are not tentative at the outset, they can use source monitoring skills to treat them as tentative retrospectively, at least over short time spans.

Key Words: ambiguity; knowledge judgments; uncertainty; decision making; procedural knowledge; explicit knowledge; source monitoring.

Much of the time we have to act on the basis of ambiguous information. We might hear an utterance that fails to identify uniquely the speaker's intended referent or we might see a view of a distant object that does not allow it to be identified with confidence. Adults have a range of strategies available for dealing with such circumstances. Given limited information, adults might delay making any interpretation until receiving further information (perhaps by asking a question or moving closer), they might hold in mind a set of possible interpretations awaiting or seeking further clarification, or they might make a single tentative inter-

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pretation but be ready to revise it in the light of subsequent information. The last strategy is the main focus of our attention in this article.

What might be involved in making a tentative interpretation? Presumably the person will have experienced initial uncertainty concerning interpretation, a feeling that may serve as a reminder to consider revising the interpretation in light of further information. But a feeling of uncertainty alone would be too crude to support an appropriate integration of the original and new input: Such integration requires the individual either to retain the original input and to identify the other potential referents or to retain the set of potential referents identified initially. Broadly this involves taking into account the circumstances under which the original interpretation was made, an activity which is labeled "source monitoring" (e.g., see review by Johnson, Hashtroudi, & Lindsay, 1993).

There is evidence suggesting that 4- to 6-year-old children show signs of having detected a problem when they try to interpret ambiguous input. They show longer response latencies in search tasks when the instructions are ambiguous rather than informative (Bearison & Levy, 1977; Plummert, 1996) and their nonverbal behavior is typically hesitant (Beal & Flavell, 1982; Patterson, Cosgrove, & O'Brien, 1980). Yet research to date offers quite a gloomy view of young children's ability to deal effectively with ambiguous input and suggests that they often fail to realize the significance of any initial uncertainty.

In the 1970s and 1980s children's understanding of ambiguity was investigated in the contexts of referential communication and of undecidability in problem solving (e.g., see Braine & Rumain, 1983; Dickson, 1981; Robinson & Whittaker, 1987). More recently, understanding of ambiguity has been studied in the context of theory of mind, insofar as acknowledging ambiguity is needed to accept the role of individual interpretation in the formation of knowledge and beliefs (Apperly & Robinson, 1998; Carpendale & Chandler, 1996; Pillow & Henrichon, 1996). Overall, the picture that emerges is that until about 6 years, children are in a number of respects insensitive to ambiguity in input, being overly inclined to make interpretations of ambiguous utterances rather than to seek clarification (Cosgrove & Patterson, 1977; Ironsmith & Whitehurst, 1978; Robinson, 1981). When children do ask questions, they apparently fail to understand that further information is *necessary* to guarantee a correct interpretation (Robinson & Robinson, 1982a) and commonly they do not ask questions that specify the missing information (Lloyd, Camaioni, & Ercolani, 1995).

In addition, when asked to make explicit judgments of their own or another person's knowledge, young children tend to overestimate the knowledge to be gained from ambiguous oral or visual input (Chandler & Helm, 1984; Taylor, 1988; Robinson & Robinson, 1982b; but see Ruffman, Olson, & Astington, 1991). Even if children judge accurately that the recipient of ambiguous input will not know the correct interpretation, they may fail to reveal explicit understanding of why the problem arises or how it could be solved: They tend to evaluate the input as adequate (e.g., Asher, 1976; Beal & Flavell, 1982; Bearison & Levey, 1977; Flavell, Speer, Green, & August, 1981; Robinson & Robinson,

1976) and to judge that understanding can be achieved if the listener tries harder (Robinson & Robinson, 1978). Flavell, Green, and Flavell (1985) report that even children who could identify explicitly the ambiguity in single instructions still commonly failed to hold the problem of ambiguity in mind over a sequence of instructions: Having first made an arbitrary interpretation of an ambiguous instruction about which route to follow, and next following an unambiguous instruction, children judged wrongly that they could be confident that their final destination was correct. In studies on understanding of undecidability in logical problems, children are loath to accept either that they cannot solve an undecidable problem or that the problem cannot be solved (Acredolo & Horobin, 1987; Braine & Rumain, 1983; Fabricius, Sophian, & Wellman, 1987; Fay & Klahr, 1996; Pieraut-le-Bonniec, 1980).

Several suggestions have been offered to account for young children's readiness to interpret ambiguous input and to judge it to be adequate. They may operate on the implicit assumption that speakers are informative; they may assume that the speaker expects them to make a response; they may have a general difficulty acknowledging undecidability; and they may fail to differentiate what a speaker means from what is said and so have no conception of ambiguity in utterances (e.g., Ackerman, 1981; Acredolo & Horobin, 1987; Beal, 1988; Bonitatibus, 1988; Robinson, 1981, 1994; Robinson & Apperly, in press; Robinson & Whittaker, 1987; Speer, 1984). These suggestions are not necessarily contradictory. Whatever the reasons for children's tendency to act and judge as if ambiguous input is informative, the tendency may have benefits. Young children might make very slow progress if they refused to interpret any utterance they did not understand completely (Robinson, 1981). That is, they may need to make some response to input that is beyond their comprehension if they are to benefit from the scaffolding offered by more competent others (Wood, 1998).

