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REPORT

Young children's use of scale models: testing an alternative to representational insight

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Abstract

Using a symbolic object such as a model as a source of information about something else requires some appreciation of the relation between the symbol and what it represents. Representational insight has been proposed as essential to success in a symbolic retrieval task in which children must use information from a hiding event in a scale model to find a toy hidden in a room. The two studies reported here examine and reject a proposed alternative account for success in the model task. The results with 2.5-year-olds and 3-year-olds show that children's successful use of a scale model cannot be attributed to the simple detection of the correspondences between the objects in the two spaces. A higher-level representation of the model–room relation (i.e. representational insight) is required. The results are discussed with respect to the coalescence of multiple factors in determining performance in the model task.

Introduction

Mastering a variety of symbol systems is a universal developmental task. In modern societies, a substantial portion of the knowledge possessed by adults is acquired via symbolic artifacts, including text, numbers, pictures, video, and so on. Although normally developing children typically become proficient with symbolic media, doing so is surprisingly challenging.

One area of research on early symbolic development focuses on very young children's ability to use a symbolic artifact (a scale model, picture, video image, or map) as a source of information for solving a problem. The problem to be solved is retrieving a hidden object – a goal with high appeal for very young children. The location of the hidden object is conveyed via a symbol, and the question is whether children are able to use the symbol–referent relation to solve the problem.

In studies employing models, children watch as an experimenter hides a miniature toy in a scale model of a room (see DeLoache, 2002, for a review). They are then asked to retrieve a similar, larger object hidden in the corresponding location in the room itself. Children can succeed only if they understand that the events viewed in the model provide information about unseen events in the room. In terms of Gentner's structure mapping theory, the task requires children to represent and map the relational structure (toy and hiding place) from one space to the other (Gentner, 2003; Lowenstein & Gentner, 2001).

This research has revealed dramatic developmental change in very young children's exploitation of information provided by models, with excellent performance by 3.0-year-olds in the standard model task but very poor performance by 2.5-year-olds (DeLoache, 1987; DeLoache, Kolstad & Anderson, 1991; Dow & Pick, 1992; Kuhlmeier, 2005; O'Sullivan, Mitchell & Daehler, 2001). Both age groups are attentive to the hiding event, are motivated to find the hidden toys, and remember where the miniature toy is concealed in the model. However, most of the younger children do not use what they know about the location of the toy in the model to find the large toy in the room.

Successful performance in the model task has been interpreted as involving *representational insight*, that is, the appreciation of the symbolic or representational relation between the two spaces (e.g. DeLoache, 1987, 1995, 2002). According to this view, sensitivity to the higher-order 'stands for' relation between model and room supports older children's successful performance

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in the standard model task, and insensitivity to the relation contributes to younger children's failure. Representational insight in turn requires *dual representation* – being able to think about the model both as an object and at the same time as a representation of something other than itself.

The representational insight view has been challenged. For example, Perner (1991), Lillard (1993), and Blades and Cooke (1994) suggest that it is not necessary to posit awareness of the higher-level model–room relation to explain success in the retrieval task. Instead, they argue, 3-year-olds could solve the problem simply by noticing lower-level correspondences between objects in the two spaces: Matching the miniature chair in the model with the larger chair in the room could provide an adequate basis for successful searching.

There is no question that success in the model task requires detecting the object correspondences between the two spaces; it would be impossible to succeed otherwise. The question is whether the detection of low-level object correspondences is *sufficient* for success. Do children actually solve the task on that basis?

If they do – if the typical success of 3-year-olds in this task is based on exploiting low-level object correspondences – then the typical failure of 2.5-year-olds would reflect failure to detect those same low-level relations. It follows, then, that 2.5-year-olds, whose performance in the retrieval task is typically very poor, should be equally poor at simply detecting the correspondence between the objects in the two spaces.

