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Locating Objects and Communicating About Locations: Organizational Differences in Children's Searching and Direction-Giving

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Two studies examined spatial organization reflected in searches for objects and descriptions of locations. Six-year-olds and adults retrieved objects hidden on the floors of a house or directed another person about how to retrieve them. Of particular interest was whether children's searches and directions reflected clustering of locations by floors. Six-year-olds' searches were more organized than their directions, but a follow-up study demonstrated that they could produce organized directions if prompted. Analyses of the content and structure of spatial information in directions indicated that children and adults communicated the information in an order of decreasing size of spatial unit. Results are discussed in terms of factors underlying spatially organized searching and direction-giving.

Locating objects and places is a practical task that occupies a great deal of everyday human and animal behavior. A major concern of infants and young children, for example, is finding and maintaining proximity to their primary caregiver (Carr, Dabbs, & Carr, 1975). Adults also spend a considerable amount of time searching for valued items such as car keys, checkbooks, and papers containing important pieces of information. Likewise, children and adults frequently are confronted with requests from others to tell them the whereabouts of missing objects. A daily routine in many households, for example, is getting children to describe where they put their shoes or the last place they remember seeing their homework. Clearly, children's skill in searching for missing objects and describing their whereabouts has important practical consequences. Understanding these skills also has theoretical implications for understanding the development of children's referential communication skills and how spatial information is extracted from the surrounding environment and from memory.

Children as young as 4 years are capable of spatially organized searches in situations in which there are relatively few locations that are subdivided into a small number of spatial clusters. For example, Wellman, Somerville, Revelle, Haake, and Sophian (1984) found that 4- and 5-year-olds minimized the number of traverses they made between two clusters of locations while retrieving Easter eggs they had previously seen hidden in five buckets on a playground. Similarly, Cornell and Heth (1986) found that both 5- and 7-year-olds hid objects in spatial clusters and tended to search those clusters exhaustively when later retrieving the objects. These results suggest that the ability to use spatial organization to guide activity within the physical environment emerges fairly early in development.

One issue these results raise is whether young children are also capable of communicating information about locations in a spatially organized fashion. The major goal of spatial direction-giving is to organize the directions in a way that enables the listener to find the objects in an efficient manner. Most obviously, this pertains to the order in which the direction-giver describes how to find the objects. Although previously overlooked, another important hallmark of organized directions is the order in which the direction-giver describes spatial information about an individual location. When telling someone how to find an object in a multilevel space, it is very useful to communicate the spatial information needed to find the object in a way that narrows the listener's search. Little is known, however, about the information children and adults select to describe locations, or how this information is structured to form complex descriptions of spatial location.

There are two major factors that may influence young children's ability to organize their spatial directions. The first is the ability to take the listener's perspective. This involves an understanding of the status, knowledge, and ability of the listener. Numerous studies within the referential communication literature suggest that young children are sensitive to the needs of the listener. For example, when communicating with a blindfolded listener or a younger child, preschoolers modify their speech to accommodate the listener's needs (Maratsos, 1973; Shatz & Gelman, 1973). However, there has been little systematic investigation of the development of children's sensitivity to the listener's needs in more complex communication tasks such as spatial direction-giving.

Another factor that may influence the extent to which young children use spatial organization in their directions is their ability to systematically retrieve spatial information from memory.

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In the referential communication literature, this type of ability is part of children's substantive knowledge, or domain-specific knowledge (Sonnenschein & Whitehurst, 1984). According to Linde and Labov (1975), systematic retrieval of spatial information is often aided by using a mental-walk strategy in which the speaker imagines the listener's movement along a route. One advantage of using imagined movement is that it can be used to transform a difficult recall task into a recognition task. When describing how to find several objects in a house, for example, one can imagine the listener walking through the layout and use this information to cue memory for nearby locations. Gauvain and Rogoff (1989) have shown that children's descriptions of relatively unfamiliar spatial layouts do not exhibit characteristics of a mental-walk strategy until sometime between 8 and 10 years. One apparent result of young children's failure to use a mental-walk strategy is that their descriptions of spaces tend to lack spatial and temporal organization. When young children describe how to find something, their directions focus immediately on the target without describing how to get there from one's present location (Weissenborn, 1980).

The research on children's searching and direction-giving reviewed here suggests that children as young as 4 years are capable of carrying out organized searches in simple situations and that children under 8 years of age have difficulty producing spatially organized directions. To date, however, there have been no direct comparisons of young children's searching and direction-giving abilities. The two skills are clearly related to one another because giving directions essentially involves organizing the listener's search. Six years of age may represent a transitional age in which children are more likely to produce spatially organized searches than directions. If so, one would expect that the organization of children's directions might be aided by experience with organized searching, and that increased contextual support on the part of an adult listener might also increase the organization of young children's directions.

The goals of the two experiments reported here were threefold. The first was to directly compare 6-year-olds' ability to carry out spatially organized searches for objects with their ability to provide spatially organized directions for a listener about those same objects. The second was to investigate the factors that affect young children's ability to give organized directions. Finally, our third goal was to examine the kinds of information children and adults select to describe object locations and how they organize such information in their discourse.

Children's searching and direction-giving were compared in the first experiment using a modification of the procedure developed by Menzel (1973) in his studies of chimpanzee foraging and spatial memory organization. In the present investigation, children accompanied an experimenter and helped hide nine small identical objects along a disorganized route on the three levels of their home. Half of the children then searched for the objects and the other half gave directions to another person about how to go find the objects. To examine how experience with one task influenced performance on the other task, we asked children who searched first to give directions afterward and children who gave directions first to search for the objects afterward. We also included a group of adults for comparison purposes to examine how they approached the problems of searching and direction-giving. We chose a familiar, multilevel space as the context in which to examine spatial organization in searching and direction-giving because the representational demands of a situation are greatly reduced when children are familiar with the testing space and because locations are physically and perceptually subdivided into floors. Of particular interest in the present investigation was whether the order in which young children searched for objects and described how to find objects reflected an attempt to cluster locations by floors.

