

Research Report

GRASPING THE NATURE OF PICTURES

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Abstract—*The role of experience in the development of pictorial competence has been the center of substantial debate. The four studies presented here help resolve the controversy by systematically documenting and examining manual exploration of depicted objects by infants. We report that 9-month-old infants manually investigate pictures, touching and feeling depicted objects as if they were real objects and even trying to pick them up off the page. The same behavior was observed in babies from two extremely different societies (the United States and the Ivory Coast). This investigation of pictures occurs even though infants can discriminate between real objects and their depictions. By the time infants are 19 months of age, their manual exploration is replaced by pointing at depicted objects. These results indicate that initial uncertainty about the nature of pictures leads infants to investigate them. Through experience, infants begin to acquire a concept of "picture." This concept includes the fact that a picture has a dual nature (it is both an object and a representation of something other than itself), as well as knowledge about the culturally appropriate use of pictures.*

Most people think they know what a picture is, anything so familiar must be simple. They are wrong. (Gibson, 1980, p. xvii)

Several theorists (including Beilin, in press; Ittelson, 1996; and Sigel, 1978) have emphasized that substantial complexity is involved in perceiving, interpreting, using, and producing pictorial representations. *Pictorial competence* encompasses a range of skills and knowledge, from "the simplest perception of pictured information [to] the most sophisticated understanding of the conventions and techniques of the pictorial media" (DeLoache & Burns, 1994, p. 103).

The origins of pictorial competence have long been debated. Some theorists, most notably James Gibson and his colleagues, have focused on the perception of pictures. They have argued that learning is not required for picture perception because the process of picking up information is essentially the same for pictures as for the environment (Gibson, 1971, 1979; Kennedy, 1974). Other theorists have argued that the "language of pictures" must be learned through experience (Gombrich, 1969, 1974; Goodman, 1976).

Several studies with infants support the idea that picture perception does not require learning. Dirks and Gibson (1977) documented picture recognition in 5-month-old infants by showing that babies who had been habituated to the face of a real person dishabituated to a photograph of a novel face, but not to a photograph of the familiar face. In other words, the infants identified the similarity between the real person and a picture of that person. DeLoache, Strauss, and Maynard (1979) reported the same result with objects: Five-month-olds who had been familiarized with a real doll looked longer at a photograph of a different doll than at a photograph of the familiar doll. Slater, Rose, and Morison (1984) found that even newborns can recognize a two-dimen-

sional version of a three-dimensional pattern. Further, DeLoache et al. and Slater et al. both showed that infants could discriminate between the two- and three-dimensional stimuli they used. This finding established that the results of their studies were due to infants' ability to recognize similarities between an object and its picture, and not just failure to distinguish between them.

Alongside this evidence of sophisticated picture perception in infancy are several anecdotes and informal reports of young children confusing pictures and referents (Beilin & Pearlman, 1991; Church, 1961; Werner & Kaplan, 1967). For example, Perner (1991) described his 16-month-old son intently trying to step into a picture of a shoe. Murphy (1978) noted that 9-month-olds often "hit the pictures in the book and scratched at the pages as if trying to lift the picture from the page" (p. 379). Ninio and Bruner (1978) reported one child's attempts to grasp objects pictured in a book. The infants and young children in these observations acted as if they thought depicted objects were real objects, despite the presence of many cues, including relative size and flatness, to the contrary. However, it is not clear how much to make of these anecdotes. They might represent occasional lapses made by a few young children, or they might reflect a pervasive lack of understanding of the nature of pictures.

It is therefore important to know if these anecdotally reported manual responses to pictures are common. If they are, then the current view of infant pictorial competence would need modification: The inappropriate behavior toward pictures described in these anecdotes would have to be reconciled with the precocious picture perception abilities documented for young infants. Accordingly, the initial goal of the research reported here was to systematically examine infants' manual behavior toward pictures. Specifically, we wanted to see to what extent infants would treat depicted objects as if they were actual objects. To do so, we presented 9-month-old infants with realistic color photographs of single objects and observed all manual behaviors directed toward the depictions.

STUDY 1

Method

Subjects

The participants in Study 1 were ten 9-month-old children (8.5–9.6 months, $M = 9.1$), half girls and half boys. Infants of this age reach for and actively manipulate objects, and they have good depth perception (Yonas & Granrud, 1985; Yonas & Hartman, 1993). As in all the studies reported here except Study 3, the sample was predominantly middle class and white,¹ and stimulus order and gender were counterbalanced.

