

## Means of communication and sources of information: Two-year-old children's use of pictures as symbols

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People use pictures for many purposes, but two common functions are to communicate information to others and to extract new information. Previous research has demonstrated that 2-year-old children fail in using pictures as sources of information in search tasks (DeLoache & Burns, 1994). The purpose of this research was to investigate if children this age could, nonetheless, communicate via a picture the location of an object they have observed being hidden and, if so, whether experience with this function can facilitate using pictures as sources of information. Results show that children successfully used pictures to communicate information and that the symbolic awareness children gained with this task was rapidly transferred to one that required using pictures to extract information, task in which they otherwise fail.

**Keywords:** External representations; Pictures; Symbolic relations; Communication.

Pictures constitute a kind of external representation children in western cultures are exposed to very early in life. The ability to recognise, understand, and use pictures develops over the first few years and is a complex and lengthy process (DeLoache, Pierroutsakos, & Troseth, 1996; Ittelson, 1996; Rochat & Callaghan, 2005). The nature and the sequence of how children come to understand pictures as symbols are not completely known yet.

Pictures are symbolic artifacts that serve many functions. Among other functions, pictures serve as sources of information: It is possible to acquire new information via pictures. They also serve as a means of communication: Pictures transmit, amplify, and update information. Given the many

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This research was supported by Grant PIP 03-038 from the National Research Council and by Grant PICT 04-10882 from the National Agency for Scientific Promotion to the first author. We are grateful to the day-care centres and children who participated in this study.

functions that pictures have, understanding and using them requires a certain degree of cognitive flexibility.

As an important body of research has clearly established (DeLoache, 1987, 1991; DeLoache & Burns, 1994; Troseth & DeLoache, 1998), 2-year-old children fail in using pictures as sources of information to find an object hidden. The purpose of the present research consisted in finding out if children this age could, nonetheless, be able to communicate via a picture the location of an object they have observed being hidden and, if so, whether experience with this task can facilitate using pictures as sources of information.

In the last few years a number of researchers investigated young children's understanding of the symbolic functions of pictures. For example, Preissler and Carey (2004) demonstrated that 2- and even 1.5-year-old children take pictures and words as symbols for objects in the real world. Children repeatedly heard the name of a novel word—"whisk"—paired with a line drawing of an unfamiliar (to them) object—a whisk. Then they were shown the drawing paired with the object and asked "to point to the whisk". The toddlers picked either the object, or both the object and the picture, never the picture alone, showing that they assumed that the label referred to the object. In this way, the authors provided evidence that very young children do understand the referential relation between pictures and objects interpreting pictures and words symbolically.

Also, Harris, Kavanaugh, and Dowson (1997) asked young children to select a picture that showed the outcome of either real or pretend actions performed by an experimenter, for example pouring or pretending to pour tomato sauce on a toy. Children saw pictures of the clean toy, of the toy with tomato sauce on it, and of the toy with a white spot on its neck. Children younger than 2 years of age chose randomly between the three pictures, but children over 2 years succeeded by selecting the picture of the intended outcome. Among other issues, this study shows that small children are able to use pictures to communicate information about real and pretend actions.

As far as pictures as sources of information, DeLoache and colleagues (DeLoache, 1987, 1991; DeLoache & Burns, 1994) carried out a series of experiments in order to find out if young children can extract information from pictures to solve a problem. These studies used an object-retrieval paradigm in which an object was hidden in a room and the information about its location was provided by a picture. Two-and-a-half-year-old children were quite successful in the task. On the other hand, 2-year-olds did not show any evidence of having made the symbolic connection between room and picture. The 2-year-olds' poor performance has been replicated using videos instead of pictures as sources of information (Troseth & DeLoache, 1998; Schmitt & Anderson, 2002; Troseth, 2003).

In addition to lack of symbolic awareness, it has also been argued that 2-year-olds fail this task due to perseverative searching; ruling out perseveration by analysing only first trial execution resulted in a moderate improvement of performance (Schmitt & Anderson, 2002; Suddendorf, 2003).