Children's tendency to interpret rather than refuse to interpret ambiguous input does not necessarily mean that they place too much weight on those interpretations. Children could in principle discriminate between interpretations of ambiguous and unambiguous input in terms of their readiness to revise them in the light of subsequent input. Given the evidence of problem detection prior to interpretation, this is a distinct possibility, and yet currently we know virtually nothing about how children treat their interpretations of ambiguous input in the light of subsequent experiences.

We argued above that access to the conditions under which a belief was acquired is a prerequisite for effectively holding an interpretation as tentative. The literature on source monitoring offers little guidance as to whether children have such access. We know that by the age of around 4 or 5 years children can report the modality of their input, for example, whether their knowledge is based on having been told or having seen (e.g., Gopnik & Graf, 1988; O'Neill & Gopnik, 1991; Robinson, 2000; Whitcombe & Robinson, 1999), but we do not know whether they can access information about the informativeness of that input.

Difficulty with this type of source monitoring could contribute to problems handling ambiguous information.

In Experiments 1 and 2 we examined children's readiness to treat an interpretation of ambiguous input as tentative, subject to revision in the light of subsequent information. We studied children ages 5–6 years, whom the literature suggests still have considerable difficulty handling ambiguous input. In Experiment 1 we examined children's readiness to revise initial interpretations after receiving new information in relation to their explicit judgments of whether they "really knew" the intended referent of a message and whether revisions would be made more readily when ambiguous messages were followed by informative messages or when the order of messages was reversed. In Experiment 2 we investigated whether second interpretations were just new guesses made independently of the initial interpretation or were instead revisions built on the information contained in the initial ambiguous message.

If children were treating their interpretations of ambiguous input with appropriate caution, this would leave an apparent contradiction with the earlier literature which shows that children overestimate knowledge to be gained from ambiguous input. One possibility, explored in Experiment 3, is that when children interpret ambiguous input they do so with confidence and believe that they really know the intended referent. Perhaps it is not until they receive subsequent contradicting information that they realize the initial interpretation was inaccurate. Under these circumstances they would not be proactive in seeking clarifying information. In Experiment 3 we focused on children's ability to delay making an interpretation until they have sought further information. A finding that this is difficult for children, but that they easily revise their interpretations after receiving additional information, would be consistent with the proposal that children genuinely believe they initially know the correct interpretation of ambiguous input.

EXPERIMENT 1

We modified a procedure devised by Robinson, Champion, and Mitchell (1999) to assess children's ability to discriminate between informed and uninformed speakers. In the original procedure children either saw or guessed the content of a container, were then contradicted by an adult speaker who was either guessing or informed, and finally had the opportunity to revise or repeat their original interpretation. Three- and 4-year-olds were more inclined to revise their original suggestion when the speaker was better informed than they. With that procedure, the relatively ignorant partner saw nothing of the container's content (though knew what the possible contents were), and the relatively informed partner saw the entire content. In our experiments, we were interested in how older children would deal with partial information. As in the original procedure, children experienced a sequence of two inputs, but this time they were both messages. After hearing the second message, children had the opportunity to revise their initial interpretation. We used willingness to revise as an indicator of lack of confidence in their initial interpretation. Would children be more likely to revise

interpretations based on ambiguous versus informative messages? We compared willingness to revise under the conditions just described (the "behavioral group") to performance by a second group of children ("the know group"), who were asked to make explicit knowledge judgments following their initial interpretation of the first message on each trial. We further investigated children's responses to different types of ambiguous messages: those which were useful in that they allowed them to narrow the range of referents from four to two and those which were useless, giving no information about the intended referent. Children might be less willing to revise their interpretations of the former type of message than the latter, and more inclined to judge that they really know, simply because the useful message enabled them to narrow down the set of possible referents.

Method

Participants. We tested 37 children from an infants' school serving a predominantly working-class population in Birmingham, UK. Data from 3 children were excluded due to experimenter error, leaving 14 girls and 20 boys with a mean age of 5 years and 8 months (5;8, range = 5;3 to 6;2). Children were systematically allocated to either a behavioral group (18 children) or to a know group (16 children).

Materials. We used 10 A4 sheets each with four pictures, one sheet for each trial. For example, one picture set showed a brown monkey, brown squirrel, black-and-white rabbit, and black-and-white cow, for which the clues were "It's an animal" (uninformative—referred to any of the four pictures), "It's black and white" or "It's brown" (partially informative—referred to two pictures) and "It says moo" or "It's got a fluffy tail" (informative—refers to only one picture). In addition, we used a pack of cards each of which showed one of the pictures. On each trial the experimenter held one card to ensure that the child realized that both clues in a trial referred to the same picture. We also used a videotape in its case and a plain cardboard box, measuring approximately $20 \times 10 \times 2$ cm for the ignorance check trials.

