CHILDREN'S INQUIRY STRATEGIES IN REFERENTIAL COMMUNICATION AND IN THE GAME OF TWENTY QUESTIONS

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CHILDREN'S INQUIRY STRATEGIES IN REFERENTIAL COMMUNICATION AND IN THE GAME OF TWENTY QUESTIONS

by

Mary Louise Courage, B.A., M.Sc.

A thesis submitted to the School of Graduate Studies in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Department of Psychology
Memorial University of Newfoundland

June, 1985

St. John's Newfoundland

Abstract

Young children typically perform inefficiently as listeners on referential communication tasks and also when playing the game of 20 questions. In both cases they guess at the identity of the target rather than adopting the more efficient strategy of asking categorical questions. Certain training procedures have been effective in improving children's performance on both of these tasks. An experiment was conducted to test the hypothesis that under certain conditions these two tasks can be considered as a single problem in information- seeking. It was predicted that if children were trained to use a strategy of asking categorical questions either in the context of a 20 questions task or a referential listener task, that performance on the trained task would improve and would also generalize to the untrained task. Versions of the 20 questions and listener problems were designed in which the stimulus characteristics and information processing demands of the tasks were equated. 5- and 7-year-old male and female children were pretested on both tasks, trained either on the twenty questions task, the listener task, or given both types of training. A control group was given practice on the tasks. The treatment was followed by immediate and delayed posttesting on both tasks. Pretest performance was poor in both age groups, although the older children asked more categorical questions and identified more targets

correctly than did the younger children. Posttest data indicated a significant improvement in performance on the trained task, as well as substantial cross-task generalization in both age groups. Except for the 5-year-old control subjects who showed very little improvement from the pretest, there was little developmental difference in performance on the 20 questions task. On the listener task, only the 5-year-olds who experienced 20 Questions training performed as well as the 7-year-olds on the posttests. It was concluded that 20 questions and listener problems can be effectively solved with the common information-seeking strategy of asking categorical questions.

Acknowledgements.

I would like to express my thanks to Dr. F. Michael Rabinowitz for his guidance, encouragement, and patience during the course of this research. His supervision has been extremely valuable to me. I also appreciate the advice of Drs. John Strawbridge and Carole Peterson who served as committee members.

I would also like to thank the Office of Research at Memorial University for the financial support provided in the form of annual awards from the Vice-President's Grant for the Improvement of Qualifications.

I am also grateful to Ms.Geraldine Roe of the Roman Catholic School Board for St. John's, and to Ms. Dorothy Snow and her Staff at Holy Cross Primary School for their cooperation during this project. Finally, thanks to the children at Holy Cross who served as subjects in this study.

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Introduction

Referential Communication

Becoming a skilled listener is an important cognitive achievement with considerable practical application. Dickson, Hess, Miayke, & Azuma (1979) found that in both Japanese and American samples, accuracy of mother-child pairs on a referential communication task when the child was four-years-old was correlated with the child's school readiness a year later. The relationship remained significant even after the effects of maternal IQ, socioeconomic status, and the child's cognitive ability were partialed out. Similarly, Atkin, Bray, Davison, Herzberger, Humphry, & Selzer (1977) found that measures of listener skill provided the single best predictor of academic achievement in elementary school children. Studies by Robinson and Robinson (1976) have shown that a listener's response indicating noncomprehension following an inadequate message facilitated the speaker's communicative effectiveness, especially if the listener could specify the missing information. Patterson and Massad (1980) found that 9-year-old listeners trained to ask questions following ambiguous messages influenced 4-year-old speakers to produce better messages across trials. Similarly, Sonnenschein (1984) found that explicit feedback from a listener helped 5-year-

old children attend to message quality and improve their own speaker skills. Finally, much of the child's school day is spent listening to classroom instruction. The effectiveness of this instruction will depend, in part, on the child's listener skills. It is important that children consider communications carefully, monitor their level of comprehension, recognize an inadequate message as such, and realize that asking questions is the appropriate strategy to cope with the problem of noncomprehension.

The early literature on listener skills presented a pessimistic picture of young children's abilities with regard to these basic skills. While they were generally able to correctly identify a referent following an adequate message, when given an inadequate message their performance was poor. For example, when preschool and kindergarten children were given referential messages containing blatant inadequacies, they seemed unable to detect these problems, and selected a target without seeking clarification. They behaved in this manner in spite of the speaker's warning that some of the messages were "bad" or "tricky" (Asher, 1976; Bearison & Levy, 1977; Cosgrove & Patterson, 1977, 1978; Flavell, Speer, Green, & August 1981; Ironsmith & Whitehurst, 1978a, 1978b; Markman, 1977, 1979; Meissner, 1978; Patterson, O'Brien, Kister, Carter, & Kotsonis, 1980; Robinson & Robinson, 1976, 1977). The children's apparent

inability to detect message ambiguities was attributed primarily to their failure to complete the exhaustive comparison activities that the task required. Although children were shown to have the ability to make these comparisons, they did not do so in the task situations (Asher, 1976; Ford & Olson, 1975; Lempers & Elrod, 1983; Robinson & Robinson, 1977; Whitehurst & Sonnenschein, 1981).

Another important factor which appears to affect children's message appraisal performance is the response mode by which they express themselves. Most researchers require and record a child's verbal response. There is evidence that while children may fail to express verbally that a message is inadequate, an examination of a variety of nonverbal responses (eg. latency to respond, body movement, eye contact, puzzled facial expression) indicates that the child has detected at some level that there is a problem with the message. Several researchers have reported such discrepancies between verbal and nonverbal modes (Beal & Flavell, 1982; Bearison & Levy, 1977; Flavell et al, 1981; Harris, Kruithof, Terwogt, & Visser, 1981; Ironsmith & Whitehurst, 1978; Patterson et al, 1980).

Young children also appeared to be deficient in giving feedback to the speaker following an inadequate message. Requests of the speaker for missing information are rare in preschool and primary school children and

increase over the elementary school age range (Alvy, 1968; Cosgrove & Patterson, 1977; Dickson, 1974; Dittman, 1972; Karabenek & Miller, 1977; Markman, 1977, 1979; Meissner, 1975; Ironsmith and Whitehurst, 1978). However, it appears that a question-asking strategy can be trained in young children. Several studies have shown that children who were given such a "plan" for effective listening asked more questions, got more information, and made more correct referent choices than did control children who had not been trained (Cosgrove & Patterson, 1977, 1978; Ironsmith & Whitehurst, 1978b; Patterson, Massad, & Cosgrove, 1978; Pratt & Bates, 1982).

Thus, it appears that young children do possess the competence to give feedback. They have been observed to give feedback to speakers following an inadequate message in naturalistic observation situations (Robinson & Robinson, 1977; Spilton & Lee, 1977; Wellman & Lempers, 1977), and question-asking can be elicited with training. However, they do not spontaneously give feedback in the structured referential situation.

In summary, task component analysis of children's listener skills indicated that they do have the basic skills necessary to function as effective listeners. They have been observed to make comparisons among stimuli, detect ambiguities, and give feedback to speakers in a variety of

experimental and naturalistic situations. However, it seemed that these young children were unable to coordinate these skills to perform effectively as listeners in the structured referential communication task situation.

Conclusions

The initial attempts to resolve the discrepancy between children's competence and their performance as listeners involved strong criticism of the standard referential communication task itself (Asher, 1979; Flavell, 1977; Flavell et al, 1981; Whitehurst, 1981; Maratsos, 1973; Menig-Peterson, 1975; Whitehurst, 1981). Specifically, it was asserted that the task is highly artificial and lacking in relevance to the usual experience of young children. Furthermore, when a child is in the listener role, he/she is put in the position of criticizing an adult speaker. Young children may well be reluctant to do this, since they generally perceive adults to be competent.

It was also argued that the standard task required more in the way of communication skill than did more naturalistic communications. In everyday transactions, children spend much of their time in communication with adults, who compensate for some of their deficiencies as listeners. For example, adults have been observed to provide simpler and more repetitious messages when talking

to a young child (Bohannan & Marquis, 1977; Robinson & Robinson, 1977; Snow, 1972; Wilcox & Webster, 1977). Pratt and Bates (1982) discussed the importance of physical context in the development of young children's communication. They noted that many of the studies showing limitations in listener performance have involved verbal messages out of physical context. Finally, many of the listener tasks of everyday life make fewer demands for comparison activity and word knowledge or vocabulary than did the standard referential task. Ackerman (1979) has argued that the listener task may not address a child's communicative competence as much as his/her ability to conduct a perceptual analysis of the referential field.

Shatz (1978) discussed the importance of information processing variables such as memory and attentional capacity on children's communicative performance. She suggested that referential tasks which require recall rather than recognition measures, use large or multidimensional stimulus arrays, or involve unfamiliar materials, place heavy information processing demands on young children. This tends to degrade their performance on the tasks and results in an underestimation of their communicative competence. Several studies designed to test this information overload hypothesis have been supportive. When task demands are reduced, so that competence in exercising

the basic component skills can be examined, children perform effectively as listeners in referential communication situations (Lempers & Elrod, 1983; Patterson et al, 1980; 1981; Pratt & Bates, 1982; Robinson, 1981; Whitehurst & Sonnenschein, 1981).

Metacommunication

Recent literature on the development of listener skills reflects a different emphasis. It is suggested that while young children have the basic component skills necessary for referential communication, what they lack is an understanding about communication itself, and an awareness of the procedural rules for effective communication. Flavell (1977) refered to this aspect of knowledge as "metacommunication". Metacommunicative knowledge goes beyond having the basic component skills necessary for communication. It implies an awareness on the part of the child that a certain situation requires referential communication, and that for this to occur effectively both listener and speaker are required to interact in a reciprocal manner. Thus, the competent child recognizes communication as a dyadic enterprise, a relationship between speaker and listener around a task (Asher & Wigfield, 1978; Flavell et al, 1981; Robinson & Robinson, 1982, 1983; Singer & Flavell, 1981; Sonnenschein & Whitehurst, 1983; 1984a,

1984b).

