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Symbols and Similarity: You Can Get Too Much of a Good Thing

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Surface similarity generally promotes reasoning by analogy and physical similarity has been shown to have a powerful positive effect on very young children's use of a scale model as a source of information about another space. The research reported here investigated 2½-year-old children's performance in an object retrieval task when asked to reason from one space to a second, perceptually identical one. Contrary to the expectation that increased surface similarity would improve the children's performance, it actually had a negative effect. Children were less successful in 3 different tasks in which 2 spaces were identical than a task in which the spaces were merely similar in size and appearance. Their performance appeared to be affected by 4 factors: representational insight, memory for the most recent hiding place, the ability to resist responding perseveratively, and their level of analysis of the task. The results suggest that part of the power of symbols derives from the fact that they are virtually never identical to their referents, thereby making it possible to use one to draw inferences about the other without risk of confusing them.

The identification of similarity between separate entities is a pervasive and powerful tool of human cognition. Its power derives in part from its remarkable flexibility. We can recognize similarities between bald heads and golf balls, digital clocks and sundials, dobermans and dachshunds, the solar system and an atom. We interpret things as alike based on appearance, function, kind, and relational structure, as in the previous examples, as well as an unlimited list of other factors—material composition, size, smell, ownership, geographical origin, and so on. Without an appreciation of similarity, fundamental cognitive processes such as categorization, induction, gen-

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eralization, and analogical reasoning would be impossible (e.g., Gentner, 1983; Holyoak, 1984; Medin, Goldstone, & Gentner, 1993; Vosniadou & Ortony, 1989).

Perceptual or surface similarity is relatively salient and easy to recognize. As a result, it is often a useful index of deeper conceptual or structural similarities and can provide access to more complex relations (Gentner & Toupin, 1986; Medin & Ortony, 1989; Ross, 1989; E. E. Smith, 1989). Thus, in spite of the great difference in their size, the fact that dobermans and dachshunds look alike in many respects makes it easy to identify both as dogs and to draw inferences about other, nonobvious ways in which they are likely to be similar.

Although surface similarity can help individuals of any age appreciate deeper structural similarities, it is especially important for young children. In the absence of other information, even young children will assume that two entities that look alike are the same kind (e.g., Gelman & Markman, 1987; L. B. Smith, 1993a, 1993b). Perceptual similarity between the characters that play comparable roles in two stories helps children appreciate the analogical relation between the stories (Gentner & Toupin, 1986).

Perceptual similarity can also be helpful for detecting the relation between symbols and their referents. An *iconic* symbol is one that bears some physical similarity to its referent. Clearly, many symbols and symbol systems (such as mathematics and alphabets) are purely abstract, with no iconicity whatsoever between symbol and referent. Indeed, some theorists reserve the term *symbol* for just such wholly abstract relations (Pierce, 1932, 1955). Others appreciate that many symbolic entities are iconic (e.g., Goodman, 1976; Huttenlocher & Higgins, 1978), that symbols often enjoy some degree of similarity to their referents. It is important to note that similarity alone does not make one entity a symbol for another; something is a symbol only if someone *intends* for it to stand for or represent something other than itself (DeLoache, 1995, 2002b). A paint spill with a passing resemblance to a human figure is not a symbol but very similar markings produced by a young child in an effort to portray her mother do constitute a symbol. Even young children are sensitive to the intentional basis of symbols (see Bloom & Markson, 1998; DeLoache, 2002b; Gelman & Ebeling, 1998; Sharon, 2003).

Perceptual similarity, or iconicity, has been shown to have a powerful effect on the understanding and use of symbolic artifacts by young children. This result has emerged from studies of very young children's use of a scale model as a source of information about a larger space (for reviews, see DeLoache, 1995, 2002a; DeLoache, Miller, & Pierroutsakos, 1998)

In the standard task used in this research, children watch as a miniature toy is hidden in a scale model of a room. They are then asked to retrieve a larger version of the toy hidden in the corresponding location in the room itself.[1] Across numer-

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[1]Some children experience the opposite order, watching the larger toy hidden in the room and searching for the miniature toy in the model. There was no effect on performance, so for ease of communication only the 'hide-model, search-room' case will be used in descriptions of the task.

ous studies, 3-year-olds have performed very well, using their knowledge of the location of the smaller toy to find the larger one approximately 80% or more of the time. In contrast, 2½-year-olds' success rate is only about 20% or less.