If children produce less spatially organized directions than searches, there are a number of possible reasons why this might be the case. In our second study we examined whether 6-year-olds have the necessary spatial knowledge to produce organized directions. As in the first experiment, children hid several identical objects along a random route in their home and later gave directions to a listener for finding those objects. To examine whether children knew which objects were nearby each other, we asked one group of 6-year-olds to provide directions about the next closest object each time they finished describing a location. We compared their directions with another group of 6-year-olds who were given no such prompts. We hypothesized that if children's knowledge of the distances among the objects is inaccurate, then prompting them to provide spatially organized directions will not help. In addition, to examine whether increasing the salience of the listener's efforts to retrieve the objects resulted in more organized direction-giving, we asked all children in the second study to give directions to their listener through walkie-talkies.

Finally, to explore the issue of the kinds of information children and adults convey in their spatial directions, we devised a coding system for analyzing the content and structure of the information children and adults communicated to their listener. In particular, we focused on the kinds of spatial relations expressed, the presence or absence of basic units of spatial information (i.e., floors, rooms, and landmarks), and the extent to which these units of spatial information were referred to in a hierarchy of increasing specificity with respect to inclusiveness of physical area. This coding system was applied to data from both studies and is reported in a separate section following Study 2.

Study 1

Method

Subjects

Thirty-two 6-year-olds (M = 6 years 6 months, range = 5 years 7 months to 7 years 4 months) and 14 adults (M = 30 years 9 months, range = 19 years 0 months to 41 years 1 month) participated. There were 16 girls and 16 boys in the 6-year-old group and 6 women and 8 men in the adult group. All children were from middle to upper-middle-class families.

Design and Procedure

Two experimenters visited the children in their own homes. All children lived in three-level homes having, for example, a basement, a first floor, and a second floor. To ensure that both the child and the experimenters were familiar with the location and name of each room, children first gave a tour of their home during which they led the experimenters through the house and labeled each room. The experimenters drew a map of the layout of each floor as they and the child toured the house. After the tour, one of the experimenters explained to the child that the two of them were going to hide nine numbered pieces in different places around the house. (The numbered pieces were part of a calendar with punch-out dates that children received as a gift for participating.) Half of the children were informed that they would have to find the pieces again, and half were informed that they would have to tell the other experimenter how to go find the pieces (children were only given prior information about the first task they were to perform). The child was told that the experimenter would choose the rooms or general areas to hide the pieces, but that he or she would choose the actual hiding spots. The experimenter also instructed the child to hide the pieces out of sight and to choose hiding places he or she would remember. The experimenter led the child to each hiding location and told him or her which number to hide, and then recorded the hiding place the child chose. Immediately after each piece was hidden, the experimenter told the child the room that was the next hiding destination. The starting place was always the middle floor, and there were three hiding locations on each floor. The sequence of hiding locations resulted in a spatially disorganized route through the house that took them up or down a stairway 11 times. The hiding route was designed to be maximally spatially disorganized in that children never hid more than one object before moving on to another floor. After hiding the objects, children returned to the start on the middle floor. For the search task, children were instructed "to go find all of the pieces again." For the direction-giving task, children were seated next to their listener and were instructed by her "to tell me how to go find all of those pieces."

Children were assigned to one of two groups. All children performed both tasks, but the order in which they performed the two tasks varied between groups. In the *search first* condition, the children searched first and gave directions afterward, and in the *directions first* condition, children gave directions and then searched for the objects. Thus, children who gave directions first were asked subsequently to retrieve all of the objects, and children who searched for the objects first were asked subsequently to pretend that all of the objects were still in their hiding places and to give directions to the other experimenter about how to go find them. This resulted in a Task Order (search first vs. directions first) × Trial (Trial 1 vs. Trial 2) factorial design with the first factor as a between-subjects variable and the second as a within-subject variable. This design allowed us to directly compare the searches and directions of the two groups of children both before and after they had experience with the other task. In addition, it was possible to examine the effect that searching had on direction-giving within the search first group and the effect that direction-giving had on searching within the directions first group.

The adults performed the two tasks in their own home or in a house with which they were very familiar. The procedure was identical to that used with children in all regards except that the adults were asked to pretend that they were giving directions to someone who was relatively unfamiliar with their house rather than giving directions to an actual person. Because we were most interested in how adults organized their directions and we expected that they would have no trouble carrying out organized searches, all adults gave directions first and searched afterward. Thus, adults participated only in the directions first condition.

In the search task, the experimenter who helped hide the objects followed the subjects as they retrieved the objects and recorded the order of locations searched. All directions were audiotaped, and the experimenter wrote down the order of locations subjects described for their listener. Subjects were asked to clarify references to particular locations if the experimenter could not determine which location the subject was describing. If a subject had difficulty remembering where another object was, the experimenter gave a neutral prompt such as, "can you think of any other places you went to?" If the subject still could not remember, clues were given until he or she found or described the locations of all nine objects.

Measures

The primary questions addressed in the analyses centered around the organization of children's and adults' searches and verbal directions. The order in which subjects searched for objects and referred to locations in their directions was used to measure organization. At least three principled means of organization for retrieval and direction-giving were available in this situation: (a) ordering corresponding to the order of the hiding route, (b) ordering sequentially by numbered pieces, or (c) ordering by spatial proximity defined by floor of the house. Because preliminary analyses indicated that virtually none of the 6-year-olds or adults used either of the first two strategies, the results focus primarily on the degree of spatial clustering in subjects' searches and directions.[1]

A convenient way of thinking about spatial organization in terms of spatial proximity is the degree of clustering by floor in subjects' responses. Searches or directions that result in a large number of objects retrieved for few stair traversals would imply a high degree of clustering and spatial organization. Therefore, we calculated spatial clustering scores for each subject's search route and verbal directions by dividing the number of objects found (or mentioned) by the number of stair traversals (including those resulting from errors) used to retrieve those objects. The cutoff for number of objects found or mentioned was reached when either the experimenter gave the subject a clue about a location or, in the case of the searches, the number of unsuccessful searches in different locations was not followed by an equal number of consecutive successful searches. This latter criterion was adopted so that subjects were not unnecessarily penalized for looking for a particular object early in their search when they knew where many of the other objects were. The minimum number of stair traversals required to retrieve all nine objects was three. Therefore, the highest clustering score possible was 3.0. On the basis of the 11 stair traversals required to hide all nine objects, the clustering score of the hiding route was .82.