On the other hand, if success in the model task involves representational insight – appreciation of the higher-level relation between the two spaces – then 2.5-year-olds might successfully detect the correspondences between the objects in the two spaces but still fail the retrieval task. They might appreciate that the miniature chair corresponds to the large chair without realizing that a hiding event involving the model chair represents an analogous hiding event with the large chair in the room.

Experiment 1

In Experiment 1, we tested the prediction that 2.5-year-old children would successfully detect object correspondences between model and room, but would nevertheless perform poorly in the standard model task. In the matching task, an experimenter simply pointed to an object in a scale model and asked the child to identify the corresponding object in the room. Previous research has shown chance-level symbol-based *retrieval* performance by 2.5-year-olds when an experimenter pointed versus hid a toy in a model (DeLoache, 1991 – 25%; Kuhlmeier, 2005 – 32%). In contrast, we expected here that an adult's point to an item in a model would be sufficient to guide children's *identification* of the corresponding object in the room.

Method

Participants

The participants in the *matching* condition included 12 children (six girls and six boys) between 29 and 33 months of age ($M = 30.4$ months). Comparison data came from eight participants (29.0 to 32.0 months, $M =$ 30.4) in an earlier standard model study (DeLoache, 2000, Experiment 2b) and from four additional children (two girls and two boys) of the same age recruited to equalize the number of participants in the two groups. (The comparison data were used because the results of a large number of model studies are highly consistent and replicable – see Sharon & DeLoache, 2003.) For both studies, names of potential participants were obtained through newspaper birth announcements, and parents were contacted by telephone. Most participants were European American and from middle-class homes.

Materials

The room ($6.51 \times 5.49 \times 2.55$ m) was furnished like a living room. A scale model of the room ($84 \times 74 \times 33$ cm) contained miniature versions of the furnishings that were perceptually similar to their larger counterparts. The arrangement of furniture in the two spaces matched, and the model was aligned in the same spatial orientation as the room. The hidden objects were a stuffed toy dog (18 cm high) and a small plastic dog (2 cm high). The hiding places for the toys were inside a basket, under a tablecloth, behind a chair, and under a pillow on a couch.

Procedure

Orientation. The *matching* group received the same extensive orientation as that typically used in the standard model task. The experimenter introduced the toys ('Big Snoopy' and 'Little Snoopy') and their respective rooms (the full-sized room and the model), pointing out and labeling every piece of furniture. To emphasize the correspondence between individual items, she took the furniture from the model and held each miniature item next to its larger counterpart in the room, explicitly drawing the child's attention to the correspondence between the two.

The experimenter finished the orientation with a demonstration placement that introduced the wording for the matching trials. Placing the small toy on the model coffee table, she said, 'Little Snoopy is sitting on this [points to table]. I'm going into Big Snoopy's room to find the one that looks the same as this [points to table], and I'm going to set Big Snoopy on it.'

Matching task. Immediately following the orientation, the *matching* group was asked to identify the correspondence between furniture in the two spaces. On each of four trials, the experimenter pointed to an item of furniture in the model and *without naming it* said, 'See, this is Little Snoopy's. Go in Big Snoopy's room and show me the one that looks like this one.' If the child indicated the wrong item, the experimenter gave feedback: 'No. Here's the big one that matches the little one I showed you.' Only the child's first response was counted.

Standard model task. Immediately after the matching task, the children in the *matching* group participated in the standard model task. The experimenter stated that they would now play a hiding game. On each of the four retrieval trials, the experimenter hid the miniature toy in the model while directing the child's attention to the event (without labeling the hiding place): 'Look, Little Snoopy is hiding right behind [in, under] here [pointing to the toy and/or its hiding place]. Now I'm going to help Big Snoopy hide in the same place as Little Snoopy. Then you can come find him.' After the experimenter had hidden the larger toy, the child was encouraged to search for it in the room (symbol-based retrieval 1). Prompts ensured that it was eventually found, but only the first search was counted. Then the child was taken back to the model and asked to retrieve the miniature toy hidden at the beginning of the trial (memory-based retrieval 2).