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1. Parents were always fully informed about the general purpose of the research, as well as the specific procedures to be followed. In addition, a parent was always present throughout the session.

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Materials

Two picture books were constructed, each containing eight highly realistic color photographs of individual objects (common plastic toys). Each book contained the same set of photographs in one of two orders. The depicted objects measured approximately 3 cm × 3 cm. The pictures, mounted on cardboard pages (12.7 cm × 17.8 cm) secured by a plastic binding in the center, appeared on the right side of the binding paired with a blank white page on the left.

Procedure

Each infant sat in a high chair, and a book was placed on the tray directly in front of him or her. The infant was free to explore any part of the surface of the open pages, but we prevented other activity (such as turning pages or picking up the book). Each picture remained available for approximately 15 s.

Coding

Video recordings of the sessions were coded for two categories of manual behavior directed toward the pictured objects: One category was grasping, a change of hand shape or curling of the finger (or fingers) after contacting the surface of the page. This behavior appeared to the coders to be an attempt to pick up the depicted object. The second category included other deliberate investigative behavior, contact and active exploration of the surface of the book.

Relatively conservative coding criteria were adopted to differentiate between manual behaviors directed toward the pictures and indiscriminate hand movements. A manual behavior was coded only if (a) the subject was looking at the picture (and hence at his or her hand on the book); (b) the infant's hand, fingers, or both made contact with the book's surface either directly on the depiction or within a 0.5-cm radius around it; and (c)

the behavior was at least 1 s in duration. A behavior was considered to have ended when the subject looked away, initiated a different category of behavior, changed hands, or removed the hand (or hands) from the picture. Uninterrupted repetitions of a given behavior were counted as one instance of that behavior. Overall reliability for the two coders was .90.

Results

The basic result of this study is captured in Figure 1. Every one of the 10 infants in the study manually explored at least one picture; they felt, rubbed, patted, and grasped at the depicted objects as if they were real objects. The average number of manual behaviors per child was 6.9, ranging from a low of 2 to a high of 23. There were no differences for gender or order.

Eight of the children made at least one attempt to grasp a pictured object, reaching to it and curling their fingers around the image (as shown in Fig. 1). Some babies were highly persistent, repeatedly attempting to pick the depictions up off the page. On average, the infants made 3.7 attempts to grasp pictured objects. However, this figure is actually quite conservative, because any long bout of uninterrupted grasping motions was coded as only a single grasp attempt.

Discussion

The results of the first study establish the phenomenon of manual investigation of pictures by infants. Our formal observations substantiate the informal anecdotes of babies occasionally behaving toward pictured objects as if they were real objects. Furthermore, our data indicate that such behaviors are very common—at least for the population of infants we studied and with the highly realistic color photographs we used.