The failure of the younger children occurs even though there is a very high level of perceptual similarity between the model and room, with the large and small items being of highly similar shape, material and color. The children's difficulty with the task is not a simple problem of memory. When asked to retrieve the miniature toy that they observed being hidden in the model, 2½-year-olds' success rate is around 80–90%, just as high as that of 3-year-olds. It is also not a problem of motivation; children usually enjoy the task and 2½-year-olds' performance is equally poor when they are asked to locate a highly prized item—their own mother—instead of a toy (Troseth & DeLoache, 2003). Rather, young children's difficulty is specifically with achieving representational insight, that is, with recognizing and using the symbol-referent relation (DeLoache, 1995).

When the degree of perceptual similarity between room and model is manipulated, the pattern of performance is markedly affected for both age groups (DeLoache, Kolstad, & Anderson, 1991). Decreasing the level of surface similarity between the items of furniture in the two spaces (the low-similarity task) causes 3-year-olds to be quite unsuccessful (only 21% correct). At the same time, increasing the level of similarity between model and room leads to successful performance by 2½-year-olds. This age group is quite successful in the similar-scale task (70% correct), in which the difference in scale between the two spaces is much smaller than in the standard task. In the similar-scale task, the larger space is not a full-sized room but only twice as big as the model.

Figure 1 summarizes the results of previous research on the effects of similarity for 2½-year-olds in six previous versions of the model task. The versions differ in the degree of similarity between the two spaces in terms of (a) the surface similarity of the objects within the spaces, (b) the overall size of the spaces, and (c) the material from which the surrounding walls of the spaces are constructed. As the first six data points on the figure show, children perform very poorly with low similarity on all dimensions but their performance rises with increasing similarity between the model and the larger space.

One possibility for how similarity affects performance in the model task is that surface similarity helps young children match the items of furniture in the two spaces. Matching these items is clearly essential for successful performance. It would be impossible for children to succeed if they did not realize that the miniature couch is like the full-sized couch, the small chair like the larger chair, and so on.

An alternative possibility is that children must also notice the higher-level representational relation between model and room to reason from one to the other. Prior research supports this alternative. For example, in a study by Troseth and DeLoache (2003), the experimenter simply pointed to each item of furniture in the model, asking the child to "show me the one like this in the room." The 2½-year-old children readily indicated the matching items; however, when given

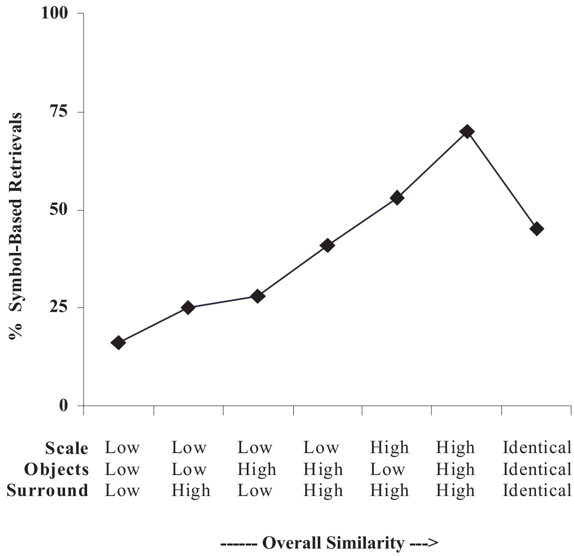

FIGURE 1 Effects of similarity on the performance of 2½-year-olds in the model task. Performance on the symbol-based retrievals increases as a function of physical similarity. In previous research (first 6 data points), performance on the symbol-based retrievals has consistently increased as a function of increasing physical similarity. This research (last data point, Study 1) suggests limits on the beneficial effects of similarity. The three sources of similarity include the size ratio between the two spaces (scale similarity), the surface appearance of the items of furniture (object similarity), and the materials from which the walls were constructed (surround similarity: rigid vs. cloth; Previous data are from DeLoache et al., 1991; Marzolf & DeLoache, 1994; DeLoache, Simcock, & Marzolf, 2003; and unpublished data.)

the standard model task, they performed poorly. Thus, being able to do the lower-level mapping between individual items in the two spaces is necessary, but not sufficient, for success in the model task. Only if children have access to the higher level relation between the two spaces do they use what they know about one to draw inferences about the other.