The *comparison* group participated in the standard model task only. For the practice trial at the end of the orientation, the experimenter put the miniature toy on the coffee table in the model and told the child to put the big toy in the same place in the room (providing correction, if necessary). Immediately following the orientation, the child participated in four retrieval trials.

Note that in both of the tasks, the intent of the experimenter's actions was emphasized. She verbally announced her intentions multiple times. In the Matching task, she pointed directly at the relevant location in the model, while instructing the child what to do in the room. In the Model task, she explicitly drew the child's attention to the act of hiding, making sure the child was looking as the toy was put in place, pointing at the toy in its hiding position and/or patting the hiding place after the toy was out of sight.

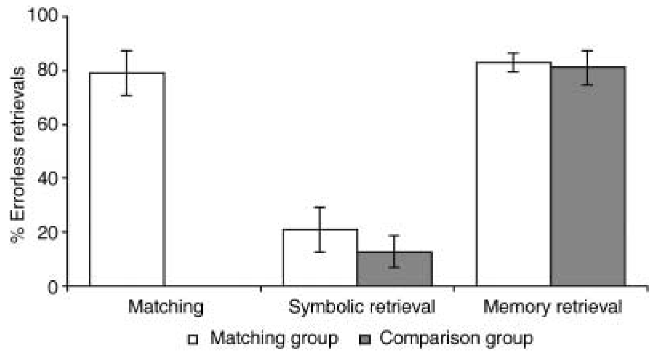

Figure 1 *Percentage of errorless retrievals achieved by 2.5-year-olds on the matching task and retrieval task by the matching and comparison groups in Experiment 1 (bars represent standard errors of the mean).*

Results and discussion

The results were straightforward. As shown in Figure 1, the children in the matching group accurately detected the corresponding individual objects in the two spaces ($M = 79\%$ correct across trials). Nevertheless, they were markedly unsuccessful at using those object correspondences as a basis for performing the symbolic retrieval in the room (21% – not significantly different from 13%, chance).[1] Their performance was comparable to that of the comparison group (13%) who had not experienced the matching task first.[2] Furthermore, the retrieval performance of both groups was similar to that reported for this age group in many previous model studies (see Sharon & DeLoache, 2003). In contrast, and again comparable to previous research, the memory retrieval performance of the children in both groups was very high (matching, 83%; comparison, 81%).

Preliminary analyses revealed no effects of gender, age, or order. The primary analysis compared success rates for the children in the matching condition when choosing the corresponding object versus retrieving the toy from the room. A one-way within-subjects ANOVA revealed a main effect of task: $F(1, 10) = 43.12$, $p < .0001$ (effect size: $d = 1.9$). The children were significantly better at identifying the corresponding objects in the two spaces than they were at retrieving the toy from the room based on the location of the toy in the model.

[1] The chance level of 13% was based on the number of potential hiding places in the room, i.e. the number of places that could fully conceal the toy.

[2] The retrieval rate over the four trials in the symbolic task was 25%, 8%, 8%, and 42% for the matching group and 25%, 8%, 0%, and 17% for the comparison group, with no significant differences over trials. Children's spontaneous error correction rate (8%, matching group; 10%, comparison group) provided no evidence of latent knowledge of the location of the toy in the room.

The pattern of individual performance indicated that success on the retrieval task was associated with prior success on the matching task: No child who failed to match passed the search task. One child was successful (chose the correct object on three or four trials) on both tasks, and four were unsuccessful on both. Seven children succeeded on matching but searched correctly only once or never.

Our final analysis confirmed that the performance of the matching and comparison groups in the retrieval task did not differ. A 2 (group: matching versus comparison) × 2 (retrieval type: symbolic versus memory) mixed ANOVA revealed only a main effect of retrieval type, $F(1, 21) = 144.09$, $p < .0001$ (effect size: $d = 2.48$), indicating that memory retrieval was much easier than symbolic retrieval for both groups.