Research based on these assumptions indicates that several metacommunicative skills appear to be relevant to listener effectiveness. For example, children must understand that the message itself is relevant to communication success or failure, and that it must refer uniquely to whatever the speaker has in mind. Studies by Robinson and Robinson (1976, 1977, 1978, 1979, 1981) have addressed these issues. They found that 5-year-old children, acting alternately as speakers and listeners, lacked this understanding. They consistently blamed the listener for communication failure following an inadequate message. More mature communicators appropriately blamed the speaker following such a communication failure. "Listener blamers" were also less likely to complete the necessary comparison activities than were "speaker blamers". They seemed to judge message adequacy on the basis of whether it fitted the referent, without considering the nonreferents. "Listener blamers" were also less well able to deliberately produce a poor message upon request. Nor could they suggest ways in which a poor message could be improved. Recently, Whitehurst and Sonnenschein (1984) showed that evaluative skills such as those required in the Robinsons' task, are later to develop than are the component skills required for competent listener performance. They concluded that child-

ren can be competent listeners without being able to evaluate a communication interaction.

Mature listeners must also understand that in a communication situation they should give appropriate feedback to the speaker, especially if the message has been inadequate. Ideally, the feedback should be explicit in specifying the missing information. This requires some perspective-taking ability in that the listener must be able to infer what it is that the speaker needs to know in order to be able to modify the message. At a simpler level, the child should at least recognize that he/she should ask a general question or otherwise express noncomprehension. Although preschool children have been observed to give feedback to speakers in naturalistic situations (Robinson & Robinson, 1978; Spilton & Lee, 1977; Welman & Lempers, 1977), they do not transfer the skill to the referential task situation (Cosgrove & Patterson, 1977; Ironsmith & Whitehurst, 1978). These children may not realize that a part of their role as listeners in the referential task situation is to inform the speaker when a message has been inadequate.

Good listeners must also be able to monitor their own level of comprehension. Although it has not been precisely defined, comprehension monitoring is seen as an executive process whereby an individual actively keeps track

of written or orally presented material, and becomes aware of his/her lack of understanding, should it occur. In research, the concept has been operationally defined as asking a question, or signaling the need for more information, following an inadequate message. It has been argued that failure to monitor comprehension is an important contributing factor in children's poor performance as listeners (Markman, 1977; 1979; Flavell, Green, Speer, & August, 1981). These researchers have stated that comprehension monitoring is a late developing skill (or set of skills) which presupposes the existence of other more basic listener skills. It is this executive process which coordinates the component skills into effective listener performance.

Others have argued that young children do have the ability to monitor their comprehension. Shatz (1978) said that if the information processing demands of a communication task were minimized, then young listeners would have more resources available to engage in comprehension monitoring. As discussed above, recent research conducted to test this idea has been supportive. When task demands are simplified, preschoolers do ask for more information following inadequate messages (Patterson, O'Brien, Kister, Carter, & Kotsonis, 1981; Pratt & Bates, 1982).

It would appear then, that asking questions is a critical listener skill in the referential communication task situation. It indicates that the child is monitoring his/her level of comprehension. It gives the speaker the essential feedback needed to modify the message. Asking questions may be the missing component which prevents the child from functioning as an effective listener in this situation. However, failure to ask questions might not mean that the child did not monitor his/her comprehension. It might be that the child does not realize that asking questions is the appropriate strategy in the situation.

Researchers have found that the most effective listener training programs are those which emphasize the acquisition of a question-asking rule. Children of primary school age who did not spontaneously question a speaker following an inadequate message did so when they were given a "plan" for effective listening which emphasized the importance of asking questions as the only way to find the correct referent when the message has been unclear. In this way, young children who made comparisons among referents and detected ambiguities, became aware of how to act in the referential situation (Cosgrove & Patterson, 1977, 1978; Ironsmith & Whitehurst, 1978; Patterson & Kister, 1981; Patterson & Massad, & Cosgrove, 1978; Patterson & Massad, 1980).

Twenty Questions

Flavell (1977) referred to the referential task as a communication problem which young listeners are required to solve. Specifically, the problem requires that they identify a target referent on the basis of a speaker's verbal message. When the message is unambiguous, children can solve the problem readily. However, when the information given is unclear, the immature listener will select a target by guessing. The mature listener will request additional information. To get additional information most efficiently, the listener should specify the nature of the needed information precisely. Thus, solving communication problems requires that children ask informative questions. Researchers have found that the type of questions children ask changes with age. Preschool children rarely ask any questions at all in a referential task situation, although they give nonverbal signs of puzzlement. When children do begin to question a speaker following an inadequate message, they do so by making general statements or by asking general questions ("I don't know which one you mean."). Over the age range from kindergarten to fourth grade, children's questions become less general and more specific or categorical (e.g. "Is it large or small?") (Cosgrove & Patterson, 1977; Ironsmith & Whitehurst, 1978;

Patterson & Massad, 1980).

Children's interrogative strategies have also been studied using the old parlor game "20 Questions". On the standard version of this task the subject is presented with 42 pictures of common objects and told to guess which one the experimenter is thinking about, using as few questions as possible. Questions can be answered only by "yes" or "no". Mosher and Hornsby (1966) discovered dramatic shifts away from "single-item" questions, and toward "categorical" questions between the ages of 6- and 11-years. A single-item question is one that will eliminate one item at a time and bears no relationship to previous questions (Is it the car?). A categorical question is one that will eliminate more than one alternative from the array of possibilities (Is it a tool?). The latter type of question allows the child to narrow in on the correct answer more quickly, and thus results in more efficient problem-solving.

Several attempts have been made to alter children's question-asking strategies through observational learning. Two early studies exposed children to exemplary models who played the 20 Questions game with them by asking either single-item or categorical questions (Laughlin, Moss, & Miller, 1969; Denney, 1972). The results showed that children aged 6- to 8-years-old did not increase their categorical questions after having played with the

categorical-question model. The older children, aged 9-, 11-, and 13-years did ask more categorical questions under these circumstances. However, only the children in the two older groups showed any improvement in problem-solving efficiency along with their increase in categorical questions. Problem-solving efficiency was operationally defined as the number of questions that the child asked before being able to identify the target stimulus.

A different approach to the modification of question-asking strategies has been to expose children to "cognitive" or "strategy" models who (a) verbally demonstrate how to classify similar stimuli into categories, (b) exemplify categorical questions based on such classification, and (3) verbally indicate how to use the information received as the result of the question-asking (Denney, Denney, & Ziobrowski, 1973; Denney & Denney, 1974; Denney, 1975). These researchers found that exposure to strategy models increased the categorical questions asked by children from 6- to 8-years old. Thus, strategy modeling seemed to be more effective with children at the beginning of the transition in question-asking as defined by Mosher and Hornsby (1966). However, accompanying increases in problem-solving efficiency among these young children were not always observed. For children at the upper end of the transition period, both exemplary and strategy models are

effective in improving problem-solving efficiency.

Denney and Connors (1974) modified the interrogative strategies of preschoolers by testing them with a slightly different version of the standard 20 Questions task. Instead of using visual stimulus arrays, categories were determined by the experimenter ("I am thinking of a type of food. . . "). It was believed that this type of stimulus material would force the children to ask categorical questions because of the potentially large size of the array. Further, that since the array was not physically present, children would be discouraged from simply naming the stimuli. Children were exposed to either strategy or exemplary models in this manner. On the first posttest, in which the stimulus items were the same as those used in training, children in both modeling conditions asked more categorical questions, and required fewer questions for solution than did control children who were not trained. However, on the second posttest, which used different stimulus items, only children who had been exposed to the strategy model asked more categorical questions and were more efficient problem-solvers.

Denney, Jones, and Krigel (1979) investigated the effect of various strategy modeling variables on the performance of 6-year-olds. Children were assigned to one of three training groups. They received direct instruction

either on how to classify stimuli, or on how to ask categorical questions, or on how to use the information gained from answers to categorical questions. Only the children who experienced categorical question training asked more questions of this type on the standard 20 Questions task. Problem-solving efficiency was not evaluated in this study.

In summary, young children do not spontaneously ask categorical questions to solve the standard 20 Question problem. However, they can be trained to do so following exposure to, or direct instruction from, a strategy model who verbalizes or demonstrates the purpose and method of asking categorical questions in this task. The problem-solving efficiency of these children can also be increased following training. However, increases in efficiency are not always found, and the matter needs further study. Exposure to exemplary models, who simply illustrate categorical questions while playing the game, does not alter the interrogative strategy of young children. In contrast, older children ask more categorical questions, and require fewer questions to solution following exposure to either strategy or exemplary models.

Conclusions

Although it has not been the focus of the research discussed above, it could be argued that the task of the listener in referential communication and the task of the player in 20 Questions are comparable. The goal is the same in each case. The subject must identify a target stimulus from an array of items. In both cases this is most efficiently done by asking the speaker categorical questions which enable the child to narrow in on the target quickly. In much of the existing research however, a child is considered to have responded correctly on a listener task if he/she merely indicates that the message has not been understood. No questions are required. While indicating noncomprehension is an adequate response, communication is most efficient when the listener can provide the speaker with explicit feedback about the nature of the missing information. This can be achieved effectively by asking categorical questions. Another similarity between the 20 Questions and listener tasks is that young children of primary school age adopt a similar strategy in both of these task situations. When the target is not immediately apparent they guess its identity. Older children will adopt the more efficient strategy of asking categorical questions to get more information, or to eliminate items or referents before identifying the target.