The goal of the two studies presented here was to further investigate the role of similarity in young children's performance in the model task. The steady improvement in performance as a function of similarity (see Figure 1) suggests that if similarity were increased even more, performance would improve still further. Indeed, performance might be expected to be best if the two spaces were identical in appearance, making it maximally simple to achieve representational insight into the relation between the two spaces and also making it easier to map between them. Accordingly, we conducted two studies using the symbolic retrieval task with identical spaces.

PRELIMINARY STUDY

The goal of this study was to examine 2½-year-old children's ability to reason from one space to another identical one. To provide a strong test of the expected superior performance with maximal similarity, two quite different identical-spaces tasks were used. One involved identical small-scale commercial dollhouses and the other full-sized rooms.

Method

Participants. There were twenty-four 30-month-old participants in the identical-rooms condition, (M = 30.3, range = 29.0–32.0) and 16 in the identical-dollhouses condition (M = 29.9, range = 29.0–30.0), including approximately equal numbers of boys and girls.

Stimuli and apparatus. The *rooms condition* used two rooms of the same shape and size (4.8 × 2.7 × 2.5 m). The rooms were adjacent to one another on a hallway of offices, so any external sounds would be essentially the same. They were furnished with several identical items, including a chair, desk, floor pillow, large box fan, and wastebasket. The items were in the same relative positions in the two spaces. The toys used for hiding and retrieving were two identical stuffed toy dogs (15 cm long). Each had a ribbon, either blue or red, tied around its neck. They were referred to as "Blue Dog" and "Red Dog."

The *dollhouses condition* employed two identical commercial dollhouses (55 × 25 × 30 cm) open on one side. Each had seven rooms with identical items of plastic furniture. The dollhouses sat in the same orientation on two tables approximately 1 m apart in a room. A divider between them prevented the child from seeing both at the same time. The toys used for hiding and retrieving were two small plastic dogs that, like the larger ones, had either a blue or red ribbon around their necks.

Procedure. Children were tested individually by a single experimenter. A brief warm-up period was followed by an extensive orientation. First, children were introduced to the two toy dogs, labeled Red Dog and Blue Dog (based on their ribbons). The experimenter then referred to one of the spaces as Red Dog's room. (For half the children, it was Blue Dog's room, but for ease of communication we only describe the version in which the child observed Red Dog being hidden.) Each item of furniture was pointed out and labeled as belonging to Red Dog. Next, the experimenter explained that Blue Dog "has a room just the same as Red Dog's." In the dollhouses condition, the experimenter directly compared all the pieces of furniture in the two spaces, placing each item from the one dollhouse by the corresponding item in the other, while commenting on the correspondence between them. This direct comparison could not be done in the rooms condition but the experimenter emphasized the similarity between the items of furniture in the two spaces. The experimenter then explained that the two dogs like to do the same things in their rooms. She placed Red Dog on the shelves in one space and instructed the child to put Blue Dog in the same place in his space. If the child had difficulty, the experimenter placed the toy correctly. The last part of the orientation was one or two practice trials in which the experimenter labeled the toy's hiding location as she placed it (locations were never labeled once the test trials began).

The orientation was followed by four retrieval trials, each of which involved three parts:

1. Hiding event: The child watched as the experimenter hid one of the dogs in its space (room or model). The experimenter called the child's attention to the act of hiding, but without naming the location: "Look, Red Dog is going to hide here." She then told the child that she would hide Blue Dog "in the same place in his room." The child was unable to see this second hiding event in either condition.
2. Symbol-based retrieval: The experimenter then led the child to the second space and asked him or her to find the toy. Before permitting the child to search, the experimenter provided a reminder: "Remember, he's hiding in the same place as Red Dog." If the toy was not found on the first search, the child was free to search other places. If necessary, the experimenter provided increasingly explicit prompts until the child found the toy. Only the first, unprompted search was counted in calculating correct performance.
3. Memory-based retrieval: After Blue Dog was found, the child was taken back to the first space and asked to retrieve Red Dog. The child was again prompted to continue searching if the first search was incorrect.