Procedure. Apart from the first six children tested (see below), each child began with two ignorance check trials. All then had two warm-up trials, followed by eight experimental trials. The purpose of the *ignorance check trials* was to familiarize children with the experimenter and to check whether they could evaluate themselves as ignorant in at least some circumstances. First children were shown a videotape box, and we expected them to say they did know what it contained. Then they were shown an unfamiliar box to see whether they would admit ignorance as to its content. With each box the experimenter said: "We'll look inside this box in a minute, but first, can you just tell me, do you really know what's in this box or don't you really know?" After answering each knowledge question, the child was shown the content of the box, a videotape in the familiar box and a crayon in the unfamiliar box. No other feedback was given.

Children then entered either the behavioral or the know procedure. The procedure for children in the *behavioral group* follows. On each of the two *warm-up*

trials the child was shown one of the picture sheets and asked to name the four pictures. The child was then told, "I've got a card here with one of these pictures on it. I'm going to tell you about the picture and let's see if you can work out which one it is. I'll tell you two things about the picture and sometimes you'll be able to work out straightaway which one I've got and sometimes you'll want to change your mind." In the first warm-up trial children were told "It's blue" and were then asked "So which one do you think it is?" Since only one object pictured was blue (a balloon with a long string) we expected children to choose correctly and confidently. Immediately after they had chosen a picture they were told "I'll tell you something else about this picture: It's got a long string" and were then asked "So which one is it?" After they had responded children were shown the picture on the card held by the experimenter, who said "See that time it was the balloon so you knew straightaway, didn't you?" On the second warm-up trial children saw an orange shirt, orange scarf, purple trousers, and purple hat. They were given the clue "You can wear it," followed by a disambiguating clue which was inconsistent with their chosen object: "You wear it on your head/legs." Children were also given feedback on this trial: "So that time it was the hat/trousers, so you wanted to change your mind, didn't you?" The appropriate responses were explained to children regardless of their response. Four of the 18 children in the behavioral group wrongly changed their interpretation following the second clue in the first introductory trial.

The remaining eight trials were the *experimental trials*. Children continued to see sets of four pictures, but received no feedback on the correctness of their responses. Instead they were told that they would see all the chosen pictures together at the end of the game. Children had two trials each of four types of trial: An uninformative clue followed by a partially informative one (uninformative–partially informative); uninformative–informative; partially informative–informative and informative–uninformative. Both the uninformative and the partially informative clues were ambiguous. An example of each trial type is given in Table 1. Trials were presented in four orders chosen so that each trial occurred in the first, second, third, and fourth positions. The same sequence of trials was presented twice to produce a total of eight. The order of the pictures used was systematically varied, using five predetermined orders. For all trial types except informative–uninformative the experimenter gave second clues that contradicted the child's interpretation. Thus, on trials where the first clue was uninformative or partially informative, we ensured that the child's first interpretation was incorrect. The informative–uninformative trials were included to check that children did not revise their suggestion as to the intended referent simply because a second clue was given.

At the end of the game children were shown all the pictures that had been chosen and were encouraged to identify which ones they remembered to give the game a satisfactory ending. The experimenter used sleight of hand to ensure that the cards the child saw at the end were consistent with the clues that had been heard.

TABLE 1
Trials Used in Experiments 1 and 2

Experiment	Trial type	First clue	Second clue	Appropriate response
Exp. 1	Uninformative–partially informative	It's an animal (chooses monkey)	It's black-and-white	CHANGE to cow or rabbit
	Uninformative–informative	It's an animal (chooses monkey)	It goes moo	CHANGE to cow
	Partially informative–informative	It's black and white (chooses rabbit)	It goes moo	CHANGE to cow
	Informative–uninformative	It goes moo (chooses cow)	It's an animal	STICK with cow
Exp. 2	Informative–partially informative	It's got a flower on it (chooses train)	It goes on the ground	STICK with train
	Partially informative–informative	It's orange (chooses train)	It's got a star on it	CHANGE to helicopter
	Partially informative–disambiguating	It's orange (chooses train)	It goes in the air	CHANGE to helicopter

Children in the *know group* were warned on the first *warm-up trial*: "Sometimes you'll really know which picture I've got and sometimes you won't really know." On every trial, having made an interpretation following the first clue, children were asked, "Do you really know it's that one or don't you really know?" The feedback given on warm-up trials was "See that time it was the balloon, so you really knew didn't you?" and "So that time, it was the hat, so you didn't really know, did you?" Seven children of 16 in the know group wrongly said they knew the correct referent on the second warm-up trial. However, as children were then shown the actual referent, which contradicted their choice, these trials were useful in making it absolutely clear to the children that there were occasions on which they could guess the wrong picture.

The experimental trials for 11 of the children in the know group were the same as for the behavioral group: uninformative–partially informative, uninformative–informative, partially informative–informative, and informative–uninformative. After hearing the first clue the child was asked to evaluate his/her knowledge by responding to the test question "Do you really know it's that one or don't you

really know?" Following an uninformative or partially informative clue it was appropriate to acknowledge ignorance, "I don't know" and following an informative clue it was appropriate to say "I do know." These children also heard the second clue and were given the chance to revise their interpretation.