The two tasks also require many of the same cognitive or information processing skills. Consider the following analysis of the steps required of an efficient subject in a case in which the two tasks are identical. Such identity exists between the requirements of a modified version of the 20 Questions task, and the task of a listener following a speaker's uninformative message. In neither of these cases is the subject given useful information on the first trial. Suppose that the subject is presented with a simple stimulus array of four items which vary from each other along two dimensions. An example would be: a large blue square, a large red square, a small blue square, and a small red square. Under 20 Questions instructions the child should procede as follows:

Step 1. Scan the stimulus array.

Step 2. Categorize the stimuli into two groups.

Step 3. Ask question 1: Is it blue? (Answer: Yes.)

Step 4. Scan the remaining items in the array.

Step 5. Categorize the stimuli into two groups.

Step 6. Ask question 2: Is it large? (Answer: Yes.)

Step 7. Identify the target with question 3.

In instances where the child gets a negative response to a question, the minimum number of questions needed for solution does not change. However, the child will need to perform an additional operation of the type "If not A, then

B." and store this information in memory.

When presented with the same stimulus array and an uninformative message ("It's a square."), in a referential communication task context, the listener should procede as follows:

Step 1. Scan the stimulus array.

Step 2. Categorize the stimuli into two groups.

Step 3. Ask question 1: Is it red or blue?
(Answer: Blue.)

Step 4. Scan the remaining items in the array.

Step 5. Categorize the stimuli into two groups.

Step 6. Ask question 2: Is it large or small?
(Answer: Large.)

Step 7. Identify the referent with question 3.

However, when the listener starts with a partly informative message ("It's blue."), or a fully informative message ("It's large and blue."), his/her task is clearly simpler and fewer of the steps described above will be required to identify the target.

Although there are similarities between the requirements for the referential and 20 Question tasks, there are also some notable differences between them. In the example discussed above, the child playing the modified version of the 20 Questions task must be able to use the information provided by a "no" answer. He/she must be able

to understand the logical operation "If not A, then B.", and use the information derived to eliminate non-target stimuli. This operation is not a part of the listener's task in referential communication, since the child is always told what the target is, rather than what it is not.

Considering the existing literature, another point of difference is that across a series of trials the listener in referential communication is generally given more information to work with than is the subject playing 20 Questions. While speakers do give uninformative messages on some trials, they also give partly or fully informative messages on other trials. In 20 Questions the child begins with no information other than that which is provided by the stimulus array, and must solicit all the information by asking questions.

In addition, most of the researchers who have studied the 20 Questions problem have used the standard 42 item stimulus array. This version of the task requires more scanning, categorizing and use of memory than do any of the listener tasks that researchers in referential communication have reported using.

A final point of difference involves the requirement of making comparisons among stimuli in the array. In the 20 Questions task the efficient player must scan all of the items in the array before forming a

hypothesis about the identity of the correct target. In the referential task, in which the speaker gives the listener some information about the identity of the target, the child also has to scan the array in order to find a match. In addition, the listener has to be able to detect any ambiguity in the message, for example, the presence of more than one item that fits the speaker's description. This requires the child to compare each stimulus item with his/her memory representation of the speaker's message. It has been suggested that an important reason why children fail to function as effective listeners and instead make incorrect choices, is because they don't complete the necessary comparison process. Rather, the child is likely to conduct an incomplete search which ends with the identification of the first appropriate match (Asher, 1968, 1979; Asher & Parke, 1975, Bearison & Levy, 1977; Ford & Olson, 1975; Robinson & Robinson, 1976, Whitehurst & Merkur, 1977; Whitehurst & Sonnenschein, 1978). It is possible that the necessity of checking for a match between the characteristics of the message and the items in the stimulus array could make the listener task a more difficult one for young children.

Considering these points of difference between the two tasks it might be expected that the referential communication problem would be an easier one for young

children to solve. In many ways it is less demanding. However, it is not clear that this is so. While young children do not perform efficiently on either task without training, researchers seem to have had more success in training children on the 20 Question task. While there are no studies which have compared performance on the two problems directly, there are some data which tend to support this possibility. For example, preschoolers ask more categorical questions and solve the 20 Questions problem more efficiently following appropriate training. In contrast, on the listener task, while children across grades one to four show significant improvement in question-asking following appropriate training, only the older children in this age range ask more categorical questions. Preschoolers and kindergarten age children are more difficult to train in the question-asking strategy, and the results are mixed (Ironsmith & Whitehurst, 1978b, Patterson et al, 1978, 1981).

The reason for this discrepency is not clear. It may be that the 20 Question problem has more task relevance for the young children. Their role in the situation is not one of criticizing the adult speaker, but one of seeking clues to the solution of a game. It may be more obvious to the child that his/her task is to ask questions.

An important explanation may lie in the different

way that a trial is defined in the two tasks. In the 20 Questions problem a trial begins when the child asks the first question, and ends after the target has been identified or 20 questions have been asked, whichever occurs first. The dependent variables of interest are the number and type of questions asked. On the referential communication problem a trial begins when the listener asks the first question, but ends when the first target is selected. If the choice is correct, the child is scored as right, if it is incorrect, the child is scored as wrong and a new trial begins. If trials and dependent measures were equated in these two tasks children's performance may be more comparable.

Finally, it is also possible that, as discussed above, young listeners may be unable to detect message ambiguity because they fail to complete the necessary comparison process which requires them to match each item in the array with their memory of the speaker's message. Thus, the listener task may genuinely be more difficult for young children. The first hypothesis of this study was formulated to test the potential importance of this problem in the listener task. If children were unable to search and compare exhaustively, then it could be argued that detecting ambiguity is an additional cognitive requirement that would make the listener task different from, and more difficult

than the 20 Questions task. To test this possibility, children were given a perceptual scanning task in which they were required to scan a stimulus array in search of a varied number of targets which had certain specified characteristics. It was predicted that children would be able to conduct an exhaustive search of a stimulus array and thus perform competently.

The primary purpose of this study was to investigate the relationship between children's inquiry strategies as listeners in referential communication, and their inquiry strategies in the game of 20 Questions. While these two tasks can be considered as logically similar, they have always been studied independently. Furthermore, researchers in each of these areas have drawn different conclusions about children's ability to ask questions. The basic hypothesis that this study was designed to test was that if the information processing and task demands of the 20 Questions and referential listener problems were equated, then both of these tasks could be reduced to a single problem in information seeking. It was predicted that if children were trained in the strategy of asking categorical questions either in the context of a 20 Questions task or a referential listener task, that performance would improve on the trained task, and would also generalize to performance on the other task.

Consequently, versions of the 20 Questions and listener tasks were designed in which the stimulus characteristics and the information processing demands of the two tasks were equated. Young children were pretested on both tasks, and then trained either on the 20 Questions task, the listener task, or given both types of training. A control group of children was given practice on the tasks. The training or practice was followed by immediate and delayed posttesting on both tasks. Training and transfer effects were evaluated in this manner.

Method

Subjects

The subjects consisted of 32 boys and 32 girls aged 5-years-old (mean age 5 years 8 months), and 32 boys and 32 girls aged 7-years-old (mean age 7 years 5 months). They were selected from kindergarten and grade two classes of a local primary school. Permission to conduct the study was obtained from the school board concerned, and from the parents of the children. Data from ten additional 7-year-old children were eliminated from the study following perfect performance on the pretests. Data from another ten of the 5-year-old children who did not want to participate in the study were also eliminated.

Stimuli

Eleven, eight-item stimulus arrays were used to evaluate both 20 Questions and listener performance. Each array consisted of eight line drawings of a common object. The drawings in each array varied systematically along three dimensions. Each dimension was represented by two values. An example set would be: a house which is either red or blue, with or without a door, with or without windows. Three of the arrays were used in the perceptual scanning task. Two of the arrays were used during pretest, two for

immediate posttesting, and two during delayed posttesting. The final two arrays were used in training. Selection of the particular arrays to be used on the scanning task, during training, and at each of the three phases of testing was randomized for each subject.

Design and Procedure

An Age (5 years, 7 years) x Sex x Treatment (Listener, 20 Questions, Listener and 20 Questions, no-training control) x Phase (pretest, immediate posttest, delayed posttest) factorial design was used. The first three factors were between-subjects, and the fourth was within-subjects.

Subjects were quasi-randomly assigned to one of the four training conditions such that age and sex were counterbalanced across training conditions. Thus, a cell consisted of eight children of the same sex and age who experienced the same training procedure.

Each subject was seen individually on two occasions. On the first day he/she was pretested, trained, and given an immediate posttest. One week later a delayed posttest was given. Before the pretest and the posttests, subjects were given the perceptual scanning task. The purpose of this task was to check whether the children would scan a stimulus array exhaustively while searching for

certain specified targets. Thus, the child was shown one of the arrays and instructed to point to the pictures on the array which illustrated certain features and combinations of features as specified in a speaker's message. The children were given four messages which varied in the number of stimulus characteristics specified on each of the four trials. Accordingly, the child had to identify either one, two, four, or eight of the items on the array. A scanning error was recorded if the child included a target that did not fit the message, or excluded an item which did fit the message.

Following the scanning task, the subject was given one 20 Questions problem and five listener skills problems. The order in which the two tasks was given on each of the three tests was counterbalanced across subjects in a cell, such that each of the subjects experienced a different combination of the eight possible counterbalanced orderings. An example of one of the possible orderings is: 20 Questions followed by listener on the pretest, listener followed by 20 Questions on the immediate posttest, and listener followed by 20 Questions on the delayed posttest.

Testing. Instructions to the subjects performing the 20 Questions task were as follows:

"We are going to play a question-asking game. I will think of one of these pictures and it is your job to

find out which one. The way to find out is by asking questions which I can answer "yes" or "no" -any question at all as long as I can answer "yes" or "no". So you try to figure out which picture I am thinking about by asking questions. You have eight questions to get the answer, but try to ask as few as possible."