The toy was hidden in a different location on each of the 4 trials (none of which was used in the orientation trials) and half the children in each condition received one of two orders of hiding places.

Results and Discussion

The results did not reveal the expected benefit of increased similarity. Indeed, as seen in Figure 2, the children in the identical-dollhouses and identical-rooms conditions succeeded in retrieving the toy on only 41% and 43% of the symbol-based retrievals, respectively. This is well below the average of 68% that has been found for this age group in various studies using the similar-scale task (DeLoache et al., 1991; Marzolf & DeLoache, 1994; and unpublished data). Of interest, performance in the memory-based retrievals—66% in the dollhouses and 64% in the rooms conditions—was also lower than the 80% to 90% expected on the basis of previous research. Inspection of performance across trials revealed that perfor-

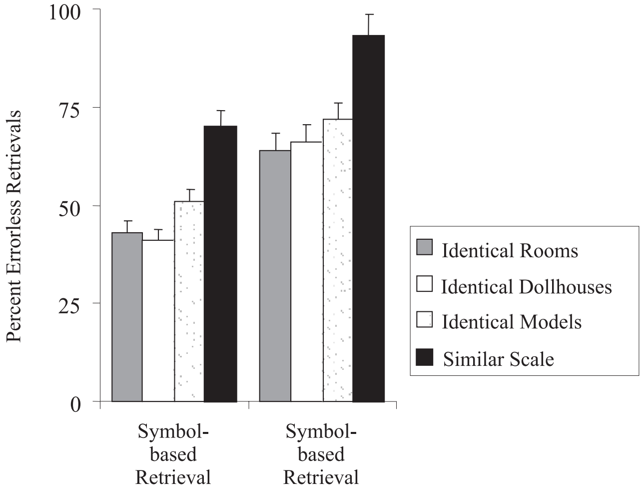

FIGURE 2 Overall performance on both types of retrievals in the preliminary study—identical rooms and dollhouses—and in Study 1—similar scale and identical models. Error bars represent 1 standard error.

mance was highest in the first trial, for both conditions and for both types of retrievals. Mean performance in the symbol-based retrievals was 57% in Trial 1, followed by 33%, 40%, and 38% in the subsequent trials. Mean performance in the memory-based retrievals was 70% in Trial 1, then 60%, 63%, and 65% in the subsequent trials. Thus, children performed more poorly than expected on every trial and for both types of retrieval.

Clearly, the children in this preliminary investigation were not helped by having identical rather than highly similar spaces. Indeed, the use of identical spaces seemed to have a negative effect on their performance on both types of retrievals, compared to children in previous studies.

Two logistical factors may have contributed to the children's low performance. In the identical-rooms condition, the large scale of the spaces precluded surveying the entire space at one time, which may have increased the chances of a child first noticing and searching an incorrect location. In the identical-dollhouses condition, the individual rooms were very small and the items of furniture closely spaced, making it easy for the children to impulsively search multiple locations. In addition, the children sometimes knocked over or otherwise displaced items of furniture while searching, possibly disrupting the search process.

Given the unexpected and nonintuitive nature of the results of the preliminary study and their significance for early symbol use, it seemed prudent to see if they could be replicated in a task not subject to the problems just mentioned. Hence, a new study was conducted employing the same small-scale space that has been used in numerous studies with both the standard and similar-scale model tasks.

STUDY 1

In Study 1, 2½-year-old children were asked to reason from one small-scale space to another, identical one. One of the spaces was the model used in previous replications of the similar-scale task; the second space was identical to it.

Method

Participants. Twenty-four 30-month-old children participated (M = 30.7, range = 28.5–32.5; 12 boys and 12 girls) and 24 children previously tested in the similar-scale task (DeLoache et al., 1991) served as a comparison group (M = 30.6, range = 29.5–32.0; 12 boys and 12 girls). The performance of 2½-year-old children has been assessed in this task in 8 separate replications in which performance on the symbol-based retrievals has ranged from 58% to 75%, with an overall average of 68% (DeLoache et al., 1991; Marzolf & DeLoache, 1994; and unpublished data). This comparison group was selected because its performance was right at the overall mean for the groups combined.