Experiment 1 shows that 2.5-year-olds are capable of identifying the lower-level object correspondences involved in the model task, but the very same children fail to rely on those object correspondences to solve the standard retrieval task – even when tested immediately afterward. By showing that success in the model task involves something more than detecting correspondences between objects, the results provide support for the representational insight account: To solve the retrieval task, children must detect the representational relation between model and room.

Further support for this account could come from testing older children, using a *low-similarity* version of the scale model task in which 3-year-olds have performed relatively poorly in earlier research (DeLoache *et al.*, 1991; Marzolf & DeLoache, 1994). In this task, the items in the two spaces differed in surface appearance (color and material).

Experiment 2

We predicted that the same pattern of performance reported in Experiment 1 for 2.5-year-olds would be found for 3-year-olds in the low-similarity task. That is, these children should detect the correspondence between the comparable objects in the two spaces, even with differing surface appearance, but they should show the relatively poor performance typical of 3-year-olds in this retrieval task.

Method

Participants

The participants included 12 children (five girls and seven boys) between 34.7 and 37.5 months of age (M = 36.3 months), recruited as in Experiment 1. Comparison data came from 11 participants (35.5 to 40.5 months, M = 37.5) in an earlier low-similarity model study (Marzolf & DeLoache, 1994, Experiment 2).[3]

Materials

The research employed a tent-like portable room (1.9 × 2.5 × 1.9 m high) and a scale model of the room (46 × 70 × 38 cm) used in earlier studies (DeLoache *et al.*, 1991; Marzolf & DeLoache, 1994). Both spaces were constructed of plastic pipes supporting white fabric walls, and were furnished with several items of furniture.[4] Each item of miniature furniture was perceptually different from its larger counterpart (i.e. made of or covered with different material and of a different color). The arrangement of furniture in the two spaces and the alignment of the spaces was the same. The hidden toys were large and small toy frogs, referred to as Big and Little Freddy. The hiding locations included behind a dresser, behind a chair, inside a basket, and under a floor pillow.

Procedure

All aspects of the procedure – including the orientation, matching trials, and retrieval trials – were the same as in Experiment 1, except that the wording was modified slightly to reflect the dissimilar appearance of the furniture pairs. During the retrieval trials, the experimenter said to the child, ‘See, this is Little Freddy’s. Go in Big Freddy’s room and show me one that’s like this one.’

Results and discussion

The pattern of results was very similar to that in Experiment 1 (see Figure 2). The children in the matching group accurately matched the corresponding individual objects in the two spaces (M = 79% correct across trials), but they were less successful searching in the room (48%).[5] Symbolic retrieval performance was above chance, $t(11)$

[3] We included only participants who saw the toy hidden in the model and searched in the room (other children encountered the spaces in the opposite order).

[4] The earlier study used a white cardboard box as the surrounding space rather than the cloth model; in a direct comparison, this difference had little effect on performance (DeLoache *et al.*, 1991, Experiment 1). These studies used large and small toy dogs as the hidden objects.

[5] Performance on the four symbolic retrieval trials was 33%, 50%, 42%, and 67% for the matching group and 55%, 46%, 36%, and 64% for the comparison group, with no significant differences across trials. Children’s spontaneous error correction rate (14% for both the matching and comparison group) provided no evidence of latent knowledge of the hiding places.