In order to avoid reinforcing guesses, the child was told a choice was correct only if the other seven possibilities had been logically eliminated. This could occur in a minimum of four responses if the child used the strategy of asking categorical questions, and efficiently used the information gained from the questions. An example of four such questions would be: Is it blue? Does it have a door? Does it have windows? Is it the blue house with a door and windows? In order to minimize the information processing load on the child, all categorical questions were answered "yes" by the experimenter, provided that they were consistent with previous choices. This practice was followed for the listener task as well. The child was allowed a maximum of eight questions. If the target had not been identified by this time, he/she was told the correct answer. The dependent measures were the type of question asked (single item or categorical), and whether or not the target was identified correctly.

Instructions to the subject performing the

listener task were as follows:

"Now we are going to play a listening game. We each have a set of pictures that are the same. Here's how we will play. I will tell you about one of my pictures. I will call it the "special one". Your job is to find the special picture that I am talking about. Sometimes I won't tell you enough about the special picture and you won't know which one I mean. If that happens and you can't tell which one I mean, you can ask me questions to help you find the special picture."

The child was questioned to make sure that he/she knew that questions were permissible. One practice trial was given to insure that the child understood what was expected of him/her. On the practice trial the child was given a partly informative message which gave information about one of the three dimensions (e.g. "It's a house with windows."). If he/she asked a categorical question it was answered directly. If he/she asked a single-item question or selected a target without seeking clarification, the experimenter explained that only one picture was correct, and since there were several which could fit the speaker's description (These were illustrated), he/she had to ask questions to get more information. Following the practice trial the subject doing the listener task was given four additional listener trials without explicit feedback. The

same stimulus array was used on all 5 trials. Each trial began with the speaker giving the listener a new message. The messages given by the speaker varied in informational adequacy as follows: Set 1 was accompanied by a fully informative message which gave information about all three dimensions (e.g. "It's a blue house with a door, but no windows."). Set 2 was accompanied by a partly informative message which gave information about two of the dimensions (e.g. "It's a blue house with a door."). Set 3 was accompanied by another partly informative message which gave information about one dimension (e.g. "It's a blue house."). Set 4 was accompanied by an uninformative message which gave no useful information (eg. "It's a house."). The order in which these sets were presented to the child was randomized for each subject on each test.

The speaker answered any categorical questions that the child asked. In order to avoid reinforcing guessing, the child was told that a choice was correct only if the other logical possibilities had been eliminated. The number of possibilities depended, of course, on the degree of adequacy of the message presented to the child. If the child asked a single-item question, and thus took a guess without seeking clarification, the speaker responded "That's wrong. Let's try another one."

The dependent measures of interest were the type

of questions that the child asked (single-item or categorical), and whether or not the child selected the correct target referent.

Training. After pretesting, the subjects experienced one of the following four types of training: 20 Questions, Listener, both 20 Questions and Listener, or no-training control.

Participants in the 20 Question training were taught to ask categorical questions as the most efficient way to identify the target. They were given the following instructions:

"Those were hard games, weren't they? You did well, but now I am going to show you a way that will help you to do even better. Let's go back to the question-asking game. This is what you should do. Whenever you ask a question, try to think of one that will tell you about more than one picture at a time. Don't just take a guess. Try to figure it out. For example, you could ask if the house is blue. If I say "yes", then that tells you about four of the houses doesn't it? You know that the house is a blue one. Then you could ask me if it's got a door. That tells you about two of the houses that are left. If I say "yes", then you know that the house is blue and has a door. Next, you could ask me if the house has any windows. If I say "yes", then you can figure out the answer. You know that

it's a blue house with a door and windows. Remember, you have to figure out the one I'm thinking about by asking good questions. 'Go ahead and ask me a question." If the child asked a single-item question (i.e., guessed) the experimenter explained again how to ask categorical questions emphasizing "Don't just guess, try to figure it out." The subject was guided through eight trials in this manner.

Participants in the listener training were taught that the best strategy to cope with an uninformative or a partly informative message is to ask categorical questions to clarify the ambiguity. They were given the following instructions: "Those were hard games weren't they? You did very well, but now I am going to show you a way to do even better. Let's go back to the listening game. I will tell you about the special picture just like I did before. Sometimes I won't tell you enough about the picture and you won't know which one I mean. So be sure to take your time and look carefully at all of the pictures. If you can't tell which one is the special one because I didn't tell you enough about it, you know that it's time to ask a question so you'll know how to find the special picture." Let me tell you how to ask some good questions. Whenever you ask a question, try to think of one that will tell you about more than one picture at a time. Don't just take a guess, try to figure it out. For, example, you could ask if the house is

blue. If I say "yes", then that tells you about four of the pictures, doesn't it? You know that the house is a blue one. Then you could ask me if it has a door. That tells you about two of the pictures that are left. If I say "yes", then you know that the house is blue and has a door. Next, you could ask me if the house has any windows. If I say "yes", then you can figure out the answer. You know it's a blue house with a door and windows. Let's see how well you can do. Remember, the trick is to ask good questions that will help you to find the special picture."

The children were given corrective feedback on all eight of the training trials. When the child selected the correct target following an informative message he/she was told: "Very good. You found the special picture." Following a partly informative or an uninformative message the child should begin to ask questions to seek more information. If he/she asked a single-item question the speaker said "There are two (or four, or seven) other pictures that could also be right. I didn't tell you enough about the special picture, did I? I gave you a tricky message. I think you were guessing. Don't forget to ask me questions if you need help to find the special picture." If the child began to ask categorical questions they were answered so that the last logical choice was correct. The speaker's message varied in informational adequacy. Since a message could give

information about three, two, one, or none of the stimulus dimensions, each subject experienced two of each type. The order of message types was randomized for each subject (in blocks of four).

Participants in the combined 20 Questions/Listener training received both types of training as described above. They were given four trials of listener training and four trials of 20 Questions training. The order of training and type of stimulus set was counterbalanced.

Subjects in the no-training control group were given eight practice trials either on the 20 Questions task or on the listener task. They were alternately assigned to one or the other practice group according to the order of their placement in that group. Age and sex of the subject were balanced in each practice group. No corrective feedback was given.

Results

Perceptual Scanning Task

At the beginning of each phase of testing, subjects were given a scanning task. The reason for including this task was to test each child's ability to make an exhaustive search of a stimulus array, while attempting to locate certain items in the array which had been described in a speaker's message. The speaker's message varied in the number of stimulus characteristics that were specified on each of the four trials. Accordingly, the child might have to indicate one, two, four, or eight targets on any given trial. A scanning error was recorded if the child included a target which did not fit the speaker's description, or excluded a target which did fit the speaker's description.

A 2(Age) x 4(Treatment Condition) x 2(Sex) x 3(Phase of Testing) x 4(Number of Targets) analysis of variance was performed on the scanning error data. The analysis revealed a significant interaction of Age x Sex x Number of Targets, $F(3,672) = 3.69$, $p<.05$, which was higher order to the significant main effects of sex, $F(1,112) = 4.61$, $p<.05$, and number of targets, $F(3,336) = 3.25$, $p<.05$. Inspection of the data in Table 1 indicates that the number of scanning errors for all of the children was extremely

low. In general, female subjects at both age levels had lower error scores than did the male subjects. The 5-year-old males made most errors when they had to identify one or two targets on the basis of the speaker's message. Among the 7-year-old males, most errors were made when they had to identify eight of the targets following the speaker's message. However, the higher error rate in this age group was largely the result of the poor performance of two boys who did not appear to understand the instructions.

The analysis also revealed a significant main effect of phase of testing, $F(2,224) = 5.03$, $p<.01$. In general, children reduced the number of errors they made from the pretest to the posttests. However, this main effect was lower order to a significant Phase of Testing x Number of Targets interaction, $F(6,672) = 2.48$, $p<.05$. The data in Table 2 indicate that in general, children reduced their error scores from the pretest to the posttests. They appeared to have most difficulty with the task on the pretest when the speaker's message required them to identify all eight of the targets or only one of the targets. It is possible that the instructions ("Point to all the pictures that show...") may have confused them on these trials, and set an expectation that they should identify less than eight, or more than one of the targets.

In summary, scanning errors in all treatment

conditions, and at both age levels were infrequent. For the 7-year-old subjects 82.8% of the scanning trials were without error, and for the 5-year-old subjects 76% of the scanning trials were without error. This indicates that when children were asked to identify target stimuli with specified characteristics they were exhaustive in their search of the stimulus array. Children checked each item in the stimulus array for a potential match rather than terminating their search after the first appropriate target had been located.

20 Questions Task

Targets correct. The mean number of targets correctly identified on each of the modified 20 Questions tasks are presented in Table 3. On each of these tasks the subject was presented with an eight-item stimulus array and asked to try and identify the item the speaker had in mind, by asking questions. A maximum of eight questions was allowed. A 2(Age) x 4(Treatment Condition) x 2(Sex) x 3(Phase of Testing) analysis of variance was performed on these data. The analysis revealed a significant interaction of Age x Treatment Condition x Phase of Testing, $F(6,224) = 4.29$, $p<.001$, which was higher order to the significant main effects of age, $F(1,112) = 35.68$, $p<.001$, treatment condition $F(3,112) = 11.63$, $p<.001$, and phase of testing

$F(2,224) = 168.94$, $p<.001$, and the interactions of Age x Treatment Condition, $F(3,112) = 4.48$, $p<.01$, and Treatment Condition x Phase of Testing, $F(6,224) = 5.98$, $p<.001$.