Stimuli and apparatus. For the *identical* condition, the identical models (63 × 48 × 38 cm) were constructed of white cloth walls supported by plastic pipes. Corresponding objects in the two models (floor pillow, shelf unit, wastebasket, chair, chair pillow, dresser, and rug) were identical in appearance and were in the same relative positions. The models were placed in the same orientation on the floor approximately 1 meter apart in a large room. A divider between them prevented children from being able to see both spaces at once. The hiding objects were two small plastic dogs (2 cm long), one with a blue ribbon around its neck and the other with a red ribbon.

In the *similar-scale* condition, the smaller space was one of the models used in the identical condition. The larger space was approximately twice as large (92 × 70 × 61 cm) and was also constructed of white cloth walls supported by plastic pipes. It contained larger versions of the same furnishings (same shape, color, and texture) as were in the smaller space, all in the same relative positions. Finally, the toys were plastic toy dogs (3 cm and 7 cm high) with no ribbons.

Procedure. The procedure was the same as that in the preliminary study, except that there were no practice trials.[2] Two changes were made in scoring the children's search behavior. First, in addition to scoring their first search on every trial as correct or not, we scored a self-correction whenever children, after first searching in the wrong place, spontaneously searched the right place without searching anywhere else first and without receiving anything but a nonspecific prompt (a reminder that the two toys had been hidden in the same places). Second, we scored errors as perseverative whenever a child's first search on any trial after the initial one was in the same location that had been correct on the immediately preceding trial. (The children always had retrieved the toy on the preceding trial, either because they had searched correctly or because of experimenter prompts.)

Results and Discussion

The results basically replicated those of the preliminary study, in that performance on both types of retrieval was poorer when the two spaces were identical. As can be seen in Figure 2, the children in the identical models condition achieved a relatively low rate of success—51% on the symbol-based and 72% on the memory-based retrievals. This level of performance was very similar to that in the identical-dollhouses and rooms tasks in the preliminary study. In contrast, the comparable figures for the similar-scale comparison group were 70% and 93%, respectively. As in the preliminary study, the highest overall level of performance occurred on the first trial for both conditions and for both types of retrievals.

To get a clear picture of how performance in the two conditions differed for symbol- and memory-based retrievals, we conducted two analyses, both of which were 2 (Condition: identical vs. similar-scale) × 4 (Trials) mixed-model analyses of variance (ANOVAs), with trials as the within-subjects factor. (Note that the analyses were conducted on raw scores.) The results are shown in Figure 3 and 4. The analysis of symbol-based retrievals revealed significant main effects for condition, $F(1, 46) = 4.20$, $p < .05$, and for trials, $F(3, 138) = 7.72$, $p < .001$, but no interaction between them. Simple contrasts of performance in Trial 1 compared to performance in each subsequent trial revealed that Trial 1 performance was significantly higher than all other trials(all ps $< .05$). Furthermore, repeated contrasts of performance between adjacent trials indicated that the only significant change between trials occurred between Trials 1 and 2, $F(1, 46) = 23.93$, $p < .001$.

[2]Practice trials were used in some early studies with the standard model task in an effort to make the model-room relation clearer. However, these trials had no beneficial effect and were eventually dropped from the standard task.

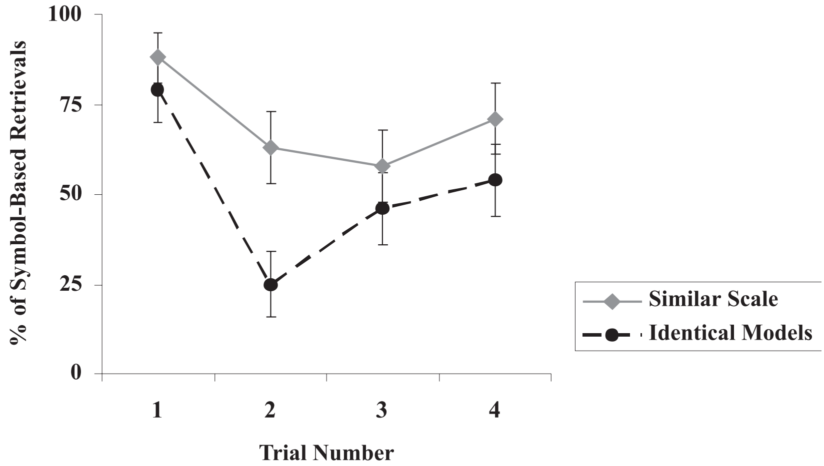

FIGURE 3 Performance by trials in Study 1 in the similar scale and identical models conditions: symbol-based retrievals. Error bars represent 1 standard error.