The remaining five children in the know group, those in the one message subgroup, were run under a more conservative procedure. These children did not hear the second clue and had no opportunity to revise their interpretation. We ran this subgroup to check whether being allowed to revise their interpretation influenced children's answers to "do you know?" However, our early results confirmed (i) that even with the possible learning opportunity available to the main two message know group, children's knowledge judgments were inaccurate; and (ii) there was no hint that knowledge judgments under the two procedures were different from each other. We therefore ran the majority of children under the two message procedure described above, to give them, if anything, the better chance of learning to make accurate knowledge judgments. Data from both procedures were pooled for comparisons with the behavioral group.

Results and Discussion

Ignorance check trials. The first 6 children tested were not given these trials due to experimenter error. These children were split equally between the know and behavioral groups. Their data were included since all gave one or more correct "don't know" response in the experimental trials and so clearly were willing to acknowledge ignorance. Of the 28 children who were given both ignorance check trials, 26 responded "don't know" on at least one of them and so were willing to acknowledge ignorance at least under some conditions. Unexpectedly, many children responded in this way to the video box because they did not know which particular video it contained.

Experimental trials. Children in the behavioral group were given a score of 1 every time they updated their initial choice to be consistent with the second message and 0 every time they repeated their original choice. (On two occasions children changed to a second picture that was inconsistent with the second message, and these were given scores of 0.) Scores for each of two similar trials were summed to give each child a set of four scores each of maximum 2. Children in the know group were given a score of 1 every time they judged "No I don't know" and 0 every time they judged "Yes I do know." The children in the one message subgroup heard only the first clue belonging to each of their eight trials but for the purpose of making comparisons with the behavioral group we could still consider their knowledge judgments as arising from each of the trial types which the rest of the children in the knowledge group experienced.

On the partially informative–informative, uninformative–partially informative, and uninformative–informative trials, adultlike behavior is indicated by a score of 2 for each set of trials. For the informative–uninformative trials adultlike behavior is indicated by a score of 0.

Judgments on the *knowledge trials* were in line with the previous literature: Children generally acknowledged correctly that they did know following informative messages (only one child claimed not to know) but there was a strong tendency to overestimate the knowledge gained from uninformative and partially informative messages. The mean number of don't know responses for each trial, with confidence intervals, are shown in Table 2. A repeated-measures ANOVA, with trial type as a within-subject variable, revealed a significant within-subject effect of trial, $F(3, 45) = 7.58$, $p < .001$. From examination of the confidence intervals it can be seen that there is no difference between the responses to the trials that began with partially informative or uninformative clues. However, the confidence intervals for responses to the trials that began with informative clues did not over lap with those of the other trial types. Children were apparently discriminating between message types, being more likely to say "don't know" following uninformative or partially informative messages than following informative ones, but their performance overall was far from ceiling.

In contrast, performance by children in the *behavioral group* was impressive. Their mean responses are also shown in Table 2 with confidence intervals. Importantly, 14 of the 18 children correctly repeated their initial suggestion on both informative–uninformative trials, so they were not merely revising following any second message. Yet 13 of 18 always revised their interpretation appropriately on uninformative–informative, partially informative–informative, and uninformative–partially informative trials. Using a repeated-measures ANOVA with trial type as the within-subject variable, we again found a significant difference in responses to the different trials, $F(3, 51) = 66.00$, $p < .001$, and examination of the confidence intervals shows no difference in performance on partially

TABLE 2
Mean Number Responses of "Don't Know" in the Know Group and of Changes in the Behavioral Group in Experiment 1

Trial[a]	Mean "don't know" responses for know group	Mean change responses for behavioral group
Partially informative–informative	0.56 (0.23–0.90)	1.83 (1.64–2.02)
Uninformative–partially informative	0.75 (0.30–1.21)	1.83 (1.64–2.02)
Uninformative–informative	0.94 (0.48–1.39)	2.00 ceiling performance
Informative–uninformative	0.06 (–0.01–0.20)	0.33 (0.01–0.68)

Note. Max. score = 2; 95% confidence intervals are given in parentheses.

[a] The second clue is heard by behavioral group and by the two message subgroup of the know group. The one message subgroup heard only the first clue.

informative–informative and uninformative–partially informative trials. Performance on the uninformative–informative trials surpassed this, as the children performed at ceiling. Again, comparing the responses to the informative–uninformative trials to the ambiguous trials for which we have confidence intervals there appear to be differences. Children in the behavioral group were less likely to change their interpretation following the second message on the informative trials than on the ambiguous ones. Children were behaving as if they understood the relative weights that could be placed on their interpretations.

Although children in both groups discriminated the trials in which it was appropriate to change their interpretation or say "don't know" from those in which they should stick with the original interpretation or say "do know," performance by the behavioral group was apparently considerably better. To check this statistically we classified children according to their individual strategies across the eight trials. Fourteen of the 18 children in the behavioral group (78%) used an appropriate strategy on all trials or on all but one trial, but only 2 of the 16 in the know group (12.5%) achieved this level of performance, a significant difference in favor of the behavioral group: $\chi^2(df = 1) = 16.2$, $p < .001$.