Inspection of the data in Table 3 reveals that the main effect of phase of testing is interpretable. Subjects in all groups increased their targets-correct scores from the pretest to the first posttest. In order to clarify the Age x Treatment Condition x Phase of Testing interaction, separate analyses of variance were carried out on the pretest and posttest data. Age and treatment condition were factors in both analyses. Phase of testing was also a variable in the posttest analysis. Only the main effect of age, $F(1,112) = 22.51$, $p<.001$, was significant in the pretest analysis. The 7-year-olds identified more targets correct than did the 5-year-olds. Analysis of the posttest data revealed a significant Age x Treatment Condition interaction $F(3,112) = 7.97$, $p<.001$, which was higher order to the significant main effects of age $F(1,112) = 15.72$, $p<.001$, and treatment condition $F(3,112) = 16.15$, $p< .001$. There were no significant contrast effects involving the phase of testing variable. Posttest averages are presented in Table 3. The significant interaction reflects the fact that the 5-year-old children in the three experimental groups performed almost as well as the 7-year-old children. However, 5-year-old children in the control group were

significantly poorer than the 7-year-old children, $F(1,112 = 189.11, p<.001)$. It seems that the younger children require training to substantially improve their targets-correct scores, whereas practice is sufficient for the older children.

Type of questions asked. The data on the number of categorical versus single-item questions asked while performing the 20 Questions tasks are presented in Table 4. A categorical question is one which eliminated more than one alternative from the array of possible targets. A single-item question is one which eliminated one item only from the array. A 2(Age) x 4(Treatment Condition) x 2(Sex) x 3(Phase of Testing) x 2(Type of Question) analysis of variance was performed on these data. This analysis indicated a significant interaction of Age x Treatment Condition x Phase of Testing x Type of Question, $F(6,224) = 15.080, p<.001$, which was higher order to the significant main effects of age, $F(1,112) = 28.92, p<.001$, treatment condition, $F(3,112) = 8.36, p<.001$, phase of testing, $F(2,224) = 164.03, p<.001$, and type of question, $F(1,112) = 57.09, p<.001$, and the significant interactions of Treatment Condition x Phase of Testing x Type of Question, $F(6,224) = 5.42, p<.001$, Phase of Testing x Type of Question, $F(2,224) = 194.33, p<.001$, Age x Treatment Condition x Type of Question, $F(3,112) = 3.07, p<.05$, Age x Type of Question, $F(1,112) = 40.83$,

$p<.001$, Treatment Condition x Type of Question, $F(3,112) = 9.14$, $p<.001$, Age x Treatment Condition x Phase of Testing, $F(6,224) = 3.28$, $p<.01$, Treatment Condition x Phase of Testing, $F(6,224) = 5.24$, $p<001$, and Age x Treatment Condition, $F(3,112) = 2.92$, $p<.05$.

The data shown in Table 4 reflect the fact that subjects in all groups tended to increase the number of categorical questions and decrease the number of single-item questions they asked from the pretest to the immediate and delayed postests. This pattern of response reflects an increase in efficiency in solving the 20 Questions problem. Categorical questions enable the child to eliminate more non-targets than do single-item questions and, thus, narrow in on the correct target with fewer questions.

In order to clarify the Age x Treatment Condition x Phase of Testing x Type of Question interaction, separate analyses of variance were conducted on the pretest and posttest data. Age, treatment condition, and type of question were factors in both analyses. Phase of testing was also a variable in the posttest analysis. The analysis of the pretest data revealed significant main effects of age, $F(1,112) = 18.86$, $p<.001$, and type of question, $F(1,112) = 215.78$, $p<.001$. However, these can only be interpreted with reference to the significant Age x Type of Question interaction, $F(1,112) = 21.06$, $p<.001$. Inspection

of the data indicates that on the pretest measure, 7-year-old children asked more categorical and fewer single-item questions than did the 5-year-olds.

Analysis of the posttest data indicated that, as was the case with the target data, there were no significant contrast effects involving the phase of testing variable. The posttest averages are presented in Table 4. The analysis did indicate a significant interaction of Age x Treatment Condition x Type of Question, $F(3,112) = 6.31$, $p<.001$, which was higher order to the significant main effects of age, $F(1,112) = 12.35$, $p<.001$, and treatment condition, $F(3,112) = 12.20$, $p<.001$, and the significant interactions of Age x Type of Question, $F(1,112) = 20.98$, $p<.001$, Age x Treatment Condition $F(3,112) = 5.15$, $p<.01$, and Treatment Condition x Type of Question, $F(3,112) = 12.78$, $p<.001$.

The significant interaction reflects the fact that in general, the 7-year-olds asked more categorical and fewer single item questions on the posttests than did the 5-year-old subjects. However, the 5-year-olds who received direct training on the 20 Questions problem, or a combination of both 20 Questons and Listener training, asked as many categorical questions as did the 7-year-old children on this task, $F(1,112) = .718$, $p>.05$. The 5-year-olds who had been given Listener training alone improved their 20 Questions

performance from the pretest level, but not to the level achieved by the children who were given direct training on the 20 Questions task, $F(1,112) = 13.45$, $p<.001$. The 5-year-old control children who received practice on the tasks improved only marginally on the posttests, and were significantly poorer than the experimental group children, $F(1,112) = 68.68$, $p<.001$. Among the 7-year-old subjects, both training and practice conditions were effective in improving their posttest performance on the 20 Questions task. Experimental and control subjects did not differ significantly, $F(1,112) = 1.82$, $p>.05$. It should be noted however, that all of the children experienced some minimal training on the listener task during pretesting. At this time the children were given one example of a listener problem. If they asked a single-item question it was explained that while their target fitted the speaker's description, so did several other targets. They were reminded that they could ask questions to clarify ambiguity. This brief experience which pointed out the existence of message ambiguity may have influenced the performance of the 7-year-old control children.

In summary, both the targets-correct and type of questions measures of 20 Questions performance are consistent. On the pretest, 7-year-olds asked more categorical and fewer single-item questions, and identified

more targets correctly than did the 5-year-olds. Children at both age levels became more efficient in their inquiry strategies across the phases of testing. They asked fewer single-item and more categorical questions on the posttests. Consequently, their targets-correct scores increased. The 5-year-olds required training in order to improve from the pretest to the posttests. Treatment conditions which gave them direct training on the 20 Questions problem were most effective. The 7-year-olds improved their efficiency from the pretest to the posttests following any of the training conditions, or following a period of practice with the tasks.

Listener Task

Targets correct. The mean number of targets correctly identified on each of the listener tasks are presented in Table 5. The listener task was a referential communication problem in which the child was required to identify a target referent on the basis of a speaker's verbal description. Each task consisted of four trials in which the speakers's message varied in informational adequacy, leaving either one, two, four, or eight targets possibly correct. A 2(Age) x 4(Treatment Condition) x 2(Sex) x 3(Phase of Testing) x 3(Degree of Message Ambiguity) analysis of variance was performed on these data.

The data in Table 5 show that when the speaker's message was unambiguous, and gave all the information necessary to identify the target, children in all groups performed the listener task accurately. Thus, these data were not included in the analysis. The analysis revealed significant main effects of age, $F(1,112) = 36.11$, $p<.001$, treatment condition, $F(3,113) = 7.54$, $p<.001$, and phase of testing, $F(2,224) = 214.64$, $p<.001$. These main effects were lower order to the significant interactions of Treatment Condition x Phase of Testing, $F(6,224) = 5.57$, $p<.001$, and Age x Sex x Phase of Testing, $F(2,224) = 3.23$, $p<.05$.

Inspection of the data in Table 6 reveals that the main effect of phase of testing is interpretable. All of the children increased their targets-correct scores from the pretest to the immediate and delayed posttests. The main effect of age can also be interpreted. In general, 7-year-old children identified more targets correctly than did the 5-year-old children. There is one exception to this pattern which occurs in the 20 Questions training group. On the immediate posttest, the 5-year-olds had slightly higher targets-correct scores than did the 7-year-olds in that condition.

In order to clarify the Treatment x Phase, and the Age x Sex x Phase interactions, separate analyses of variance were performed on the pretest and the posttest

data. Age, sex, and treatment condition were factors in both analyses. Phase of testing was also a variable in the posttest analysis. The analysis of the pretest data revealed a significant main effect of age, $F(1,112) = 7.72$, $p<.01$. This reflects the fact that the 7-year-olds identified more targets correctly than did the 5-year-olds on the pretest measure.

The analysis of the posttest data revealed significant main effects of age, $F(1,112) = 29.06$, $p<.001$, and treatment condition, $F(3,112) = 11.27$, $p<.001$. Inspection of the data in Table 6 indicates that the 7-year-old subjects identified more targets correctly on the posttests than did the 5-year-olds, and that experimental subjects at both ages identified more targets correctly than did control subjects.

The posttest analysis also revealed a significant Age x Sex x Phase of Testing interaction, $F(1,112) = 6.08$, $p<.05$, which was higher order to the significant main effect of phase of testing, $F(1,112) = 31.74$, $p<.001$. The data in Table 7 indicates that the phase variable is interpretable. All of the subjects improved their targets-correct score from the immediate to the delayed posttest. Inspection of the data in Table 7 also reveals that the significant interaction primarily reflects the performance of the 7-year-old females on the immediate posttest. They scored

significantly higher than any of the other subjects at that time of testing, $F(1,224) = 27.71$, $p<.001$.

Categorical questions. The data on the number of categorical questions asked during the listener tasks are presented in Table 8. As was defined above, a categorical question is one which eliminated more than one item at a time from the array of possibly correct targets. When performing the listener task, a child must ask categorical questions following a speaker's ambiguous message in order to identify the target referent correctly. A single-item question represents a guess, and the child is scored as incorrect on that trial. The number of categorical questions required to identify the target depends on the degree of ambiguity of the speaker's message. Thus, the child must ask one, two, or three questions, depending on whether the speaker's message leaves two, four, or eight possible alternatives correct. When the speaker's message is unambiguous, a child can identify the target referent with a single-item question. The data in Table 5 indicates that in this condition the children's identification of correct targets was very accurate. Also, when a child has narrowed down the number of possible alternatives in a speaker's message by asking categorical questions, he/she can then identify the target with a single-item question.

Since both the maximum and minimum number of single-item questions that a child can ask on either correct or incorrect trials is one, the data on the number of single-item questions asked does not provide any useful information, and was not included in the analysis.