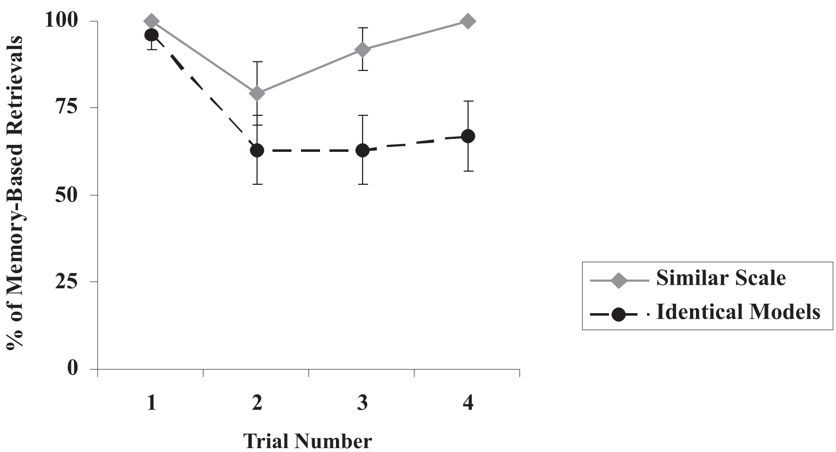

FIGURE 4 Performance by trials in Study 1 in the similar scale and identical models conditions: memory-based retrievals. Error bars represent 1 standard error.

The same results were obtained in the analysis of the memory-based retrievals: main effects for condition, $F(1, 36) = 8.65$, $p < .01$, and for trials, $F(3, 138) = 5.88$, $p < .001$, with no interaction between them. Simple contrasts again showed that Trial 1 performance was significantly higher than performance in all subsequent trials (all ps < .005) and repeated contrasts again showed that the only significant change between trials occurred between Trials 1 and 2, $F(1, 46) = 17.43$, $p < .001$ (see Figure 4).

An additional analysis compared overall performance in the two conditions on the symbol-based and memory-based retrievals. As is typically found in the model task, overall performance was significantly better in both conditions for the memory-based compared to the symbol-based retrievals, $F(1, 46) = 23.73$, $p < .0001$.

To further assess differences between the two groups, we examined perseverative searching and self-corrections.[3] Perseverative responding (searching at the location that had been correct on the preceding trial) was more common in the identical condition than in the similar-scale condition. For the symbol-based retrievals, the proportion of all first searches that were at the previously correct location (after the first trial)[4] was 47% for the children in the identical task (significantly greater than the chance level of 25%, $t = 4.21$, $p < .001$). The comparable figure in the similar-scale task was 28%. The difference between conditions was significant, $t(46) = 5.66$, $p < .05$. For the memory-based retrievals, the comparable figures were 32% and 7%, $t(46) = 11.54$, $p < .005$. (The level of perseverative responses in the memory-based retrievals of the similar-scale task was actually below chance, $t = -6.40$, $p < .001$.)

Children frequently corrected themselves following an incorrect first search. The rate of spontaneous self-correction in the identical condition was 49% for the symbol-based retrievals and 74% for the memory-based retrievals. Both figures are significantly greater than the chance level of 33% (symbol-based retrievals: $t = 3.38$, $p < .005$; memory-based retrievals: $t = 5.41$, $p < .0001$). This relatively high rate of self-correction suggests that children in the identical condition had more symbolic understanding than was evident in their initial search. The rate of self-correction in the similar-scale condition, in which retrieval performance was fairly high, was 41% for the symbol-based retrievals and 57% for the memory-based retrievals. (The latter figure is based on only seven errors.)