It is interesting to note that in DeLoache and Burns' (1994) study there were two manipulations in which 2-year-olds did succeed. First, children could find the toy when the experimenter told them where she put it (82% errorless searches) showing that children understand words as symbols before they understand pictures as symbols. Second, children were able to follow a request to put a toy at a place in a room indicated in a photograph (83% errorless placements), showing that they recognise the correspondence between a picture and the object it represents.

In summary, as a substantial body of research (DeLoache, 1987, 1994; DeLoache & Burns, 1994; Schmitt & Anderson, 2002; Troseth & DeLoache, 1998) has clearly demonstrated, 2-year-olds fail in using pictures as a source of information to solve search tasks. On the other hand, at this age children are able to use pictures referentially (Preissler & Carey, 2004), to match a real or imaginary situation with their pictorial representation (Harris et al., 1997), and to recognise picture-object correspondences (DeLoache & Burns, 1994). These evidences made us hypothesise that 2-year-old children might also be able to use pictures as a means of communication in a search task.

In the present research we specifically investigated if children this age could demonstrate being able to point in a picture the location of an object they have just seen having been hidden in a room—*point task* (Study 1). We also explored if this type of previous experience could improve children's use of a picture as a source of information in the standard search task (Study 2).

Previous experience has been proposed as a mechanism for promoting *symbolic sensitivity*, "a general expectation or readiness to look for and detect symbolic relations among entities" (DeLoache, 2002, p. 216). Evidence supporting this hypothesis comes from transfer studies that showed that 3- and 2.5-year-olds have transferred both within (from more to less iconic scale models) and across symbolic media (e.g., from pictures to scale models) (DeLoache, 1991; DeLoache, Simcock, & Marzolf, 2000; Marzolf & DeLoache, 1994; Peralta de Mendoza & Salsa, 2003; Troseth & DeLoache, 1998). In these studies, performance on an easier version of a search task was associated with a better performance on a more difficult, highly analogous version of the same task. In Study 2 we examined transfer effects between two different tasks, as the point task is not a version of the search task, but is a different task in nature. In the point task children had

to use a picture as a means of communication, whereas in the search task they have to use it as a source of information.

## STUDY 1

The purpose of this study consisted in finding out if 2-year-old children were able to indicate in a photograph of a room the location where they have just seen a toy being hidden.

### Method

#### *Participants*

Fourteen children ranging in age from 24 to 26 months ( $M = 25.6$  months; six females and eight males) participated in this study. The children of this and the following study were from a large city in Argentina, they were recruited through day-care centres, and they were middle and lower-middle class.

#### *Materials*

A portable room and its colour photograph. The room ( $95 \times 80 \times 65$  cm) was constructed of fabric supported by pipes, with the front open; it contained an armchair, floor pillows, a table, a basket, a dresser, a plant, and a curtain. A divider separated the room from a low table on which the photograph was displayed, so that the children could not see the room and the photograph simultaneously.

The photograph ( $16 \times 20$  cm) depicted a front view of the entire space clearly showing all pieces of furniture. During the experimental trials a small toy child was hidden.

#### *Procedure*

The sessions took place in a room of the children's day-care centre. Two experimenters were present during the session, one to interact with the children and the other to videotape the children's behaviour.

The session lasted approximately 20 min and began with an orientation phase in which children were familiarised with the materials. First, the experimenter introduced the toy ("Pete") to the children. She then oriented the children to the room ("This is Pete's house") naming all the items of furniture. Afterwards, she presented the photograph ("This is a picture of Pete's house"), naming each piece of furniture in the photo and making an explicit comparison between each one of them and the real ones in the room.

This orientation was followed by a demonstration, the purpose of which was to try to highlight the room-photograph symbolic relationship. During this demonstration, children were given a placement trial. The experimenter, pointing to the table in the photograph said: "Pete wants to go to his house and sit right there. Can you help him?". If the child failed, the experimenter helped them. Finally, the picture-referent relationship was again stressed: "Very good. Pete is sitting at his table (pointing to the real table) and here is his table in the photograph (pointing to the photo)".