Results

The analyses that follow focus on two aspects of performance. Our primary interest was the organization of the subjects' searches and directions. In particular, was a similar level of organization reflected in children's searches and directions? We used three analyses to address this issue. First, we compared the degree of spatial clustering in 6-year-olds' searches and directions. Second, we compared the degree of spatial clustering reflected in 6-year-olds' and adults' searches and in their verbal directions. Finally, we assessed chance organization by comparing the number of stair traversals in subjects' searches and di-

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[1] Spearman rank order correlations were computed for each subject between the order of the hiding route and the order in which the subject searched for the objects or referred to them in his or her directions. All mean correlations were low, ranging between .04 and .22. To determine whether subjects ordered their searches or directions by number, we also computed Spearman rank order correlations for each subject between a numerical ordering of the pieces (e.g., 1 to 9) and the order of the numbers each subject retrieved or referred to in their directions. These mean correlations were also low, ranging between −.12 and .16. Finally, other forms of organization such as categorical clustering of hiding places were precluded in this situation because children rarely chose hiding places that were categorically related. On average, there was less than one pair of similar hiding places in the set of hiding places each child chose. This was also true of the hiding spots children chose in Study 2.

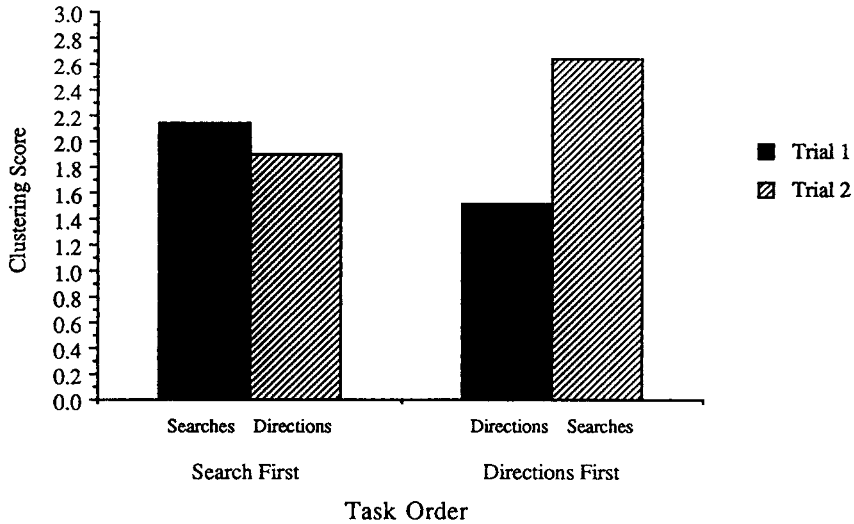

Figure 1. Six-year-olds' mean spatial clustering scores as a function of task order and trial.

rections with a distribution of stair traversals obtained through a Monte Carlo computer simulation based on a random model of retrieval. The other aspect of performance analyzed was the number of objects children found or mentioned in their searches and directions.

Organization of Searches and Directions

Comparisons between children's searches and directions. The 6-year-olds' spatial clustering scores were entered into a Task Order (search first vs. directions first) × Trial (Trial 1 vs. Trial 2) repeated measures analysis of variance (ANOVA) with the first factor as a between-subjects variable and the second as a within-subject variable. A main effect of trial indicated that performance on Trial 2 (M = 2.27) was more highly organized than performance on Trial 1 (M = 1.83), $F(1, 30) = 10.90, p < .01$. This effect is very likely due to the facilitory effect of practice with locating and recalling the objects.

The primary result of interest was a significant interaction of Task Order × Trial, $F(1, 30) = 26.53, p < .001$. First, simple effects tests revealed that searches were more spatially organized than directions in Trial 1, $F(1, 30) = 8.33, p < .01$, and in Trial 2, $F(1, 30) = 12.37, p < .01$ (see Figure 1). The other way of looking at this interaction is to test whether searching first had any effect on children's subsequent directions, and vice versa. Simple effects tests revealed no difference between the organization of children's searches and directions in the search first condition, $F(1, 30) = 1.71$, *ns*. In contrast, the searches of children in the directions first condition were more organized than their directions, $F(1, 30) = 35.71, p < .001$. These results suggest that performing an organized search first facilitated children's subsequent ability to give organized directions and that producing less organized directions first did not have a deleterious effect on children's subsequent ability to carry out organized searches.

Comparisons between children and adults. An Age (6 years vs. adult) × Task (directions vs. searches) repeated measures ANOVA with the first factor as a between-subjects variable and the second as a within-subject variable was performed on clustering scores to compare the spatial clustering scores of adults with those of the 6-year-olds who, like adults, participated in the directions first condition. A main effect of age indicated that adults were more organized than the 6-year-olds, $F(1, 28) = 8.98, p < .01$, and a main effect of task indicated that searches were more organized than directions, $F(1, 28) = 30.68, p < .001$. In addition, there was a significant Age × Task interaction, $F(1, 28) = 9.05, p < .01$. Simple effects tests revealed that the 6-year-olds' directions (M = 1.51) were less organized than the adults' directions (M = 2.46), $F(1, 28) = 13.93, p < .001$, but that there was no difference between the searches carried out by the children (M = 2.64) and by the adults (M = 2.79), $F(1, 28) = 0.62$, *ns*.