A 2(Age) x 4(Treatment Condition) x 2(Sex) x 3(Phase of Testing) x 3(Degree of Message Ambiguity) analysis of variance was performed on the data in Table 8. This analysis revealed a significant Age x Treatment Condition x Phase of Testing x Degree of Message Ambiguity interaction, $F(12,448) = 2.05$, $p<.05$, which was higher order to the significant main effects of age, $F(1,112) = 40.81$, $p<.001$, treatment condition, $F(3,112) = 9.00$, $p<.001$, phase of testing, $F(2,224) = 273.16$, $p<.001$, and degree of message ambiguity, $F(2,224) = 2,224) = 321.19$, $p<.001$, and the significant interactions of Age x Degree of Message Ambiguity, $F(2,224) = 11.83$, $p<.001$, Treatment Condition x Degree of Message Ambiguity, $F(6,224) = 5.36$, $p<.001$, Treatment Condition x Phase of Testing, $F(6,224) = 6.20$, $p<.001$, Age x Treatment Condition x Phase of Testing, $F(6,224) = 3.15$, $p<.01$, and Degree of Message Ambiguity x Phase of Testing, $F(4,448) = 67.20$, $p<.001$. This analysis also revealed a significant interaction of Age x Sex x Phase of Testing x Degree of Message Ambiguity, $F(4,448) = 2.47$, $p<.05$.

Inspection of the data in Table 8 indicates that only the main effect of phase of testing can be interpreted. Subjects in all groups increased the number of categorical questions they asked from the pretest to the posttests. In order to clarify the Age x Treatment Condition x Degree of Message Ambiguity x Phase of Testing interaction and the Age x Sex x Degree of Ambiguity x Phase of Testing interaction, separate analyses of variance were performed on the pretest and posttest data. Age, sex, treatment condition, and degree of message ambiguity were factors in both analyses. Phase of testing was also a variable in the posttest analysis.

The results of the pretest analysis revealed significant main effects of age, $F(1,112) = 15.41$, $p<.001$, and degree of message ambiguity, $F(2,224) = 5.86$, $p<.001$. These results reflect the fact that the 7-year-olds asked more categorical questions on the pretest than did the 5-year-olds, and that, in general, more categorical questions were asked at the higher levels of ambiguity.

The posttest analysis revealed significant interactions of Age x Degree of Message Ambiguity, $F(2,224) = 10.31$, $p<.001$, and Treatment Condition x Degree of Ambiguity, $F(6,224) = 5.82$, $p<.001$. These were higher order to the significant main effects of age, $F(1,112) = 25.48$, $p<.001$, treatment condition, $F(3,112) = 12.91$, $p<.001$, and

degree of message ambiguity, $F(2,224) = 410.31$, $p<.001$. Inspection of the posttest average data in Table 8 reveals that the main effects of treatment condition and degree of message ambiguity can be interpreted. Experimental group subjects at both age levels asked more categorical questions than did control group subjects. Also, all of the subjects increased the number of categorical questions they asked as the degree of ambiguity in the speaker's message increased.

The significant interactions of Age x Ambiguity and Treatment Condition x Ambiguity primarily reflect the performance of the 5-year-old children in the control group. These children asked fewer categorical questions on the posttests than did any of the other groups, at all levels of message ambiguity, $F(1,112) = 148.57$, $p<.001$. Both 5- and 7- year-old children in the other treatment conditions increased the number of categorical questions they asked on the posttests. However, the 5-year-olds who were given Listener training, or the combination of both Listener and 20 Questions training, and the 7-year-olds in the control condition showed less improvement in performance than did the 5-year-olds in the 20 Questions group and the 7-year-olds in the three experimental groups, $F(1,112) = 9.68$, $p<.001$).

The posttest analysis also revealed a significant interaction of Age x Sex x Phase of Testing x Degree of

Message Ambiguity, $F(2,224) = 4.39$, $p<.05$, which was higher order to the significant main effect of phase of testing, $F(1,112) = 13.03$, $p<.001$. The data are presented in Table 9. This interaction reflects the fact that among the 5-year-old children, females asked more categorical questions than did the males on the second posttest, at the level of message ambiguity which left four possible alternatives correct. Among the 7- year-old children, females asked more categorical questions than did the males on the first posttest at the level of message ambiguity which left four possible alternatves correct. The reason for these differences is not clear.

In summary, the targets-correct data and the categorical questions data were consistent. On the pretest measures the 7-year-olds asked more categorical questions than did the 5-year-olds, and thus identified more targets correctly. On the immediate and delayed posttests all children improved their performance, asking more categorical questions and identifying more targets correctly. However, this improvement was marginal among the 5-year-old control children. The 5-year-olds who had been given 20 Questions training performed almost as well as the 7-year-olds in that condition. As message ambiguity increased, children asked more categorical questions, as the task required. On both dependent measures, experimental group subjects performed

more efficiently than did control group subjects. Thus, there were significant effects of training at both age levels on the listener task.

Discussion

Perceptual Scanning Task

The results of the perceptual scanning task supported the first hypothesis of this study. It had been predicted that children at both age levels would be capable of conducting an exhaustive search of a stimulus array while attempting to locate targets which fitted a speaker's verbal description. In fact, both 5- and 7-year-old children made very few errors either of inclusion or exclusion on this task. This finding has implications for the literature on children's referential communication skills. It had been suggested by some researchers that an important reason why young listeners perform poorly on standard referential tasks is that they fail to detect ambiguities in a speaker's message. This was presumed to occur because they didn't conduct an exhaustive search of the stimulus array, checking each potential target with the characteristics of the message. Instead, they terminated their search after the first appropriate target was located. Since the children in the present study generally did conduct an exhaustive search on the scanning task, they are clearly capable in this regard.

Although it has been shown that children can search exhaustively, it is still a possibility that they sometimes

fail to do so in the referential communication situation. This possibility was addressed by Whitehurst and Sonnenschein (1978). They found that when 5-year-old speakers were given explicit perceptual instructions to tell about how a referent "looked different" from the nonreferents, they were able to do so more efficiently than subjects who had not been given such explicit instructions. They concluded that children know how to make comparisons but do not realize that comparison is relevant to effective referential communication. It is not unreasonable to assume that the same generalization may apply to children's listener performance. Although they can make an exhaustive search of a stimulus array when searching for targets with specified characteristics, as in the scanning task reported in this study, they may fail to see that the listener role in referential communication also requires exhaustive scanning. Thus, knowing that children can search exhaustively does not insure that they will do so.

It is also possible that children simply adopt a different criterion for selecting a target in the perceptual scanning and listener tasks. On the listener task children are instructed to look for one target. Young children may interpret this to mean "any one target". Thus, they may terminate search following identification of the first appropriate target without searching for others. In the

perceptual scanning task the child knows he/she is usually looking for more than one target, and thus keeps searching.

Although incomplete scanning was infrequent on this task, it did contribute to errors made in some instances. A few of the children responded impulsively following the message and did not scan carefully. Thus, they terminated their search prematurely. It is also possible that children made errors because they misinterpreted the task requirements. Some of the children indicated puzzlement when the speaker's message required them to identify all eight of the targets, or only one of the targets. The instructions ("Point to all the pictures that show. . .") may have created an expectation that they should identify less than eight or more than one of the targets. This was especially evident on the pretest trials. In these instances the children took longer to respond, and gave more nonverbal signs of confusion; seeming more thoughtful than impulsive.

Twenty Questions and Listener Tasks

The second hypothesis that this study was designed to test was also confirmed. It had been predicted that since the 20 Questions and listener tasks had many cognitive requirements in common, training children to perform either one of the tasks would generalize to their performance on the other task. Children at both age levels who were

trained on a modified version of the 20 Questions task were able to generalize the training to their performance on the listener task. Similarly, children who were trained on a referential listener task were able to generalize the training to the 20 Questions task. It is important to note that both Listener training and 20 Questions training involved direct instruction in the technique of asking categorical questions. The success of these training procedures in producing a high level of performance and cross-task generalization supports the basic assumption that both the 20 Questions and Listener tasks can be viewed as information-seeking problems which are highly similar in their cognitive and task requirements. Correlational analyses between the training task scores and the generalization task scores for subjects within age by group cells might provide additional support for this assumption. However, such analyses were not carried out on the present data because the children's 20 Question scores on the posttests were too near ceiling.

Twenty questions. The children's pretest performance on the modified 20 Questions task was consistent with that reported by previous investigators. When 5-year-old children were given this task they asked very few categorical questions. Instead, they adopted a strategy of guessing, or asking single-item questions. Consequently, they correctly

identified very few of the targets within the permitted number of questions. The 7-year-old children asked significantly more categorical questions on the pretest and, thus, correctly identified more targets than did the younger children. However, they did not use this strategy reliably. These data are consistent with the early report by Mosher and Hornsby (1966). They found that children between 6- and 8-years-old begin to acquire the strategy of asking categorical questions. These children tended to switch from categorical to single-item questions on a given problem, a strategy labeled "pseudo-constraint seeking" by Mosher and Hornsby.

Posttest performance indicated that 7-year-olds given Listener training, 20 Questions training, or a combination of both types of training all performed at near ceiling level on the immediate posttest, and maintained their level of performance on a follow-up test a week later. These children readily adopted the strategy of using categorical instead of single-item questions to narrow in on the correct target. The 7-year-olds in the control group also performed at near ceiling level, their performance being only slightly poorer than that of the trained children. It would seem that the ability to ask categorical questions was in the repetoire of these children, and mere exposure to the task, either through training or practice

was sufficient to elicit the strategy.

The 5-year-old children also improved their 20 Questions posttest performance following training. Children who had been given 20 Questions training or the combination of 20 Questions and Listener training asked almost as many categorical questions and correctly identified as many targets as did the older children. They were also able to generalize the Listener training to their 20 Questions performance, being only marginally less efficient in this condition. However, 5-year-old children in the control group who received only practice with the tasks, showed only marginal improvement on the posttests.