Interestingly, there was no difference in either the behavioral or the know group in children's responses to uninformative and partially informative clues. They seem not to have assumed (wrongly) that having made some, rather than no, exclusions on the basis of a partially informative clue, they could be more certain of the intended referent.

Children in the know group who were given a second clue after they had made their knowledge judgments performed very well in response to the second clue despite their overestimation of the knowledge gained from uninformative and partially informative clues. Of the 11 children in this group, all performed at ceiling or made only one mistake on the behavioral responses, but only 2 made no or one mistake in response to the knowledge questions. That is, many children said that they really knew the intended referent of an uninformative or partially informative clue but then correctly revised their interpretation in the light of the subsequent informative clue.

The behavioral responses of the 5- and 6-year-olds in this experiment are consistent with the possibility that they could make genuinely tentative interpretations following uninformative or partially informative messages and could revise these in the light of subsequent information. If so, then their explicit knowledge judgments would seem seriously to underestimate their understanding of the informativeness of ambiguous input. This could, though, be a generous interpretation of what the children in our sample were doing. One alternative possibility is that children initially detected a problem in interpreting the ambiguous input, but having gone on to make an interpretation they did not hold that as tentative but believed that they really knew the intended referent. On hearing the second message they may then have recalled the original state of affairs (both the clue and the possible referents) and with hindsight recognized the need to revise their original interpretation. If this were the case, then the initial interpretation would

not be held as tentative, and the child would be dependent on the provision of further information to prompt appropriate behavior. The explicit judgment "I really know" would be a genuine reflection of the child's understanding prior to the receipt of the second contradicting message.

Yet another possibility is that children made an interpretation and believed that they really knew that it was the intended referent, but on hearing the second contradicting message did not recollect accurately the earlier state of affairs and so had no way of integrating the two inputs. For such children the situation would be like one in which they received a sequence of informative but contradicting messages. In order to resolve this contradiction children may have abandoned their first interpretation and made a second in accord with the second input.

The main aim of our second experiment was to see whether we could exclude this last possibility: On hearing the second piece of information, were children just making a second, independent interpretation rather than revising their original interpretation?

EXPERIMENT 2

We used the same procedure as for the behavioral group in the first experiment, but used new sets of pictures, which allowed for a new trial type. In this partially informative–disambiguating trial type the first clue could refer to two of the four pictures (A or B), and the second clue in isolation also referred to two of the four pictures (B or C). Taking the two clues together, B could be identified as the correct referent. If children's initial choice in response to the first clue was A, we could see what choice was made following the second clue. Children who were equally likely to select either referent of the second clue (B or C) could have made a confident interpretation of the first ambiguous clue, failed to understand (even with hindsight) that it could be revised, and so made an independent interpretation of the second clue. On the other hand, children who consistently revised their interpretation to choose the picture that was consistent with both clues (B) would appear to understand that their interpretation of the first ambiguous clue could be inaccurate and were prepared to revise it on hearing the second.

Method

Participants. We tested 38 children from a primary school serving a predominantly lower middle-class population in Birmingham, UK. Data from 1 child was excluded due to experimenter error, leaving 8 girls and 29 boys in the final sample (this was a result of the gender imbalance of the year group in the school), with a mean age 6 years and 2 months (6;2, range = 5;9 to 6;8).

Materials. We again used A4 sheets with four pictures on each. There were two sets of pictures for the warm-up trials and six sets for the experimental trials. On experimental trials, children were shown one of four sheets, each using a different layout of the pictures (e.g., clockwise from top left: car, train, plane, and helicopter as one layout and helicopter, plane, train, and car as another). As before, a pack of picture cards was used for the experimenter to hold.

Procedure. The game was introduced as in Experiment 1, with two warm-up trials followed by six experimental trials. There was no need for ignorance check trials since children did not make explicit knowledge judgments in this experiment. On presentation of each sheet of pictures, children were asked to identify which of the pictures corresponded to the two clues they would hear; for example, if the messages were to be "It's orange" and "It goes in the air" they identified which of the pictures were orange and which were purple and which traveled in the air and which on the ground before hearing any clues about the experimenter's chosen picture. The experimenter talked them through this initial identification, prompting with "Are there any more?"' to ensure that they always identified all the possible referents. This was included in the procedure to reduce the chance of children making confident initial interpretations because they failed to notice the other possible referents.

There were three types of experimental trials and each child had two trials of each type, presented in a counterbalanced order. Clues were either informative or partially informative, as in Experiment 1, or disambiguating, as described above. Trial types were partially informative followed by informative; informative–partially informative; or partially informative–disambiguating. Examples of these trials are shown in Table 1. The informative–partially informative trials were included so children did not always have to update their initial interpretation; our main interest was in the comparison between the other two kinds of trials. Order of presentation of the sets of pictures and of the arrangement of the pictures on the sheets were systematically varied, using four different arrangements of the pictures on the sheets and five different orders of presentation of the sets of pictures themselves.

Results and Discussion

We coded the children's responses as correct when they chose a second picture that was consistent with *both* clues. Simply scoring children as repeating or updating their initial responses (as in Experiment 1) would not capture correct behavior on partially informative–disambiguating trials. On partially informative–informative trials children were correct if they changed to the single picture identified by the second clue, and on the informative–partially informative trials they were correct if they restated their original choice.