In summary, children's performance in Study 1 was highly consistent with the initially surprising result in the preliminary study: The 2½-year-old children in the identical condition were less successful overall than were children of the same age in the similar-scale version of the task. This result was true for both symbol-based and memory-based searches. The two groups started out at the same level, but children in the identical condition showed a greater decline from Trial 1 to Trial 2, with an especially precipitous drop in their symbol-based retrieval performance (from

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[3]It was not possible to examine self corrections and perseverative searching in the preliminary study, as only first searches were recorded (primarily due to the difficulty of precisely scoring the rapid sequence of searches that often occurred in the dollhouses condition).

[4] We also calculated perseverative searching as a proportion of errors rather than responses. Consistent with previous research, perseverative searching was the dominant error. For the identical condition the percentages were 81% and 88% for the symbol-based and memory-based retrievals, respectively. For the similar-scale condition, the percentages were 57% and 88%, respectively.

79% to 25%). Particularly high rates of perseverative searching occurred for the symbol-based retrievals in the identical condition; after the first trial, these children searched first at the previously correct location nearly half the time. Finally, self corrections were common, suggesting that children in the identical condition frequently did hold a memory representation of the toy's actual location.

GENERAL DISCUSSION

The preliminary study and Study 1 establish the counterintuitive fact that it is more difficult for very young children to reason from one space to another identical one than to a highly similar one. As Figure 1 shows, increasing levels of similarity between two spaces are associated with steadily improving performance by 2½-year-olds in the model task up to the point of identity, where the success rate drops. Our analyses of multiple performance measures in the identical and similar-scale conditions in Study 1 suggest the involvement of four factors in the observed patterns of performance.

First, to succeed in any version of the model task, representational insight is crucial: The child must appreciate the relation between the two spaces to apply what he or she knows about one space to the other. As has been shown in many studies, achieving representational insight is quite challenging for very children (see DeLoache, 2002a). Once achieved, it can be quite fragile. For example, 3-year-old children who are normally very successful in the standard model task can lose sight of the model-room relation when a delay occurs between the hiding event in the model and the opportunity to search in the room (Uttal, Schreiber, & DeLoache, 1995).

In Study 1, the symbolic retrieval performance of the children in the similar-scale and identical conditions was at the same very high level on Trial 1. This result points to comparably high levels of representational insight at the beginning of the task. Clearly, the children's representation of the relation between the two spaces was initially adequate to support successful symbol-based retrievals. Similarly, their memory representation of the hiding event they had just observed supported successful memory-based retrieval on the first trial.

A second factor that is crucial for success in any model task is memory: On each trial, children must remember the hiding event in one space to search successfully in the second space. Over trials, they must continually update their memory representations to know which hiding location is relevant on a given trial. Thus, even if children have achieved representational insight, they can succeed only if they keep track of which hiding place is relevant for this trial. However, in the identical condition, the absence of a size cue to differentiate between the spaces makes it more difficult to keep track of which memory representation should guide this search. For example, children might be uncertain whether to rely on their memory of seeing one toy dog behind a chair (where it had most recently been placed by the experimenter—the information they should use) or their memory of seeing another identical dog under the floor pillow in an identical space (where they had most recently found it on the previous trial—the information they should ignore). Consistent with this, children in the identical condition performed unusually poorly on the memory-based retrievals after the initial trial, strong evidence that they experienced difficulty keeping track of the relevant locations from trial to trial. Thus, memory problems appear to have contributed to their relatively poor performance.

A third factor known to be problematic for young children in search tasks is a tendency to search perseveratively, to return on trial *n* to the location that was correct on trial *n – 1* (e.g., Diamond, 1991;Thelen, Schoener, Scheier, & Smith, 2001; Zelazo, Reznick, & Spinazzola, 1998). Perseveration can stem from problems inhibiting a previous response or from difficulty inhibiting outdated information (for a review, see Harnishfeger & Bjorklund, 1993). For the children in the identical condition, the difficulty of updating their memory representations from trial to trial may have contributed to their substantially higher rate of perseverative searching in both memory-based and symbol-based retrievals. (For further discussion of the role of perseveration in children's performance in the scale model task, see Kuhlmeier, in press; O'Sullivan, Mitchell, & Daehler, 2001; Sharon & DeLoache, 2003).