*The test-point task.* This task followed the demonstration. During the test children were given six trials, each trial consisted of: (a) hiding (memory segment), (b) point-picture (test segment), and (c) retrieval (memory segment). The hiding locations were in the basket, under the armchair, under the table, in the dresser, behind the plant, and under the floor pillows. The children received two hiding orders; half the children received one and half the other.

On each trial, first, the children watched the experimenter hide the toy while they were reminded that their job was to remember where the toy was hidden (hiding event). Immediately after, the children and the experimenter went to the other side of the divider where the photograph was displayed (test segment). The experimenter then asked the children to point to the photograph to the place where the toy was hidden: "Can you show me the photo where Pete is hiding in his house?". If the children did not respond, the experimenter repeated the instruction once. If the child pointed to a wrong place, they were not corrected.

Afterwards, the children returned to the room in order to retrieve the hidden toy (memory segment). If the children did not find the toy, the experimenter helped them.

## Results and discussion

Analyses were carried out on the number of correct trials. Subjects were credited with a correct trial if they pointed to the right hiding place in the photograph in their first attempt. Observers were able to easily determine where the child was pointing, because each piece of furniture was depicted in the photograph.

Although percentages of correct trials are used throughout the study to facilitate comprehension and comparison with other studies, the number of errorless retrievals was used for all statistical analyses.

The results demonstrate that 2-year-old children are quite capable of using a picture as a means of communication in this task; they suc-

pointed to the hiding location 74% of the time. This performance was significantly above chance,  $t(13) = 11.40$ ,  $p < .05$ .

The good performance of the children could be observed looking at their individual performance. Of the 14 participants, four pointed to the right location on all six trials, three on five trials, and four on four trials. Only three children seemed not to understand the photograph-referent relationship; they had scores of three and two correct trials.

Although relatively few errors were committed, an interesting set of data arises from their analysis. Of the 17 errors, six (35%) were pointing to the last previous location (perseverative), six (35%) to any other location, and five (29%) did no pointing at all. Research using search tasks have repeatedly reported that the most common errors children make are perseverative ones (O'Sullivan, Mitchell, & Daehler, 2001; Sharon & DeLoache, 2000; Suddendorf, 2003). The similar rates found in this study for the three types of errors suggest that this novel point task seems not to specially trigger perseveration.

Finally, children's performance on the memory segment of the task was extremely high (93% correct on the first attempt).

The results of this study show that 2-year-old children understood the photograph-referent symbolic relationship, being able to use it to communicate what they knew about an observed reality.

## STUDY 2

The purpose of this study consisted in examining whether experience in the point task has an impact on the subsequent performance of 2-year-olds on the standard search task. We hypothesised that if children succeeded in using pictures as a means of communication, they might come to realise that pictures have a variety of functions, being able to use them also as sources of information.

### Method

#### *Participants*

Twenty-two 2-year-old children participated in this study, eleven in the experimental group (23.5–26 months,  $M = 25.69$  months; four females and seven males) and eleven in the control group (23.5–26 months,  $M = 25.69$  months; six females and five males). The children of this study were recruited in the same way as the children in Study 1.

#### *Materials*

The materials were the same as those used in the previous study.

### Procedure

Children were tested on two consecutive days. On Day 1, the experimental group received the *point task* (as described in Study 1) and the control group received a *search task* (DeLoache, 1987, 1991; DeLoache & Burns, 1991, Study 1). On the following day, Day 2, both groups were tested with the *search task*.

*The search task.* The orientation and demonstration phases were the same in the search task as the ones used in the point task. The test included six hiding/retrieval trials with a different hiding place each. There were alternating hiding orders; half the children received one and half the other.