Monte Carlo analysis. Were subjects searching or giving directions in a manner that was more organized than that expected by chance? How many floor traversals would a person make if they were picking up the pieces at random? To answer these questions, a Monte Carlo computer program simulated retrieving at random nine objects placed three to a floor. Figure 2 shows the cumulative percentage of trials with less than or equal to a given number of floor traversals out of a run of 1,000 trials. The minimum number of floor traversals required to retrieve all nine pieces was 3, and the maximum number possible was 12.[2]

[2] The Monte Carlo analysis consisted of a series of trials simulating how many floor traversals would occur if a sequence of nine locations was chosen at random from a set with three locations on each of three floors. The simulation was carried out assuming no replacement. That is, no location could be chosen twice on the same trial. This was a conservative procedure as permitting replacement or repetitions could have resulted in a greater number of floor traversals. Thus, if subjects performed above chance level without replacement they would also be performing above chance level with replacement. (In fact, there were very few repetitions of locations by children or adults in their searches or directions.)

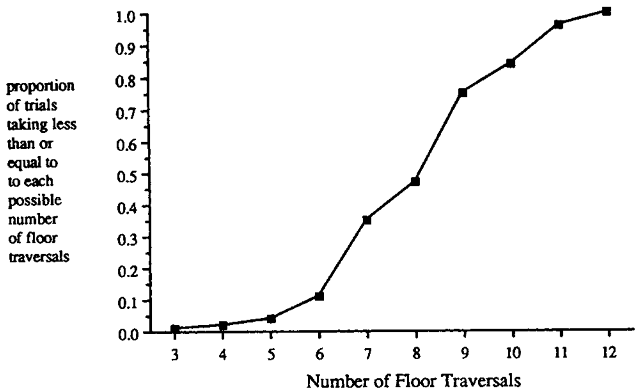

Figure 2. Distribution of Monte Carlo runs for random retrieval of nine objects.

Consider the results of the 6-year-olds first. Eight of the children in the search first condition retrieved all nine pieces without any errors. They used a mean of 4.1 floor traversals to accomplish their searches. As seen from Figure 2, 4 or fewer floor traversals occurred by chance only about 1% of the time. Two subjects in the directions first condition mentioned all nine pieces in their directions and did so with a mean of 7 floor traversals. As can be seen in Figure 2, 7 or fewer floor traversals occur by chance about 33% of the time. Thus, the order in which children searched for the objects was much more organized than that expected by chance, but the order in which children referred to the locations in their directions did not differ from that expected by chance. Adults, on the other hand, searched for the objects and described the object locations in an order that resulted in fewer floor traversals than that expected by chance. Adults who recalled all nine objects in their directions used a mean of 3.9 floor traversals to do so and a mean of 3.6 floor traversals to retrieve the objects afterward. Note that a similar pattern of results was obtained for children and adults who recalled fewer objects.

Number of Objects Recalled

The previous analyses showed that searches were more organized than directions. Is this difference reflected in the number of objects children found in their searches and mentioned in their directions? To answer this question, we analyzed the number of objects children recalled in a Task Order (search first vs. directions first) × Trial (Trial 1 vs. Trial 2) repeated measures ANOVA with the first factor as a between-subjects variable and the second as a within-subject variable. A main effect of trial indicated that more objects were remembered in Trial 2 ($M = 8.4$) than in Trial 1 ($M = 7.7$), $F(1, 28) = 12.27, p < .01$.

There was also a significant Task Order × Trial interaction, $F(1, 28) = 5.45, p < .05$. First, simple effects tests revealed that there was no significant difference between the number of objects children recalled during searches and directions performed during Trial 1 ($M = 7.9$ and $M = 7.4$, respectively), $F(1, 30) = 0.96$, *ns*, or Trial 2 ($M = 8.7$ and $M = 8.1$, respectively), $F(1, 30) = 3.27$, *ns*. However, simple effects tests of the number recalled during searches and directions within each condition indicated that children in the directions first condition recalled significantly more objects during Trial 2 ($M = 8.7$) than during Trial 1 ($M = 7.4$), $F(1, 30) = 17.05, p < .001$. In other words, they retrieved more objects during their searches than they referred to in their directions. However, children in the search first condition did not recall significantly more objects during Trial 1 ($M = 7.9$) than during Trial 2 ($M = 8.1$), $F(1, 30) = 0.68$, *ns*. No comparisons were made between children and adults because the number of objects adults recalled was at ceiling.

Discussion

The comparisons between 6-year-olds' searches and directions showed that they produced more spatially organized retrieval routes when they physically retrieved the objects than when they told their listener how to retrieve the objects. Adults' directions, on the other hand, were much more organized than the 6-year-olds' directions. In addition, 6-year-olds benefited from experience with searching for the objects because there was no difference between the organization of searches and directions when children searched first and gave directions afterward.

One explanation for the high degree of spatial organization reflected in children's searches was the presence of visible environmental structure. Because children had the advantage of actually moving through the space when they searched for the pieces, visual cues about the locations and physical proximity of other objects were available. In addition, the physical structure of the houses may have guided children's movement in such a way that they remained on a floor and retrieved the pieces there before moving on to another floor. Further studies in which environmental structure is systematically manipulated may shed more light on its role in search organization.

What accounts for the relative lack of spatial organization in the 6-year-olds' directions? One possibility is that they did not think about the effort their listener would have to expend if she followed their disorganized directions. Another possibility is that they did not have knowledge of where each hiding location was in relation to the others. Obviously, knowledge of the spatial relations between locations is a prerequisite for giving spatially organized directions. Children may have been able to search in a systematic and organized fashion without having clear knowledge of the spatial relations between the hiding locations because visual cues were available to remind them of nearby hiding locations during the search.

Two factors proposed to account for children's disorganized directions are examined in Study 2. First, to investigate whether children give less organized directions because they do not know the spatial relations among the hiding locations, we specifically instructed a new group of 6-year-olds to direct their listener from one location to the next by telling her where the next closest location was. Their directions were contrasted with those of another, new group of 6-year-olds who were given the same instructions as the subjects in Study 1. Second, both groups of children gave directions to their listener through walkie-talkies. Having children give directions through walkie-talkies ensured that they knew their listener was actually following their directions as they were given. This allowed us to examine whether children gave more spatially organized directions when the saliency of the listener's effort was increased.