The facility with which the younger children were able to acquire the categorical question strategy suggests that they already possessed the relevant sub-skills (scanning, asking questions, classification) prior to training. Exposure to training helped them to coordinate the components and to use them efficiently to solve 20 Questions problems. However, direct instruction was necessary for these children. Mere exposure to the task was insufficient to elicit the strategy.

This posttest performance of the children in both age groups is generally consistent with the existing 20 Questions literature. The subjects in this study readily increased the number of categorical questions and decreased

the number of single-item questions they asked following direct instructional feedback from the experimenter to do so. The older children were also able to adopt this strategy following practice with the task. This finding is also consistent with the age norms reported by Mosher and Hornsby (1966) which indicated that at about eight years of age, children begin to ask categorical questions spontaneously. The results of this study further indicate that adopting a strategy of asking categorical questions increases problem-solving efficiency. The children identified more targets correctly following adoption of the appropriate strategy, and did so with the minimum number of questions. The effectiveness of asking categorical questions on problem solving efficiency has not been clearly demonstrated in the previous literature.

Listener task. The results of this study also indicated that young children can perform competently as listeners in a referential communication task situation. When the speaker's message was fully informative, children at both age levels were able to correctly identify the referent. Their performance was near ceiling level without any training. This is consistent with the results of other research and is yet another indication that young children can keep a speaker's message in working memory while scanning a stimulus array in search of a match, terminating

their search only when it has been located. However, when the message is fully informative there is no ambiguity to be identified, so terminating search with the identification of the first match results in a correct choice.

In contrast, when the children were given an ambiguous message on the pretest, their performance was poor. The pretest scores showed that very few categorical questions were asked and, consequently, very few target referents were correctly identified. Instead, children asked single-item questions, which reflected the use of a guessing strategy. The pretest performance of the 5-year-olds was significantly poorer than that of the 7-year-olds, although the latter asked categorical questions infrequently. These children guessed at the identity of the correct referent in spite of having been forewarned that some of the messages would be unclear and that they could ask questions of the speaker if they were uncertain.

This inadequate listener performance is typical of that observed by other researchers with children of this age. Two types of explanations have traditionally been offered. The first is that children fail to complete the nesessary comparison activity needed to detect the ambiguity in the message. As discussed above, this could occur either because the children were unable to complete the comparisons, or because of a "metacommunicative" deficit

whereby they fail to realize that in the referential communication task the speaker's message has to fit the target uniquely. Thus, they adopt a different standard for selecting the correct target. The second explanation is that children can make exhaustive comparisons and do detect the ambiguities, but do not realize that the next thing that they have to do is ask for more information. This could also be considered a problem in metacommunication. Since common observation indicates that young children can and do ask questions, it may be that they do not see the necessity of doing so in this particular situation. There is considerable evidence to support this latter explanation. Cosgrove and Patterson (1977,1978) found that giving children a plan for effective listening which emphasized the importance of asking questions to resolve ambiguity produced a significant improvement in listener performance of 6-, 8-, and 10-year-old children, but not in 4-year-olds. This plan was more effective than one which emphasized making comparisons. They concluded that the children were already making comparisons but needed to be aware of the follow-up strategy of asking questions, or of indicating in some manner, the need for more information. Similar conclusions were reached by other researchers (Meissner, 1978; Pratt & Bates, 1982; Whitehurst & Sonnenschein, 1983).

The results of the present study also support the

conclusion that getting children to ask questions is the critical skill needed to improve their listener performance on the referential task. In addition, the results of this study indicated that children not only must be made aware of the need to ask questions, but specifically, that they should ask categorical questions. They need to know not only when to ask questions, but also what type of questions to ask. The posttest performance of children in both age groups showed a significant improvement in listener performance following training procedures which provided them with direct instruction in the technique of asking categorical questions. All children asked fewer single-item questions, and identified more referents correctly following this training. The trained children maintained, and further improved their performance on a delayed posttest a week later. They also asked more categorical questions as the degree of message ambiguity increased. Children in control conditions who received only practice remained significantly poorer in their performance than did the experimental children. The poorer performance of the 7-year-old control children on the listener task contrasts with their performance of the 20 Questions task. In the latter condition, mere exposure to the task through practice resulted in a significant improvement in their performance on the posttests. It should be noted however, that although

the listener performance of these older children was inferior to that of their trained peers, they did show more improvement on the posttests than did the 5-year-old control children. This was especially evident on the delayed posttest.

It is important to recall that as was the case with the 20 Questions task, the same training procedure was presented to the children in one of two different contexts. Children were either trained to ask categorical questions in the context of a 20 Questions task or in the context of a listener task. For another group these two contexts were combined. The posttest results showed that children at both age levels were able to benefit from direct training on the listener task, but were also able to improve their listener performance following 20 Questions training.

Although teaching children to ask categorical questions in either of these contexts was effective in improving listener performance, the younger children seemed to find it easier to generalize the technique of asking categorical questions following 20 Questions training. The 5-year-old children in this condition performed better than their peers, and as well as the 7-year-old experimental children on the listener task. This somewhat unexpected finding may be attributable to the different information processing demands of the two tasks. Performance of both

the 20 Questions and Listener tasks required the children to scan, categorize and ask questions. However, performance of the Listener task also required that the children check for ambiguity between the speaker's message and the characteristics of the targets in the array. Thus, the strategy of asking categorical questions may have been more salient in the context of the 20 Questions training procedure. The 5-year-olds who were given listener training or the combined training also improved significantly on the posttests, as did the 7-year-old control children, but their performance was not as efficient as that of the former groups. The 5-year- old control children who received practice on the tasks showed only marginal improvement on the posttests.

The significant training effects obtained with the 5-year-old children in this study contrasts with the results reported by other investigators who were less successful in demonstrating competent listener performance in children of this age (Cosgrove & Patterson, 1977,1978; Ironsmith & Whitehurst, 1978a, 1978b). Furthermore, the stimulus arrays used to evaluate performance in the present study were more complex than those used by other researchers who did report some training effects. Children in this study were presented with eight item arrays which consisted of stimuli that varied on three dimensions, with two values on each dimension (medium complexity). Most frequently, researchers

have presented children with four item arrays consisting of stimuli that varied on two dimensions, with two values of each dimention (low complexity). Some have used even simpler two item arrays. Although it was not a training study, Patterson et al (1981) studied the effects of stimulus complexity on comprehension monitoring in a listener task and reported that 5-and 7-year-old children did not indicate the need for more information following an ambiguous message when presented with high and medium complexity arrays, although the 7-year-olds did do so with low complexity arrays. Whitehurst and Sonnenschein (1981, 1983) found that 5-year-old children could be trained as listeners if they could point to a "bad message button" following a speaker's ambiguous message. However, the children were not required to formulate any question to elicit the missing information. The training procedure involved giving the child corrective feedback following an error, which pointed out that the speaker had not told how the targets looked different, and that the child must have been guessing. Pratt and Bates (1982) found that 4-year-old children, trained with a verbal self-regulation procedure to indicate that they "needed to ask a question", did so following a message containing an ambiguous pronoun. The type of questions asked was not discussed in this study. The focus was on children's ability to monitor their own

comprehension, operationally defined as a recognition of the need for more information.

Conclusion

The successful cross-task generalization demonstrated by children at both age levels indicates that, as predicted, the 20 Questions and referential listener tasks have similar requirements. These results support the conclusion that both tasks can be viewed as problems in information-seeking, the solution to which requires the child to ask categorical questions.

However, while they are highly similar, the two tasks are not isomorphic. Children at both age levels found the listener task to be somewhat more difficult than the 20 Questions task. The performance of all of the experimental group children, and that of the 7-year-old control children, reached near ceiling level on the 20 Questions task by the first posttest. In contrast, performance on the listener task improved on both the first and second posttests, but did not approach ceiling level in any of the groups. There are a number of reasons which might explain the discrepency in children's performance on these two tasks. For example, observation of the children performing the listener task suggested that they found it to be puzzling. In natural conversation, adults do not deliberately give ambiguous messages to children. As Grice (1975) has argued, reciprocal conversations usually require listeners to employ a cooperative principle, by which they assume that speakers

seek to be informative, relevant, truthful, and clear. Furthermore, when conversational information is ambiguous, to guess at what the speaker means is usually an appropriate strategy. Their guess will generally be followed by feedback which informs them that they have made a correct or an incorrect response. In the latter case, the adult will generally supply the missing information automatically, the child does not have to request it specifically. An incorrect guess certainly does not terminate the interaction as it does in the referential task situation.

Ackerman (1978, 1981) has argued that young children have learned to respond to ambiguity in natural conversational exchanges with a "performative" bias by which they feel under obligation to produce a referent if it is possible to do so. Thus, as long as the referent fits (or almost fits) the message, the child will select it. Ackerman has shown however, that even 6-year-old children are sensitive to the fact that it is not always appropriate to select an ambiguous referent, that in some contexts only a unique referent will do. Thus, children look to contextual variables, such as the speaker's intent, his/her degree of certainty or authority, and the net cost to the listener of selecting an approximately correct target versus continuing to search for a unique target, before responding to a message. In natural settings, understanding is not simply a

function of decoding a message, as it is in referential comunication, but also of interpreting contextual variables. The child in the referential listener situation has to realize the speaker's intent is that the target must fit the message uniquely, and that ambiguity has to be resolved by careful decoding of the message and by requesting additional information.

The effectiveness of the training procedure used in the present study may be attributable to the explicit instructional feedback that was provided to the children. They were told that the appropriate response to an ambiguous message was to ask categorical questions, and not to simply take a guess. In this way, the children may have been relieved of the need to interpret an important contextual variable (i.e., the speaker's intent), and were thus able to focus their attention on decoding the message. The decoding process was perhaps facilitated by the presence of the perceptual array which enhanced detection of the dimensions along which stimuli could be compared and contrasted, and along which ambiguity could occur. Consequently, asking categorical questions was not difficult under these conditions. In comparison, there is never this problem with interpreting ambiguity in the 20 questions task. No messages are given by the speaker. The child knows that he/she has to elicit all the information necessary to solve

the problem. Thus, although solving the listener problem may not seem to make greater task demands than solving the 20 questions problem, it may take children a little longer to adapt their usual listener behavior to cope with the ambiguity in the referential task.