A fourth factor that could also have contributed to the poorer performance in the identical condition is the children's level of analysis of the problem with which they were confronted. Application of the problem solving model of Aguiar and Baillargeon (2000) suggested that the extreme similarity between the two spaces in the identical condition may have led those children to a relatively shallow construal of the task during the orientation. Their task analysis was adequate to see them through the first trial successfully. However, on the second trial, they simply did again what had worked on the first; that is, on the symbol-based retrievals, fully 75% of the children searched in the same location that had yielded the toy the last time. After failure on Trial 2, they may have then realized the need to update their memory representation of the correct hiding place from trial to trial and hence devoted more attention to the hiding event and to keeping it in mind. This would account for the upwards trend in performance after the low performance in Trial 2.

We conclude that the combination of these four factors, all of which are known to influence the performance of very young children in various situations, produced the observed pattern of results for both symbol- and memory-based retrievals. These results underscore the fact that very young children's performance in symbolic-retrieval asks is always the result of a combination of multiple factors (DeLoache, 2002b). We suspect that the performance of children older than the 2½-year-olds in these studies would be less disrupted by identical spaces. For example, 3-year-olds would probably achieve a more stable level of representational insight to begin with, thereby leaving more cognitive resources to meet the challenge of keeping track of the currently-relevant location over trials. In addition, older children would likely do a deeper analysis of the task in the first place, leading them to more quickly bring to bear strategies for keeping track of the hiding places over trials.

It is worth considering the role of similarity in the broader context of reasoning in the general domains of analogy and symbolization. As in the research reported here, the effect of similarity is not as straightforward as might be assumed; it can both help and hinder performance. In analogical reasoning, superficial similarity among entities typically promotes analogical transfer by initiating a comparison process that then reveals the underlying abstract similarity of the analogues (Gentner, 1989; Goldstone, Medin, & Gentner, 1991; Medin & Ross, 1989). However, highly salient superficial similarities sometimes impede transfer by discouraging people from looking for deeper-level similarities (Goldstone & Sakamoto, 2003). Another case in which surface similarity impairs analogical mapping is when highly similar elements play different roles in two analogues; in this case, transfer is worse than if there were a lower level of similarity (Gentner & Toupin, 1986; Loewenstein & Gentner, 2001; Rattermann & Gentner, 1998).

With respect to identity, we would expect a similar story; that is, identical elements should sometimes facilitate cognition but impede it other times. In general, when entities should be treated the same, identity could help. Counting a set of objects, for example, is easier for young children when the objects are all the same (Starkey, 1992). Identical entities should also facilitate the drawing of valid inferences from one to another. Categorizing a new object as a member of an already learned category is easier if the new element is highly similar or even identical to known members of the category (L. B. Smith, 1989). However, if it is important to keep track of elements over time or to avoid confusion among elements (or both), as in this research, identity of elements would make the task more difficult. Identity would also be counterproductive in the acquisition of new categories. A category based on entirely identical entities would be extremely narrow and possess little generalizability. Of interest, research (L. B. Smith, 1989) suggests that very young children of the age tested in our studies do not give special weight to identity. Unlike adults and older children, 2-year-olds tend to classify multidimensional stimuli on the basis of their overall perceptual similarity, whereas older children and adults tend to classify stimuli based on identical values on some dimension. The special weight attached to identity appears to be a developmental acquisition.

Finally, it should be noted that the identical spaces conditions in this research represent an anomalous situation. A symbol is never identical to its referent, nor is one analogue the same as another; symbolic and analogical relations are fundamentally asymmetrical (Goodman, 1976). Often the basis of the asymmetry is the fact that they do not share the same affordances (DeLoache, 2002a, 2002b): One can sit in a chair but not in a photograph of a chair or a miniature replica of a chair.

A symbol and its referent are *qualitatively different* kinds of entities. A symbol brings to mind its referent (and vice versa), making it possible to draw inferences about one of them from what is known about the other. At the same time, the qualitative difference between symbol and referent prevents confusion, making it unlikely that inappropriate inferences will be drawn.

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