Study 2

Method

Subjects

Twenty-five 6-year-olds (M = 6 years 5 months, range = 5 years 11 months to 7 years 1 month) participated. There were 8 boys and 8 girls in an *unprompted* condition and 4 boys and 5 girls in a *prompted* condition.

Design and Procedure

The basic procedure was the same as in Study 1. Prior to hiding the objects, the children practiced with the walkie-talkies and were informed that later they would use the walkie-talkies to tell their listener how to find all of the hidden objects. When children finished hiding the objects, they returned to the start and the walkie-talkies were turned on. They were instructed that their listener would go to each place that she was told to go and look for the object until she found it. Unknown to the children, however, was that the listener did not actually pick up the objects. This allowed us to have the children retrieve the objects after they gave directions. Therefore, all of the children gave directions first and searched for the objects afterward. When the listener either found the object or gave one neutral prompt such as, "I still can't find it, can you tell me more about where it is?," she asked the child for directions to another location. The prompt was given when the listener judged that the child's directions were insufficient to specify the location of the hidden object. Instructions for the searches were the same as in Study 1. The experimenter who helped with the hiding recorded the order of locations the child described in his or her directions and later retrieved in the search. Directions also were audiotaped.

To examine whether 6-year-olds were capable of producing spatially organized directions if specifically prompted to think about the distances among locations, we manipulated the instructions used to elicit directions. As in Study 1, we instructed children in the unprompted condition to tell the listener "where to go next" each time the listener was ready to go to a new location. In the prompted condition, however, each time the listener was ready to go to another location she asked the child to tell her "where the next closest piece is so I don't have to walk very far." This resulted in an Instructions (unprompted vs. prompted) × Task (directions vs. searches) factorial design with the first factor as a between-subjects variable and the second as a within-subject variable.

Measures

As in Study 1, the spatial clustering scores were based on the number of objects recalled divided by the number of stair traversals (including those made in error). Again, the cutoff for number of objects found or mentioned was reached when either the experimenter gave the subject a clue about a location or the number of unsuccessful searches in different locations was not followed by an equal number of consecutive successful searches.

Results

The following analyses are organized into two main sections. The first section concerns the organization of children's directions and searches. The primary questions of interest in this section are (a) whether children's directions were more spatially organized when the listener explicitly prompted them to guide her from each location to the next closest one and (b) whether giving directions through walkie-talkies resulted in more organized directions than in the previous study. The second section concerns the number of objects children recalled while giving directions and searching.

Organization of Directions and Searches

An Instructions (unprompted vs. prompted) × Task (directions vs. searches) repeated measures ANOVA with the first factor as a between-subjects variable and the second as a within-subject variable was conducted on children's spatial clustering scores. A main effect of instructions indicated that performance was more organized in the prompted condition (M = 2.45) than in the unprompted condition (M = 1.68), $F(1, 23) = 33.72, p < .001$, and a main effect of task showed that searches (M = 2.38) were more organized than directions (M = 1.54), $F(1, 23) = 24.25, p < .001$.

Most important, there was also a significant Instructions × Task interaction, $F(1, 23) = 16.26, p < .001$. Simple effects tests showed that directions given in the prompted condition were more organized than those in the unprompted condition, $F(1, 23) = 79.01, p < .001$ (see Figure 3). There was no significant difference between the searches of children in the two conditions, $F(1, 23) = 0.80$, *ns*. In addition, directions given in the unprompted condition were less organized than the searches carried out afterward, $F(1, 23) = 55.72, p < .001$, but there was no difference between directions given in the prompted condition and the subsequent searches, $F(1, 23) = 0.31$, *ns*.

To test whether giving directions through walkie-talkies increased the organization of children's directions, we performed a one-way ANOVA comparing directions given by children in the unprompted condition from Study 2 with directions given by children in the directions first condition from Study 1. This analysis indicated that directions given with walkie-talkies (M = 1.06) were actually slightly less organized than directions given without walkie-talkies (M = 1.51), $F(1, 30) = 5.34, p < .05$.

Number of Objects Recalled

An Instructions (unprompted vs. prompted) × Task (directions vs. searches) repeated measures ANOVA with the first factor as a between-subjects variable and the second as a within-subject variable was performed on the number of objects recalled while subjects were searching and giving directions. A main effect of task indicated that significantly more objects were found during the searches (M = 8.8) than were mentioned in the directions (M = 7.8), $F(1, 23) = 14.04, p < .01$. There was no difference between the number of objects children in the unprompted and prompted instructions conditions mentioned when giving directions (M = 7.6 and M = 8.2, respectively), or between the number of objects found during the searches that occurred after children gave directions in the unprompted and prompted conditions (M = 8.8 and M = 8.8, respectively).

Discussion

Clearly, the high degree of spatial clustering in 6-year-olds' directions when they were specifically prompted to guide their

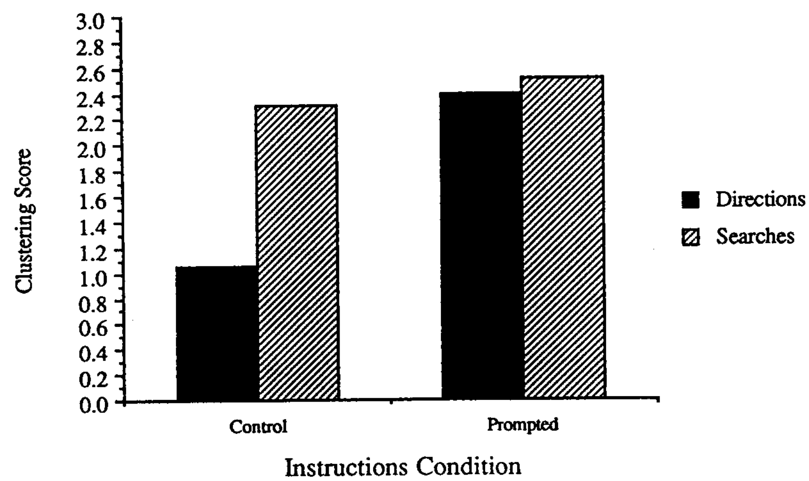

Figure 3. Six-year-olds' mean spatial clustering scores as a function of instructions condition and task.

listener from each location to the next closest one indicates that they knew the spatial relations between the hiding locations. This finding strongly suggests that the lack of spatial clustering in children's unprompted directions is a problem of access rather than a lack of knowledge per se. Furthermore, it seems likely that children's difficulty with accessing spatial information in a spatially organized fashion is linked to deficits in metacognitive and perspective-taking skills. Specifically, although 6-year-olds were capable of producing spatially organized directions, it did not cross their mind to do so unless explicitly prompted. Even when the listener's efforts were made obvious by having her retrieve the objects, children did not attempt to cluster locations in their directions. Nonetheless, children searched in an organized fashion for the objects afterward regardless of whether they had given organized or unorganized directions.