Performance on the informative–partially informative trials was important, as in Experiment 1, to confirm that children did not change to a new interpretation merely because they heard a second clue. Children performed reasonably well on these trials: 29 of the 37 children never changed their interpretation when an informative clue was followed by a partially informative one, and the mean score was 1.68 of a maximum of 2. Four children wrongly changed on one trial and 4 did so on both trials. In all cases these errors consisted of selecting a picture that was consistent with the second clue but not the first.

Having confirmed that most children resisted changing their interpretation when the initial clue was informative, our interest was in children's performance

on the partially informative–disambiguating trials. Children performed well: 35 of the 37 children always selected the picture that was consistent with both messages, and the remaining 2 made a single error by selecting a picture which was consistent with the second message only. The mean score was 1.95 of a maximum of 2. This is close to the ceiling performance of the children on the partially informative–informative trials (mean score 2.0). A one-sample *t* test to compare performance on the partially informative–disambiguating trials with a mean score of 2 (ceiling performance) revealed no significant difference between the partially informative–disambiguating scores and this ceiling score: $t(df = 36) = -1.43$, $p = .16$. The power of this test is relatively low, .29, but our data provide no grounds for suggesting that on partially informative–disambiguating trials children made an interpretation of the second message alone. As mentioned above, 35 of the 37 children performed perfectly.

It is possible that coincidentally children found the correct referent more attractive or salient than the other. To check, we compared the initial choice made when a particular clue occurred first (on partially informative–informative trials) with the choice made in response to that same message when it occurred second (on partially informative–disambiguating trials). We inspected the data for all six clues that occurred in both positions. In every case when the partially informative clues came first the choices were split between the two potential referents, but when the same clue was a disambiguating one, children chose the potential referent that was also consistent with the first clue. The differences in distribution were significant by binomial tests for four of the six sets; for the remaining two sets the sample sizes were too small to test statistically. We conclude that selections of the appropriate referent on the partially informative–disambiguating trials were not an artifact caused by children's preferences for one of the two potential referents.

The results of Experiment 2 go beyond the results of the first experiment in showing that children were genuinely revising their interpretations of the ambiguous clues and were not simply making an independent interpretation of the second clue. The results from the partially informative–disambiguating trials also support our claim that to interact successfully with ambiguity children need to retain the circumstances surrounding their first interpretation and that merely tagging an interpretation as uncertain would be insufficient to produce a correct integration of clues. On the partially informative–disambiguating trials, each clue taken separately would lead to an uncertain interpretation, with no way of putting them together to remove the uncertainty.

Insofar as they made genuine revisions of the first ambiguous clue, rather than abandoning it, the 5- and 6-year-old children treated their initial interpretations of the ambiguous clues as tentative. They behaved as if they understood that the interpretation was subject to revision in the light of subsequent information. Why then did the children in the know condition of the first experiment so often judge that they really knew the intended referent of an ambiguous clue? As suggested in the discussion of Experiment 1, children could have been confident in their initial

interpretation until the second, contradicting, clue was received. This contradiction may have prompted them to reconstruct the circumstances under which the original interpretation was made and then make an appropriate revision to their interpretation. In our final experiment we explored an implication of this possibility.

EXPERIMENT 3

We know from the results of Experiments 1 and 2 that children could treat their interpretation of an ambiguous clue as tentative when subsequent contradicting information was offered to them, but what if the onus was on them to gather the information? In the final experiment we investigated whether children would seek additional information to increase the accuracy of their interpretation of an ambiguous clue. To try and make things easy, we did not require children to seek information to revise an interpretation already made and to which they might feel committed. Rather, we gave them the opportunity either to make an immediate interpretation of a clue or to use a very simple strategy to gather additional information. If children used these two strategies appropriately following ambiguous and unambiguous clues, this would be consistent with their realizing without external prompting that an interpretation of ambiguous input could be wrong. Previous research suggests that young children tend not to seek clarifying information. In many of the investigations of young children's ability to identify ambiguous or undecidable situations, however, the required response has been to indicate "can't tell" by either verbal or nonverbal means (e.g., Markman, 1977; Patterson & Kister, 1981; Robinson, 1981). In these types of task if children judge that they can't tell then that is the end of the trial; any tendency to act on the message must be overridden in favor of a more reflective response. In other studies, children are invited to ask questions when they receive an ambiguous message (e.g., Cosgrove & Patterson, 1977; Ironsmith & Whitehurst, 1978; Lloyd et al., 1995), which could be a more familiar way of dealing with problematic utterances. Yet with both kinds of procedure, children below the age of around 6 to 7 years typically treat ambiguous utterances as if they were informative. In our procedure we provided a very simple information-seeking response (lifting a cone to see what was beneath), which was similar to the interpreting response (placing a doll in front of a cone). In addition, in contrast to responding to an ambiguous utterance with "can't tell," in our procedure obtaining the missing information enabled the child to complete the task correctly. We also tested an older group of children on this procedure to ensure that successful performance would be seen at an age when children are reported to behave appropriately with regard to single ambiguous utterances (e.g., Bearison & Levey, 1977; Sodian, 1988), though, as mentioned in the introduction, older children still make errors evaluating ambiguous information as part of a sequence of instructions (Flavell et al., 1985).