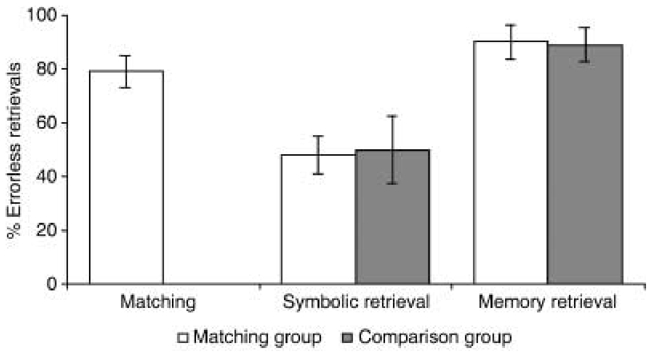

Figure 2 *Percentage of errorless retrievals achieved by 3-year-olds on the matching task and low-similarity retrieval task by the matching and comparison groups in Experiment 2 (bars represent standard errors of the mean).*

= 3.19, $p < .01$, and similar to that of children in the comparison group.[6] Children in both groups were highly successful at remembering the location of the small toy hidden in the model (90% and 89% correct memory retrievals).

Preliminary analyses revealed no gender, age, or order effects. A one-way within-subjects ANOVA revealed only a main effect of task, $F(1, 10) = 16.84$, $p < .01$ (effect size: $d = 1.18$). Like the younger children, the 3-year-olds were significantly better at identifying the correspondence between objects in the two spaces than they were at retrieving the toy from the room based on the location of the toy in the model.

At the individual level, there also was a significant difference across task: nine of the 12 children chose the correct object on three or four of the four trials in the matching task, compared to only four children in the symbol-based retrieval task (Fisher's Exact Test, $p < .05$). With respect to the pattern across tasks, three children succeeded (were correct on three or four trials) at both tasks, two were unsuccessful at both, and six succeeded at matching but not symbolic retrieval. A single child was more successful on retrieval than matching trials (three vs. two trials correct, respectively).

The performance of the matching and comparison groups did not differ in the retrieval tasks. A 2 (group: matching versus comparison) × 2 (retrieval type: symbolic versus memory) mixed ANOVA revealed only a main effect of retrieval type, $F(1, 20) = 31.57$, $p < .001$ (effect size: $d = 1.2$), reflecting the fact that memory retrieval was easier than symbolic retrieval for both groups.

The results of Experiment 2 thus agree with those of Experiment 1. In both cases, most children could detect the correspondence between the hiding places in the model and room, but most nevertheless performed poorly on the symbolic retrieval task. Crucially, four of the five children in the two studies who performed well in the retrieval task had previously performed well in the matching task. This fits with the claim that successful retrieval requires matching, but matching in no way guarantees retrieval.

General discussion

The research reported here tested a challenge to the proposal that representational insight is the central factor in young children's successful use of a scale model as a source of information. By the proposed alternative account, success in the task could simply be attributable to recognition and exploitation of the individual low-level correspondences between analogous items in the model and room (Blades & Cook, 1994; Lillard, 1993; Perner, 1991).

The current experiments demonstrate that being able to match the objects in the two spaces does not ensure success in the basic model task. Having successfully completed the matching task, both 2.5- and 3.0-year-olds performed poorly in the retrieval task just minutes later. Thus, although establishing the lower-level object matches between model and room is necessary, it is not sufficient for successful symbolic retrieval. Some representation of the higher-level relation between the two spaces is also needed. The answer to the question that originally motivated the present research is thus clear: Children do not succeed in the scale model task simply on the basis of noticing the individual low-level correspondences between model and room.

It is important to consider one procedural difference between the two tasks: The fact that the experimenter pointed to an item in the model in the matching task but hid a toy in the model in the retrieval task. In discussing the retrieval task, Kuhlmeier (2005) has suggested that pointing may be better than a hiding event for illuminating 'the communicative intent of the experimenter' (p. 368). In other words, the intention underlying an act of pointing to direct the child's search may be inherently simpler for young children to understand than a hiding event performed for the same purpose. (In both cases, of course, extensive verbal information about the adult's intentions accompanies the pointing or hiding, so neither the act of pointing or hiding is ever the *sole* source of information for the child.)

Did our participants do better in the matching task because pointing conveyed the researcher's intentions more clearly than hiding the toy in the retrieval task did?