Content and Structure of Directions

The final question addressed in this series of studies was the kinds of information children and adults convey to their listener and how this information is organized. Clearly, helping someone locate several objects involves more than telling him or her the order in which to retrieve them. At the very least, the direction-giver must provide the listener with basic units of spatial information; in the case of multilevel spaces, this includes information about floors, rooms, and the landmarks contained therein. In addition, references to movements of the listener help integrate the flow of action with the spatial information described. Distinguishing landmarks from other potentially confusable objects is also a key component of referential communication and effective direction-giving. As Craton, Elicker, Plumert, and Pick (1990) pointed out, landmarks can be differentiated by referring to their appearance (i.e., size, shape, or color) or by describing their location in relation to other objects within the space. In addition to describing the information needed to find the objects, good directions presumably structure this information in an organized fashion. One way of organizing spatial information is to structure it hierarchically in a way that progressively narrows the listener's search. For example, one possible way of guiding someone to a location is to order spatial regions and landmarks in a hierarchy from most to least inclusive area (e.g., "the book is upstairs in my bedroom next to the desk under a yellow notebook").

To provide a descriptive analysis of the content and structure of children's and adults' spatial directions, we developed a coding system to capture the major elements of spatial information needed to localize objects in multilevel spaces and to examine how children and adults organize these elements of information in their directions.

Coding

Children from both instruction conditions used in Study 2 were combined into one group and compared with the adults and the children in the directions first condition from Study 1.[3] Directions given by 15 children from Study 1, 15 children from Study 2, and 14 adults were used in these analyses. Children in the search first condition from Study 1 were not included because they gave directions after searching.

Each subject's directions for all nine locations were transcribed from audiocassette tape recordings. Only directions given prior to any clues from the experimenter were coded, and with the exception of one measure (the number of landmarks mentioned), all directions were coded for presence or absence of the targeted information. Except where noted otherwise, performance on each measure was analyzed as a proportion based on the number of directions containing the targeted information relative to the total number of coded directions. (In this

[3] Ten children were not used because of loss of directions during taping or transcribing. Five of these subjects were from the control condition and 5 were from the prompted condition. Thus, the groups were pooled to form one group of children who gave directions to their listener through walkie-talkies. All adults were included in the language analyses.

situation, a direction refers to the information conveyed about a single hiding location.) With the exception of number of landmarks mentioned, reliability for all measures was determined by dividing the number of individual locations that the coders scored identically by the total number of locations on 10 randomly selected subjects. Percentage of agreement ranged from 80% to 100% with a median of 89%. Reliability for number of landmarks mentioned was also high (r = .84).

Two measures were devised to assess how often and under what circumstances children and adults mentioned the floors containing the hidden objects. References to floors included such statements as "go upstairs," "go up," "go to the second floor," and "go to the basement." One can well imagine that a change in floor would necessitate some reference to that fact, but that mentioning the floor when directing someone to another location on the same floor would be viewed as unnecessarily redundant. Therefore, we coded the number of *redundant floor references* occurring in relation to the total number of redundant floor references possible, and also the number of *nonredundant floor references* occurring in relation to the total number of nonredundant floor references possible. In this case, the total possible number of nonredundant floor references was the number of directions in which the location was on a different floor from the previous one. The total possible number of redundant floor references was the number of directions in which the location was on the same floor as the previous one.

A *room reference* was coded as present when subjects named the room or area, mentioned its function, or described its appearance. For example, a child might refer to the same room by saying "look in the place where my dad keeps all his tools" or "look in the tool room."

Landmark references were coded to assess how often subjects referred to other objects to orient the listener. Individual landmarks included references to objects or specific parts of objects. For example, a statement such as "go to the dresser and look in the top drawer" contains two nested landmarks—the dresser and the drawer. This measure reflected the total number of landmarks in relation to the number of directions coded.

A *movement reference* was coded as present when the subject made any kind of mention of the listener's movement when going from one location to the next or when looking for the object. This included references such as "go," "into," "to," and "pick up the cushion."

A *spatial-relation reference* was coded as present when a direction contained information about the position of the object in relation to the landmark used to specify the position of the hidden object. For example, saying "look in the cup" instead of "go to the cup and look for the piece" or "look in the kitchen" was considered a spatial-relation reference. In addition, to present a more fine-grained analysis of spatial relational information in directions, we also examined the proportion of spatial-relation references in which a specific spatial relation such as "in," "on," "under," "behind," or "to the left of" was used as opposed to more general spatial relations such as "by" or "near."

A *primary landmark descriptor* was coded as present when subjects provided information about the location or appearance of the landmark used to specify the position of the hidden object. Three additional measures were used to capture the nature of the descriptive information subjects provided about the primary landmark. The first measure assessed the proportion of directions containing descriptive information in which the information concerned only the location of the primary landmark. This included references such as "it's by the bear next to the bed" or "it's under the middle plant." The second measure assessed the proportion of directions in which the only extra information provided about the target landmark were adjectives about its appearance such as shape, color, size, or material. This included statements such as "look under a big dead leaf" and "it's under a purple comb." The third measure assessed the proportion of directions containing descriptive information in which subjects mentioned both the location and appearance of the primary landmark. This measure included statements such as "open the freezer and you'll find a piece on the middle shelf on top of the Columbian coffee jar."