Method

Participants. We tested 26 5- to 6-year-old children (mean age = 6;0 range = 5;7–6;6) and 30 7- to 8-year-old children (mean age = 8;0, range = 7;5–8;5). The

children were from a primary school in Reading, UK serving a working- and middle-class population. There were 30 boys and 26 girls in the sample.

Materials. For each trial we used three 10-cm tall paper cones colored either pink, green, yellow, or blue. A large cardboard box was used to hide the cones from the child. A small plastic doll with six different accessories (hat, bucket, etc.) and a small colored mat (~10 cm^2) were also used.

Procedure. The child was introduced to a doll called Peter and a set of his toys, which the child was encouraged to label. The doll was seated on a mat on one side of the table and three paper cones were placed on the other side of the table, both within reach of the child. The game began with two *warm-up trials*, the purpose of which was to familiarize the child with the two possible ways of responding to a message—by selecting a referent immediately or by raising a cone to gain further information. The experimenter explained that she was going to hide Peter's toys from him and the child's task was to help Peter find them. In the first warm-up trial the cones were all the same color. A box was used to screen the cones from the child's view and one of the toys was hidden under one of the cones. The experimenter said, "I've hidden the [name of hidden toy] under one of these cones. I'll tell you what color it's under. It's *blue*." The experimenter then talked the child through the appropriate response: "They're all blue, so this time you need to look under the cones before you move Peter" and the child was encouraged to look under the cones. In the second warm-up trial all the cones were of different colors. In this trial the experimenter explained: "This time you could find the right cone straightaway, so you didn't need to look under them, you could just move Peter to sit by the (yellow) cone." The two strategies were then summarized: "Sometimes you have to pick up the cones when you *can't* find the right one straightaway and sometimes you don't have to pick them up, when you *can* find the right one straightaway."

Following the warm-up trials, there were four *experimental trials*. In these there were always two cones of one color and one of a different color. Clues were either ambiguous, referring to either one of two cones the same color, or informative, identifying the uniquely colored cone. Each child had two ambiguous trials and two informative trials. Half the children had the ambiguous trials first, and the others began with the informative trials. Since children would inevitably receive feedback about the location of the toy if they chose to pick up the cones, at the end of each trial all the cones were lifted up together to reveal the toy's location, although no comment was made on the appropriateness of their choice of strategy.

Results and Discussion

We were interested in whether children discriminated between the ambiguous and the informative clues by being more likely to pick up a cone following an ambiguous clue and more likely to move the doll following an informative clue. Children received two scores of 0, 1, or 2 according to the number of times they picked up the cones on ambiguous and on informative trials. Frequencies and mean responses for each age group are shown in Table 3.

TABLE 3
Frequency of Looking Under Cones on Informative and Ambiguous Trials in Experiment 3

	Frequency of looking under cones			Mean responses (max = 2)
	0	1	2	
5- to 6-year-olds				
Ambiguous	5	9	12	1.27
Informative	11	6	9	0.92
7- to 8-year-olds				
Ambiguous	2	3	25	1.77
Informative	20	6	4	0.47

Scores were entered into a repeated-measures ANOVA with trial type (informative or ambiguous) as a within-subject factor and age (younger or older group) and order (ambiguous or informative trial first) as between-subject factors. There was a main effect of trial type: Children were more likely to pick up the cones in response to the ambiguous messages than they were in response to the informative messages, $F(1, 52) = 47.86$, $p < .001$, and there was a significant interaction between task type and age, $F(1, 52) = 16.07$, $p < .001$. No other effects were significant.

The interaction between age and task type arose because the difference between tasks was significant only for the older children: Using a separate ANOVA for each age group, with trial type (ambiguous or informative messages) as a within-subject variable and order as a between-subject variable, there was a significant difference in performance on the two tasks for the 7- to 8-year-olds, $F(1, 28) = 66.13$, $p < .001$, but not for the 5- to 6-year-olds, $F(1, 24) = 3.83$, $p = .062$. For the younger children the test was sensitive to large effects, $\eta^2 = .14$, so it is possible that with a larger sample we would demonstrate discrimination between trial types for the younger children. Within our sample, only the older children were more likely to pick up cones in response to the ambiguous messages than to the informative ones.

Children's individual response patterns over trials were in line with the results of the above analysis. Sixteen of the 30 children in the older age group (53%) showed the appropriate pattern, always raising a cone when the clue was ambiguous and always moving the doll when the clue was informative, compared with only 4 of the 26 children in the younger group (15%): $\chi^2(df = 1) = 8.737$, $p = .003$. Of those who failed to show the appropriate pattern across trials, 7 of the younger children always picked up a cone, 4 never did, and the remaining 11 showed some other pattern of responding. The corresponding frequencies for the older group were 4, 1, and 9. Importantly, many of the younger children used both the interpreting and the seeking strategies, but unlike the older children they apparently failed to understand the circumstances under which each strategy was appropriate. Given this indiscriminate use of *both* strategies, it cannot be argued that chil-

dren who might really understand about ambiguity nevertheless chose one of the cones because they assumed implicitly that this is expected of them or that an adult would correct their errors (e.g., Speer, 1984).