[6] The chance level of 25% was based on the number of potential hiding places in the portable room.

In two scale model retrieval tasks, a pointing gesture was substituted for a hiding event. In one (DeLoache, 1991), performance was not better than in the standard task. In another (Kuhlmeier, 2005), 2.5-year-olds did well on the first trial (17 of 20 correct), but performance on subsequent trials fell to the typical low level. In contrast, in the studies reported here, children's performance in the matching task was consistently high across all trials.[7] Thus, the overall pattern of results indicates that pointing leads to a different level of performance depending on whether the gesture directs children to match objects or to detect and use a symbolic relation. The difference in performance in the two kinds of tasks is not due to pointing versus hiding events.

However, intriguing new questions are raised by the current studies and earlier ones in which the experimenter pointed to an item of furniture in the model to indicate a target in the room (DeLoache, 1991, 2000; Kuhlmeier, 2005). In two retrieval tasks in which pointing was combined with another factor that might also make the task easier, children of the same age were markedly more successful (DeLoache, 2000; Kuhlmeier, 2005). The first case comes from Kuhlmeier's study (2005), which included a condition incorporating two modifications. One was that the experimenter pointed to the correct location in the model. The second was designed to discourage perseverative searching. (Searching on trial *n* in the location where the toy was found on the preceding trial is the most common type of error in the model and other search tasks – Sharon & DeLoache, 2003.) To motivate the children to try to find the hidden toy on their first search, a contingency procedure was used: Instead of allowing the children to continue searching for the toy after an initial error, as in the standard task, the experimenter rewarded them with a sticker for finding the toy in the *first* location they searched.[8]

Children in this Contingency + Point Model condition were relatively successful, retrieving the toy 60% of the time (above chance). This level of performance was significantly better than that in the standard model task (35%) and in conditions that included only one of the modifications (Standard model task with Contingency – 20%, or with Point – 40%). Thus, retrieval performance was substantially improved only in the task that included *both* pointing to the correct location and a reward for a correct first search.

This pattern of results is consistent with the theoretical model of performance in the scale model task offered by DeLoache (1995, 2002), which proposes that successful retrieval results from the complex interaction of multiple factors. It follows that a given factor might have an observable effect only in combination with some other factor. Thus, performance was enhanced only when Kuhlmeier (2005) combined pointing to the correct location with another modification also designed to make the model task easier.

A similar account may be appropriate for another model study involving pointing and a relatively high rate of success by 2.5-year-olds – the window task reported by DeLoache (2000). This study was designed as a test of dual representation – the idea that success in the model task requires mentally representing the model both as an object and as standing for something other than itself. The idea was to make it easier for 2.5-year-old children to achieve dual representation by making the model less salient as a physical object.

One modification was that the model was put behind a window so the children never directly interacted with it. Second, the experimenter never directly interacted with the model either; instead, she simply *pointed* to a location to communicate to the child where to search in the room. (This procedure was based on the previous finding that 2.5-year-olds' performance in the model task was no better when pointing was substituted for a hiding event – DeLoache, 1991.) These modifications had an impact on performance: After watching the experimenter point to the relevant location in the model behind the window, the children were significantly better (54% correct retrievals) at finding the toy hidden in the room than were children in the standard model task (28%).

It is possible that the positive result occurred in part because the pointing event was simpler than a hiding event would have been. Thus, as in Kuhlmeier's Contingency + Point condition, the enhanced performance in the window task could have been due to the *combination* of two factors – reduced physical saliency *and* pointing.

This possibility could be tested in future research by using the window task, but substituting a standard hiding event for pointing. If performance were similar to that found before in the window task (and better than in the standard model task), it would show that pointing did not play a crucial role in the original study. In turn, this result would indicate that pointing is not inherently clearer than a hiding event with respect to communicative intent.