As mentioned previously, one way of supplying helpful spatial information is to order spatial regions and the landmarks contained therein from most to least inclusive area. To examine whether children and adults used this organization, we assessed the extent to which subjects communicated the basic units of spatial information (floor, room, and landmarks) in an order of increasing specificity with respect to inclusiveness of area. Each direction was coded for whether the information present was conveyed in the following order: floor, room, large landmark, medium landmark, and small landmark. Although not all levels of information were always present in subjects' directions, a direction was coded as hierarchically organized if the information that was included conformed to this ordering. Large landmarks included things such as parts of rooms (e.g., the left side of the room), furniture, and large boxes. Medium landmarks included references to parts of large landmarks (e.g., a drawer in a dresser), plants, and toys. Small landmarks included such things as tubes of glue, combs, and parts of medium landmarks (e.g., the left side of a drawer). Because the probability of producing a hierarchical ordering is quite high when few pieces of information are present in directions (i.e., floor, room, and landmarks), the 6-year-olds from Study 1 were not included in these analyses.

Results

The analyses that follow examine the amount and kinds of information children and adults selected to describe object locations and the extent to which they referred to floors, rooms, and landmarks in a hierarchy of increasing specificity with respect to inclusiveness. The three subject groups' scores for each measure were entered into one-way ANOVAs, and all follow-up comparisons were done using Tukey's honestly significant difference (HSD). All scores are presented in Table 1.

Redundant and Nonredundant Floor References

The proportion of nonredundant floor references was high across the groups, and there were no significant differences among the three groups, $F(2, 41) = 0.18$, *ns*. Thus, both children and adults mentioned the floor a high percentage of the time when the target location was on a different floor from that of the previous location.

Table 1
Mean Proportion of Subjects' Directions Conveying Targeted Information

	Subject group					
	6-year-olds without walkie-talkies		6-year-olds with walkie-talkies		Adults	
Information conveyed	*M*	*SD*	*M*	*SD*	*M*	*SD*
Floor reference						
Nonredundant	.77	.17	.72	.29	.78	.32
Redundant	.10	.19	.04	.10	.20	.20
Room reference	.61	.24	.76	.19	.96	.14
Movement reference	.32	.24	.45	.38	.83	.27
Spatial relation	.86	.19	.97	.07	.98	.05
Specific spatial relation	.63	.34	.84	.24	.99	.03
Primary landmark descriptors	.51	.26	.78	.18	.94	.09
Location	.64	.24	.31	.23	.39	.23
Appearance	.15	.20	.25	.20	.01	.05
Location and appearance	.21	.22	.45	.27	.60	.24

Note. The 6-year-olds without walkie-talkies were from the directions first condition of Study 1.

In contrast, the low proportion of redundant floor references reflects the fact that children and adults made relatively few references to the floor when the target location was on the same floor as the previous location. However, there was a significant effect of subject group, $F(2, 41) = 3.41, p < .05$. The proportion of redundant floor references made by adults was significantly higher than that made by the 6-year-olds who used walkie-talkies. There was no significant difference between the adults and 6-year-olds from Study 1 who did not use walkie-talkies or between the two groups of 6-year-olds. The very low proportion of redundant floor references by the 6-year-olds with walkie-talkies is interesting because it suggests that they were aware of the listener's location during their verbal interchanges and hence deemed it unnecessary to mention the floor when the next location was on the same floor.

Room References

This analysis yielded a significant effect of subject group, $F(2, 41) = 12.03, p < .001$. Again, the proportion of room references was high across the three groups, but a greater proportion of adults' directions contained a room reference than did either of the two 6-year-old groups. There was no significant difference between the two groups of 6-year-olds.

Landmark References

This analysis also yielded a significant effect of subject group, $F(2, 41) = 19.60, p < .001$. Adults included significantly more landmarks in their directions than did either of the two 6-year-old groups. The mean number of landmarks adults referred to was 3.83 (SD = 1.80), the mean number of landmarks 6-year-olds from Study 1 referred to was 1.39 (SD = .48), and the 6-year-olds who used walkie-talkies referred to 1.94 landmarks on average (SD = .52). The difference between the 6-year-old groups was not significant.

Movement References

This analysis also revealed a significant effect of subject group, $F(2, 41) = 10.68, p < .001$. Follow-up tests showed that a significantly greater proportion of adults' directions included a movement reference than did those of the two groups of 6-year-olds.

Spatial Relation References

Children and adults alike almost always provided a spatial term specifying the position of the hidden object in relation to a nearby landmark. There was, however, a significant effect of subject group, $F(2, 41) = 3.87, p < .05$, as the result of the fact that a greater proportion of directions given by adults and the 6-year-olds who used walkie-talkies contained a spatial relation reference than did those of the 6-year-olds from Study 1. There was no difference between adults and the 6-year-olds who used walkie-talkies.

A separate analysis was also conducted to examine the proportion of spatial relation references that were specific spatial relations such as *on* or *under* as opposed to *by* or *near.* Again, the proportion of spatial relational terms that were specific spatial relations was very high, particularly for the adults and 6-year-olds who used walkie-talkies, $F(2, 41) = 7.93, p < .01$. A greater proportion of their directions, in fact, contained a specific spatial relation than did those of the 6-year-olds from Study 1.

Primary Landmark Descriptors

The analysis of the proportion of directions containing descriptive information about the primary landmark also yielded a significant effect of subject group, $F(2, 41) = 18.56, p < .0001$. Follow-up tests showed that a greater proportion of directions of both the adults and the 6-year-olds who used walkie-talkies contained a primary landmark descriptor than did those of the

6-year-olds from Study 1. There was no significant difference between the adults and the 6-year-olds who used walkie-talkies.

Three additional analyses were performed to examine the kinds of descriptive information included in the directions containing a primary landmark descriptor. The analysis of the proportion of directions in which the descriptive information concerned only the location of the primary landmark revealed a significant effect of subject group, $F(2, 40) = 7.92, p < .01$. Follow-up tests showed that a greater proportion of directions of the 6-year-olds from Study 1 contained only location information than did those of the adults or the 6-year-olds who used walkie-talkies.