GENERAL DISCUSSION AND CONCLUSIONS

The starting point for the current work was the extensive literature showing that young children may recognize problems with ambiguous information, but may not act in accord with this recognition. Consistent with this literature, the 5- to 6-year-olds in Experiment 1 tended to overestimate the knowledge they gained from ambiguous clues. We have shown, though, that the children could nevertheless deal effectively with ambiguity under certain limited conditions. In Experiments 1 and 2 we found 5- to 6-year-olds could treat their interpretations of ambiguous information as tentative. That is, they revised their original interpretations of ambiguous messages on hearing new disambiguating and contradicting information, but generally did not revise their interpretations of unambiguous messages. In these experiments we had removed the demands of generating an appropriate response to ambiguity and instead the child's handling of ambiguity was scaffolded by the procedure.

Although the children's behavior in Experiments 1 and 2 is what we would expect if they were making genuinely tentative interpretations, in Experiment 3, using the cones procedure, the 5- to 6-year-olds had more difficulty. When their choice was either to seek new information or make an interpretation, very few of them responded correctly. Their pattern of strategy use contrasted to that of the 7- to 8-year-olds. Yet if the younger children had realized that their interpretation of an ambiguous message was as likely to be wrong as right (the message had two potential referents), surely they would have taken the simple step of lifting a cone to check?

How can we reconcile this discrepancy in performance between Experiments 1 and 2, on the one hand, and Experiment 3, on the other? Can we claim that the 5- to 6-year-olds were making tentative interpretations when they first heard ambiguous messages? Following the first experiment we suggested two possible explanations for children's behavior. First, children who act as if they are making a tentative interpretation may indeed genuinely be holding in mind the two alternatives from the beginning. Or, second, they might be making a confident interpretation of the information, which they only treat as tentative with hindsight when they encounter the contradiction. The results of Experiment 3 encourage us to reject the first description of the child's experience. The procedure in Experiment 3 gave children the opportunity to seek disambiguating information before making an interpretation. We reasoned that if an interpretation of ambiguous input is tentative, then the child should use a strategy to seek information that allows conclusive identification of the referent. Although the older children often used the seeking strategy appropriately, the younger children generally did not. This suggests that at the time of making their initial interpretation they do not treat it as tentative, that is, as an interpretation that would benefit

from disambiguating information. Furthermore, performance on the evaluative "know" judgments in Experiment 1 can support the latter proposal. Children asserted that they really knew the intended referent of the ambiguous messages. One possibility is that their difficulty here lay simply in making explicit verbal judgments. However, our results are more consistent with the possibility that they really were confident in their interpretations of the ambiguous messages, and it was not until they had the contradicting information imposed on them that they called on their source monitoring skills to reconstruct the original events and resolve appropriately the contradiction that they now experienced. It is particularly interesting to note the behavior of the children in the know group of Experiment 1 who said that they really knew the intended referent of an ambiguous clue but then revised their interpretation correctly on hearing new information. We suggest, then, that when 5- to 6-year-olds in our experiments made interpretations of ambiguous information they were confident in them until those interpretations were contradicted.

We pointed out in the introduction that adults have a range of different strategies to draw on when they encounter ambiguity in real life. Their choice of strategies will be influenced by various factors, such as their knowledge of the relative likelihood of each of the possible interpretations or their assessment of the risk involved in making a wrong interpretation. In real life children might fail to adopt a strategy that an adult would consider appropriate because they lack the background knowledge of these kinds. Although the results we obtained with our game-like procedures do not allow us to be sure how children will respond to ambiguity in real-life situations, they do allow us to suggest what skills they appear to have available. In Experiments 1 and 2, 5- to 6-year-olds used very efficiently a strategy of revising their interpretations in the light of subsequent information. Given that children appear to get by in their encounters with ambiguous input in their everyday lives, their good performance in our tasks in Experiments 1 and 2 should perhaps not surprise us. Just as the adult experimenter scaffolded the child's handling of ambiguity in our first two experiments, adults may do something similar in children's everyday lives, though as pointed out by Robinson (1981, 1994), this could impede the development of reflective understanding about ambiguity. The children who updated their interpretations appropriately in Experiments 1 and 2 did not need to understand that any uncertainty they felt on first hearing the ambiguous information should have directed their subsequent actions. Their effective handling of ambiguity was reliant on external events rather than under their own control. The results of Experiment 3 gave us no grounds for arguing that children that age were making genuinely tentative interpretations of ambiguous input, unlike the 7- to 8-year-olds in our sample who were able to seek clarifying information proactively when it was appropriate to do so. Yet the younger children in Experiment 3 were not mere victims of an impulse to interpret messages; they did use the searching strategy but not on the right occasions. They had yet to master the ability to identify for themselves which of a set of possible strategies was the most effective way of dealing with ambiguity in any particular circumstances.

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