In summary, the primary contribution of the present research was to rule out an alternative account of successful performance in the scale model task, thereby providing evidence that exploiting the informational potential of a model requires some appreciation of its higher-level representational relation to what it stands for. According to the theoretical model offered by DeLoache (2002),

[7] Of the 12 children in each experiment, the number matching per trial was 8, 9, 11, and 10 (Experiment 1) and 9, 9, 10, and 10 (Experiment 2).
[8] A similar procedure had a positive impact on the success of chimpanzees in a scale model task (Kuhlmeier & Boysen, 2001).

it is necessary to achieve representational insight into the model–room relation to use the model as a source of information. Further, in conjunction with previous research, these studies raise questions for future investigation concerning the specific role of pointing in providing information to very young children. The answers provided here to an old question and the new questions that are raised both emphasize the importance of the coalescence of multiple factors in very young children's use of symbolic objects.

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References

Blades, M., & Cooke, Z. (1994). Young children's ability to understand a model as a spatial representation. *Journal of Genetic Psychology*, **155**, 201–218.

DeLoache, J.S. (1987). Rapid change in the symbolic functioning of very young children. *Science*, **238**, 1556–1557.

DeLoache, J.S. (1991). Symbolic functioning in very young children: understanding of pictures and models. *Child Development*, **62**, 736–752.

DeLoache, J.S. (1995). Early symbol understanding and use. In D. Medin (Ed.), *The psychology of learning and motivation: Vol. 33* (pp. 65–114). New York: Academic Press.

DeLoache, J.S. (2000). Dual representation and young children's use of scale models. *Child Development*, **71**, 329–338.

DeLoache, J.S. (2002). Early development of the understanding and use of symbolic artifacts. In U. Goswami (Ed.), *Blackwell handbook of childhood cognitive development* (pp. 206–226). Malden, MA: Blackwell.

DeLoache, J.S., Kolstad, D.V., & Anderson, K.N. (1991). Physical similarity and young children's understanding of scale models. *Child Development*, **62**, 111–126.

DeLoache, J.S., Peralta de Mendoza, O.A., & Anderson, K.N. (1999). Multiple factors in early symbol use: instructions, similarity, and age in understanding a symbol–referent relation. *Cognitive Development*, **14** (2), 299–312.

Dow, G.A., & Pick, H.L. (1992). Young children's use of models and photographs as spatial representations. *Cognitive Development*, **7**, 351–363.

Gentner, D. (2003). Why we're so smart. In D. Gentner & S. Goldin-Meadow (Eds.), *Language in mind: Advances in the study of language and thought* (pp. 195–235). Cambridge, MA: MIT Press.

Kuhlmeier, V. (2005). Symbolic insight and inhibitory control: two problems facing young children on symbolic retrieval tasks. *Journal of Cognition and Development*, **6** (3), 365–380.

Kuhlmeier, V.A., & Boysen, S.T. (2001). The effect of response contingencies on scale model task performance by chimpanzees (*Pan troglodytes*). *Journal of Comparative Psychology*, **115**, 300–306.

Lillard, A.S. (1993). Pretend play skills and the child's theory of mind. *Child Development*, **64**, 348–371.

Loewenstein, J., & Gentner, D. (2001). Spatial mapping in preschoolers: close comparisons facilitate far mappings. *Journal of Cognition and Development*, **2** (2), 189–219.

Marzolf, D.P., & DeLoache, J.S. (1994). Transfer in young children's understanding of spatial representations. *Child Development*, **65**, 1–15.

O'Sullivan, L.P., Mitchell, L.L., & Daehler, M.W. (2001). Representation and perseveration: influences on young children's representational insight. *Journal of Cognition and Development*, **2** (4), 339–365.

Perner, J. (1991). *Understanding the representational mind*. Cambridge, MA: Bradford Books, MIT Press.

Sharon, T., & DeLoache, J.S. (2003). The role of perseveration in the symbolic object-retrieval task. *Developmental Science*, **6**, 289–296.

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