The analysis of the proportion of directions in which the descriptive information concerned only the appearance of the primary landmark also revealed a significant effect of subject group, $F(2, 40) = 7.51, p < .01$. Follow-up tests showed that a greater proportion of directions of 6-year-olds who used walkie-talkies contained appearance information only than did those of the adults. There were no other significant differences among the groups.

Finally, the analysis of the proportion of directions in which the descriptive information included references both to the location and appearance of the primary landmark also revealed a significant effect of subject group, $F(2, 40) = 8.92, p < .001$. A greater proportion of directions of both the adults and the 6-year-olds who used walkie-talkies contained location and appearance references than did those of the 6-year-olds from Study 1. There was no significant difference between the adults and the 6-year-olds who used walkie-talkies.

Hierarchical Organization of Directions

The analysis of the structure of subjects' directions showed that a hierarchical organization of decreasing size of spatial unit appeared on average in 73% of the 6-year-olds' directions and in 63% of the adults' directions. There was no significant difference between children and adults, $F(1, 28) = 2.02$, *ns*.

Discussion

The analyses of the content and structure of directions showed that 6-year-olds spontaneously produced directions that conveyed the basic units of spatial information needed to locate missing objects in a hierarchically organized fashion. They also recognized when it was necessary and unnecessary to provide information about the floor, they mentioned the room over half of the time, and they included between one and two landmarks on average. Interestingly, there was no difference between adults and the 6-year-olds at the most general level of information (i.e., references to floors). Children also almost always provided a spatial relational term describing the position of the hidden object in relation to a landmark. Over 70% of the time, this term defined a specific spatial relation between the object and the landmark (e.g., under the plant, inside the cup, or on top of the washing machine). In addition, both the adults and the 6-year-olds who used walkie-talkies often provided their listener with additional information about the primary landmark. The most common way they accomplished this was to provide information about both the appearance and the location of the primary landmark. This suggests that both 6-year-olds and adults were aware of the fact that there are multiple ways to identify objects and that providing the listener with multiple sources of information increases the likelihood that she will be able to find the object.

It is also worth noting that in many cases, the 6-year-olds who gave directions through walkie-talkies provided better information to their listener than did their 6-year-old counterparts from Study 1 who gave directions while sitting next to their listener. What might account for this trend? One possibility is that giving directions through walkie-talkies motivated children to provide better information because they were more aware of the listener's needs. This awareness, however, affected only the quality of the information children conveyed and not the order in which they referred to the locations.

General Discussion

The differences that emerged when children were asked to guide their own movements while searching for several objects and when they were asked to direct someone else to those same objects show that although the two tasks share a common goal of localizing objects, they elicit widely differing levels of spatial organization from the same-age children. The 6-year-olds in both experiments demonstrated considerable skill in carrying out organized searches. In contrast, the directions they provided about the same locations were far less organized. They only produced organized directions when the listener explicitly asked them to guide her from each location to the next closest one. Adults, on the other hand, gave very organized directions without any specific prompts to do so.

The results of Study 2 clearly show that children have the necessary spatial knowledge to produce organized directions. Why then did the 6-year-olds fail to use this knowledge spontaneously? Previous research on memory development has suggested that young children's failure to use a memory strategy is a result of the greater mental effort required to use it (Guttentag, 1985). When the mental effort required to use a strategy is reduced, the differences between younger and older children's recall decrease (DeMarie-Dreblow & Miller, 1988). It may be that the demands involved in verbalizing spatial information precluded children from using an organizational strategy. It would be particularly interesting to know whether young children's propensity to produce spatially organized directions can be influenced by manipulating the demands of the situation. Young children may be more likely to produce organized directions when memory and performance demands are reduced, for example, by having all locations visible or asking children to point to locations rather than verbalize their directions.

Another possible reason for why the 6-year-olds in this study produced less organized directions is that they did not take into account the needs of their listener. On one level, children need to be aware of social conventions about conveying spatial information in an organized fashion. Part of this awareness may develop from children's experiences with searching for objects. This suggestion is supported by the fact that children in Study 1 who searched before giving directions provided quite organized directions after they completed their searches. Experiences with being on the receiving end of disorganized directions may also help children to be more aware of the listener's needs. In fact, Sonnenschein and Whitehurst (1984) found that training young children to notice others' communication failures was the most effective technique for improving children's own speaking skills. Awareness of the listener's needs may also prompt children to adopt mental-walk strategies in which they attempt to imagine the listener moving along the route. In short, it may be that the social–cognitive and organizational demands of direction-giving play complementary roles.

The fact that 6-year-olds communicated the basic units of spatial information needed to find each object in a hierarchically organized fashion, however, suggests that some aspects of their direction-giving skills are well developed by 6 years. What might account for the discrepancy between children's ability to order the locations when giving directions and their ability to order the spatial information used to describe each individual location? When retrieving an object in a multilevel space, one must first go to the correct floor, then find the room, and last of all find the landmark near the object. When retrieving objects from several locations, however, there is no a priori reason that one must go to the locations in a particular order. Other researchers have shown that 5-year-olds are quite good at remembering logical or familiar sequences but have great difficulty reconstructing unfamiliar arbitrary orders (e.g., Brown & Murphy, 1975; Fivush, 1984). Thus, 6-year-olds may be sensitive to the logical structure that defines individual object locations even though they have difficulty seeing the structure that binds together groups of locations.

At a more general level, this study underscores the point that the cognitive and task demands mutually influence and constrain the organization of children's searches and directions. On the one hand, it appears that cognitive factors such as mental effort and understanding of the listener's needs may play a significant role in young children's propensity to formulate organized directions. On the other hand, aspects of the task such as the presence or absence of spatial structure and the availability of scaffolding from an older, more experienced listener may also influence the level of spatial clustering present in children's searches and directions. Further research that takes into account both types of factors may open up new lines of investigation about the development of spatial communication and the organization of children's activity within the physical environment.

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