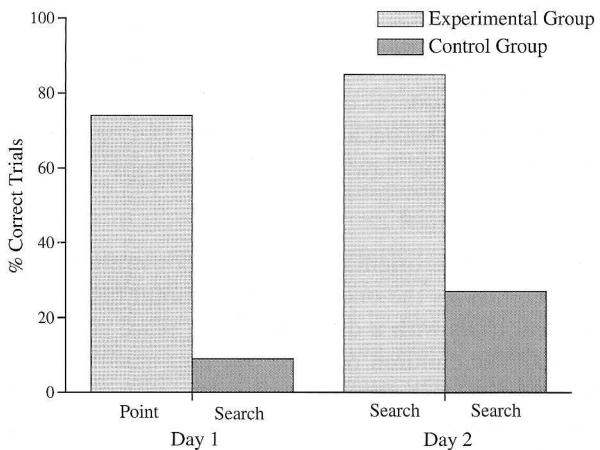
At the beginning of each trial the experimenter said "I'm going to hide Pete in his house, and when I come back you can go and find him". The children remained seated at the table where the picture was displayed while the toy was being hidden in the room outside of the view of the children. Then, the experimenter returned and pointed to the hiding place on the photo saying, "This is where Pete is hiding in his room. Go find him!" If the children failed on their first search, the experimenter encouraged them to continue searching. If children did not retrieve the toy, the experimenter

### Results and discussion

As in Study 1, the dependent measure used to assess performance was the number of correct trials. To be scored as a correct trial, the children had to find the point (point task) or search (search task) correctly on the first attempt with no help.

The results found provide strong evidence that detecting the photograph-room relation in the point task on Day 1 enabled the experimental group to solve the search task on Day 2, a task in which 2-year-olds otherwise fail. Figure 1 shows the mean level of correct trials for the experimental and control groups. Children in the experimental group were successful on both the point task (74%) on Day 1 and the search task (85%) on Day 2. Their performance in the search task (Day 2) was far more superior to the performance of the control group on both Days 1 (9%) and 2 (27%).

The transfer effects were tested with two different comparisons. First, the performance of the experimental group on Day 2 (search task) was compared with the performance of the control group on Day 1 (search task) in order to verify that prior experience with the point task was critical to succeed in the search task. An independent-samples *t*-test showed that the experimental group on Day 2 was significantly better (85%) than the control group on Day 1 (9%),  $t(20) = 9.80, p < .005$ .



**Figure 1.** Percentage of correct trials across day for the experimental and control groups

Next, we compared the performance of the two groups on Day 2 (search task) in order to examine whether the transfer effect was over and above the effect of experience with materials and procedures. Again, in Day 2, children in the experimental group (85%) performed significantly better than children in the control group (27%),  $t(20) = 5.05$ ,  $p < .005$ .

The individual performance of the subjects was also analysed. According to the logic of the transfer design, children who were successful on Day 1 should be much more likely to succeed on Day 2. Children were classified as successful if they attained a score of four or more correct trials out of five. In the experimental group, of the nine children who were successful on Day 1, eight also succeeded on Day 2. Furthermore, six of these eight subjects reached a perfect score.

As far as the control group, none of the 11 subjects was successful on Day 1, but two succeeded on Day 2 with five correct trials each. In fact, the 20% score of this group on Day 2 was attributable to these two children. Taking a closer look into these two children's performance on Day 1 we can see that one child succeeded on the last three trials and the other had one correct trial and three self-corrections after perseverative errors. It seems to be that these two children came to appreciate the symbolic function of the picture during the first session which led them to reach a successful performance on Day 2.

Finally, we analysed children's errors. Overall, children of the experimental group committed very few errors. In the point task (Day 1), the errors consisted of seven (41%) pointing to the last previous location, eight (47%) pointing to any other location, and two (17%) doing no pointing at all. This pattern closely follows that found in Study 1, showing, once again,



that this novel point task seems not to trigger perseveration. On the other hand, on the search task (Day 2), most of the errors committed by the same children were perseverative, six (40%) against four (40%) for pointing to any other location.

The pattern of errors of the control group (search task both days) was clearly different. On Day 1, 39 errors (65%) consisted of pointing to the immediate previous location, 10 (17%) of pointing to other location, and 11 (18%) doing no pointing; on Day 2, the errors were 27 (56%), 18 (37.5%) and 3 (6.5%), respectively. In sum, the errors committed in the search task by both groups are in line with the literature in the field that has repeatedly reported perseveration as the most common error in this kind of task.