It is also possible that, although young children can conduct an exhaustive search and comparison process as they did on the perceptual scanning task, they may not always do so on the listener task. It may be difficult for young children to remember on each trial that "the special one" is unique, and that finding one target that fits the speaker's description does not mean that they should terminate their search. For example, as the children in this study began to acquire the strategy of asking categorical questions during training, some of them used it inconsistently. They would sometimes ask one or two categorical questions, and, although the ambiguity of the speaker's message required that they ask one or two more, they would revert to single-item questions and fail to identify the target correctly. It is possible, then, that the necessity of checking the message against each target, and rechecking the message with the target as each new piece of information is obtained, is an additional requirement that makes the listener task genuinely more difficult than, and different from, the 20 Questions task.

Although the children in this study found the listener task to be somewhat more difficult than the 20 Questions task, training them to ask categorical questions improved their performance on both tasks. Clearly, effective information- seeking is an important skill with potential application to the solution of a variety of problems. It is also possible that the training procedures employed in this study might generalize to children's performance as speakers in a referential communication task. Transfer from speaker to listener performance, and vise versa, has been very difficult to demonstrate (Whitehurst & Sonnenschein, 1983). This is a question for future research.

It might also be useful to try to improve the listener performance of preschool children by instructing them in the strategy of asking categorical questions. While attempts to train referential listener skills in children of this age group have been uniformly unsuccessful, Denny et al (1979) found that 4-year-olds improved their 20 Questions performance following direct instructions in how to ask categorical questions. Furthermore, Pratt and Bates (1982) showed that 4-year-olds could be trained to indicate non-comprehension following an ambiguous message. This also is a question for further research and is presently under investigation.

Table 1

Mean Number of Errors on the Perceptual Scanning Task as a Function of Age, Sex, and Number of Targets Required

Targets required	Age			
	5 yrs.		7 yrs.	
	Male	Female	Male	Female
1[a]	.291	.125	.125	.031
2[a]	.240	.063	.125	.125
4[a]	.021	.000	.177	.010
8[b]	.063	.063	.417	.155

Note, Number of errors possible.

[a] eight

[b] seven

Table 2

Mean Number of Errors on the Perceptual Scanning Task as a Function of the Phase of Testing and the Number of Targets Required

Targets required	Phase of testing		
	Pretest	Posttest 1	Posttest 2
1[a]	.219	.055	.102
2[a]	.172	.117	.125
4[a]	.055	.070	.031
8[b]	.250	.227	.016

Note. Number of errors possible

[a] eight

[b] seven

Table 3
Mean Number of Targets Correctly Identified On the Twenty Questions Task

Treatment condition	Phase of testing	Age 5 years	Age 7 years
Twenty questions	Pretest	.188	.500
	Posttest 1.	1.000	1.000
	Posttest 2.	.938	1.000
	Posttest mean	.969	1.000
Listener	Pretest	.000	.437
	Posttest 1.	.813	1.000
	Posttest 2.	.875	1.000
	Posttest mean	.844	1.000
Twenty questions and listener	Pretest	.188	.563
	Posttest 1.	1.000	1.000
	Posttest 2.	1.000	1.000
	Posttest mean	1.000	1.000
Control	Pretest	.188	.437
	Posttest 1.	.250	.813
	Posttest 2.	.250	.938
	Posttest mean	.250	.875

Note. One is a perfect score in each cell.

Table 4

Mean Number of Categorical (C) and Single-Item (SI) Questions Asked on the Twenty Questions Task

Treatment condition	Phase of testing	Age: 5 years C[a]	Age: 5 years SI[b]	Age: 7 years C[a]	Age: 7 years SI[b]
Twenty questions	Pretest	.375	7.063	1.312	4.750
	Posttest 1.	2.625	1.437	2.750	1.375
	Posttest 2.	2.688	2.000	2.875	1.250
	Posttest mean	2.656	1.719	2.813	1.313
Listener	Pretest	.000	8.000	1.125	5.250
	Posttest 1.	2.000	2.875	2.875	1.375
	Posttest 2.	2.250	2.438	2.938	1.062
	Posttest mean	2.125	2.656	2.907	1.219
Twenty questions and listener	Pretest	.375	7.000	1.688	4.375
	Posttest 1.	2.625	1.375	3.125	1.062
	Posttest 2.	2.813	1.250	2.938	1.125
	Posttest mean	2.719	1.313	3.032	1.094
Control	Pretest	.562	6.688	1.125	5.250
	Posttest 1.	.750	6.250	2.500	2.250
	Posttest 2.	.750	5.813	2.750	1.750
	Posttest mean	.750	6.032	2.625	2.000

Note. Optimal score in each cell.

[a] Three

[b] One

Table 5

Mean Number of Targets Identified Correctly on the Listener Task as a Function of Message Ambiguity

Treatment group	Ambiguity	5 years Pretest	5 years Posttests 1	5 years Posttests 2	5 years Posttests mean	7 years Pretest	7 years Posttests 1	7 years Posttests 2	7 years Posttests mean
20 Q	1	1.000	1.000	1.000	1.000	.937	1.000	1.000	1.000
	2	.125	.625	.875	.750	.313	.437	.875	.656
	4	.000	.500	.813	.656	.125	.563	.750	.656
	8	.063	.563	.688	.625	.313	.625	.875	.750
Listener	1	.875	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	2	.000	.500	.563	.531	.125	.813	1.000	.906
	4	.000	.563	.688	.625	.250	.625	.938	.781
	8	.000	.500	.688	.594	.187	.750	.813	.781
20 Q and listener	1	.938	1.000	.938	.969	1.000	.938	1.000	.969
	2	.000	.688	.625	.656	.250	.813	.875	.844
	4	.000	.500	.563	.531	.250	.938	1.000	.969
	8	.062	.375	.625	.500	.062	.813	.938	.875
Control	1	1.000	1.000	.938	.969	.938	.938	1.000	.969
	2	.062	.187	.250	.219	.438	.500	.813	.656
	4	.000	.125	.250	.182	.125	.375	.688	.531
	8	.000	.187	.125	.156	.062	.500	.750	.625

Note. One is a perfect score. Ambiguity levels 1, 2, 4, and 8 leave 1, 2, 4, or 8 targets possibly correct, respectively.

Table 6

Mean Number of Targets Correctly Identified on the Listener Task as a Function of Age, Treatment, and Phase of Testing

Treatment condition	Phase of testing	Age: 5 years	Age: 7 years
Twenty questions	Pretest	.062	.250
	Posttest 1.	.563	.542
	Posttest 2.	.792	.833
	Posttest mean	.677	.688
Listener	Pretest	.000	.187
	Posttest 1.	.521	.729
	Posttest 2.	.646	.917
	Posttest mean	.583	.823
Twenty questions and listener	Pretest	.021	.187
	Posttest 1.	.521	.855
	Posttest 2.	.604	.938
	Posttest mean	.563	.897
Control	Pretest	.021	.208
	Posttest 1.	.166	.458
	Posttest 2.	.208	.750
	Posttest mean	.187	.604

Table 7

Mean Number of Targets Correctly Identified on the Listener Task as a Function of Age, Sex, and Phase of Testing

Phase of testing	Age			
	5 years		7 years	
	Male	Female	Male	Female
Posttest 1	.448	.438	.542	.750
Posttest 2	.521	.604	.860	.865

Table 8
Mean Number of Categorical Questions Asked on the Listener Task as a Function of Ambiguity, Age, Treatment, and Phase

Treatment	Ambiguity	5 years Pretest	5 years Posttests 1	5 years Posttests 2	5 years Posttests mean	7 years Pretests	7 years Posttests 1	7 years Posttests 2	7 years Posttests mean
20 Q	2	.125	.625	.938	.781	.438	.500	.875	.688
	4	.188	1.375	1.625	1.500	.563	1.438	1.688	1.563
	8	.188	2.375	2.625	2.500	1.188	2.438	2.687	2.563
Listener	2	.000	.500	.688	.594	.250	.875	1.000	.937
	4	.000	1.375	1.438	1.406	.563	1.563	1.938	1.750
	8	.063	2.125	2.250	2.188	.750	2.750	2.812	2.781
20 Q/ Listener	2	.000	.688	.563	.625	.375	.813	.875	.844
	4	.000	1.375	1.438	1.406	.813	1.875	2.000	1.937
	8	.188	1.875	2.500	2.188	.750	2.687	2.937	2.812
Control	2	.063	.250	.250	.250	.438	.563	.813	.688
	4	.125	.375	.500	.438	.688	1.125	1.500	1.313
	8	.188	.688	.688	.688	.500	2.125	2.500	2.313

Note. Message ambiguity levels 2, 4, or 8 leave two, four, or eight alternatives correct, respectively. Thus, one, two, or three questions, respectively, are needed to obtain the necessary information.

Table 9

Mean Number of Categorical Questions Asked on the Listener Task as a Function of Age, Sex, Phase of Testing, and Degree of Ambiguity

Phase of testing	Ambiguity	Age: 5 years Male	Age: 5 years Female	Age: 7 years Male	Age: 7 years Female
Posttest 1.	2	.563	.469	.625	.750
	4	1.125	1.125	1.250	1.750
	8	1.688	1.844	2.500	2.500
Posttest 2.	2	.594	.625	.875	.906
	4	1.094	1.406	1.813	1.750
	8	2.000	2.031	2.688	2.781

Note. For ambiguity levels 2, 4, and 8, the number of questions needed to get the information necessary for target identification is one, two, or three, respectively.

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