The results of this study clearly show that the symbolic awareness 2-year-old children reached in a task where the function of the photograph was to communicate information, was transferred to a task that demanded using the photograph as a source of new knowledge, a task they otherwise fail.

## GENERAL DISCUSSION

The major findings reported here are that 2-year-old children are quite capable of pointing in a photograph the location of an object that they have just seen being hidden, and that after a brief experience with this point task they perform remarkably well in a search task where information about the location of a hidden object was provided by a photograph. The high performance of 2-year-old children in the point task is somehow surprising given the persistent failure of 2-year-olds in search tasks (DeLoache, 1988, 1991; DeLoache & Burns, 1994; Troseth & DeLoache, 1998); a failure also documented by the control group of the present research. The results found in the point task indicate that 2-year-olds are able not only to connect an observed situation with its picture, but also to use the picture to communicate knowledge.

Now, why might there be such discrepancy in children's performance on these two tasks? It could be due to the cognitive demands involved. In the point task, the mental image the children had to use to guide their behavior is based on their direct experience with reality; that is, it is sustained in the observation of the actual concealing of the toy. On the other hand, in the search task the picture represents a source of new knowledge about a currently unseen reality. In order to exploit it, the children have to form a mental model of the toy hidden in the room based on a picture, but children behave as if the information provided by the picture had nothing to do with the present reality. The point task, compared to the search task, has fewer representation and mapping demands.

The reported discrepancies might also be due to the early experiences children have with pictures. Parents usually do not provide new knowledge using pictures, instead, they usually ask children to identify people or objects that they know or should recognise in pictures, for example, "do you know Grandpa" or "show me the dog" while displaying photographs or picture books (e.g., Peralta de Mendoza, 1995). Parents also frequently point to correspondences between pictures and real-world equivalents, in many cases not just to the memories of such real-world references the child has experienced, but to things immediately present, like toys, household objects, or natural entities (animals, plants). These early experiences are linked to the use of pictures to convey information, a function that is present in the first year of life (Liszkowski, Carpenter, Striano, & Tomasello, 2006). The pointing gesture is a communicative signal that children already knew when entering the point task.

Given the persistent failure of 2-year-old children in search tasks, it is somehow surprising that the representational insight gained in the point task could be so rapidly transferred to the search task. The only study so far that has also reported successful transfer at this age was the one carried out by Troseth (2003). She gave 2-year-olds an extensive 2 weeks' experience at home with video; then she tested them in the laboratory in a search task where the information about the location of the hidden object was provided by a video image, a task in which they normally fail (Troseth & DeLoache, 1998). After the extensive home training, the children performed successfully in the video task (77% correct), and also in a task in which the information was provided by photographs (60% correct).

The children we tested performed impressively well on the search task (85% correct) after a single previous experience with the point task. This experience probably increased "symbolic sensitivity" (DeLoache, 2000, p. 216), allowing children to look for and detect other symbolic relations.

One novelty regarding the type of transfer we studied consisted in having looked at transfer between symbolic tasks that differed in *content* (according to the taxonomy of transfer proposed by Barnett & Ceci, 2002). The transfer studies done by DeLoache and colleagues using the object-retrieval paradigm have manipulated only *context* variables (for a review see DeLoache et al., 2004): Performance on an easy task was associated with a better performance on a more difficult highly analogous version of the same task than otherwise obtained. Although easier, the point task is not a version of the search task; it is a different task in nature. It could be that the experience of using a picture to communicate information to others helps children achieve an insight that someone else could be using the picture to communicate information to them. With this type of experience children may have come to understand communicative intentions bidirectionally, from both the listener's and the speaker's perspectives (Tomasello, 1999).

From the studies reported here, one obvious observation to be drawn is that not all picture-referent relations are transparent for young children. What they can do is to use pictures to communicate information. With this specific previous experience, or a few months later on their own, they will also learn that pictures can have a variety of functions, including being sources of new information. Flexibility in the comprehension and use of symbols constitutes a crucial step in the route to mature symbolisation.

Original manuscript received March 2006

Revised manuscript received August 2006

First published online September 2006

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