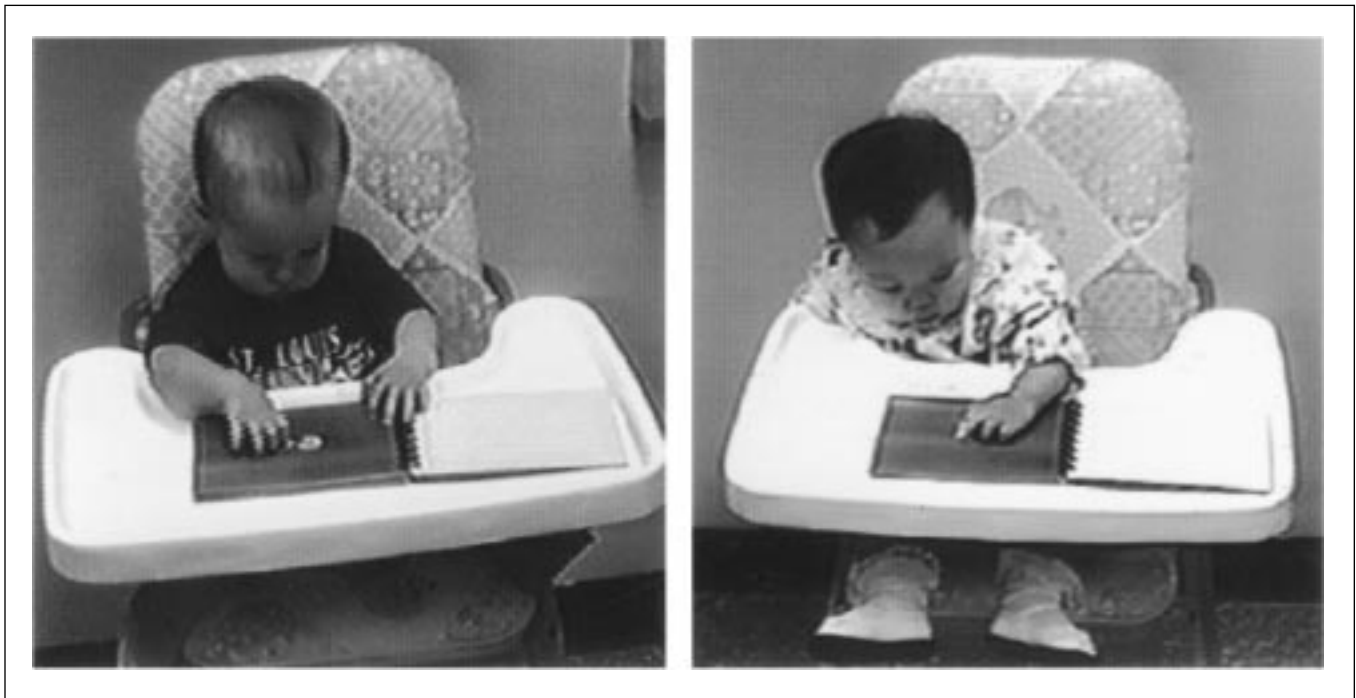


Fig. 1. Manual exploration of pictured objects by 9-month-old American infants. Two infants are shown making grasping motions toward the depictions. To an observer, the infants appear to be trying to pick up the depicted objects.

STUDY 2

The results of Study 1 suggested that the standard view of pictorial competence in infancy might need to be revised. First, however, we thought it important to confirm that 9-month-olds can distinguish between the kinds of depicted and real objects used in that study.

Method

Subjects

The participants were eight 9-month-olds (8.6–9.8 months, $M = 9.3$), 4 males and 4 females.

Materials

The stimuli were a set of eight small toys and color photos of those objects (similar to those used in Study 1). Each depicted object was the same size as the corresponding real object (ca. 3 cm × 5 cm). To make the procedure as similar as possible to the procedure in Study 1, we presented each picture-object pair in a book format. Two books were constructed in the same manner as in Study 1, except that the left-right position of the eight pictures varied, with four pictures on the left and four on the right, so that stimulus type (picture vs. object) and position (left vs. right) were counterbalanced.

Procedure

On each of the eight trials, an object and its picture were simultaneously presented, with the object affixed in the center of the blank book page opposite the picture. The open book was first held in front of the infant, out of reach, so the infant would see both stimuli before reaching. The experimenter then placed the book on the tray, and the infant was allowed 15 s to explore either or both of the stimuli.

Results and Discussion

The dependent measure was preferential reaching. There was unambiguous evidence of discrimination: 86% of the infants' first reaches were to the objects, a rate significantly greater than chance, two-tailed $t(7) = 6.01$, $p < .05$. After first contacting the object, the infants went on to contact the picture 40% of the time. Overall, the infants contacted the objects on 95% of the trials, as opposed to only 48% for the pictures.² There were no differences for gender or order.

This study establishes that 9-month-old infants can differentiate between the kinds of objects and color photographs used in Study 1 and that they prefer real objects over pictures of objects. Thus, the manual exploration of pictures documented in Study 1 was not due to an inability to distinguish between two- and three-dimensional stimuli.

STUDY 3

In a third, less formal study, we asked how common manual investigation of pictures is, and, in particular, whether it would occur in

2. We did not code the infants' manual behavior toward the pictures in the detailed way we did in Study 1. One reason was that our focus in Study 2 was to establish picture-object discrimination. In addition, the infant was typically still holding the object in one hand—presumably the preferred hand—when he or she then contacted the picture with the other hand, and it was unclear how this factor might affect manual exploration of pictures.

infants from a very different society. This is an important question, especially because cross-cultural data have figured prominently in debates about the development of picture perception (see Derogowski, 1989).

Accordingly, observations were made of infants from a society in which printed pictures are uncommon—Beng infants from severely impoverished and largely nonliterate families living in a rural village in the West African nation of Côte d'Ivoire (Ivory Coast).³ We prepared new books in which half of the eight pictures were ones used in our previous studies, and the other half were of common objects from the Beng community.

The testing situation was extremely different from the well-controlled conditions in our laboratory. The infants sat outside, either on mats on the ground or on their mothers' laps; goats and chickens wandered through the scene; attracted by the video camera, many additional adults and children gathered around, talking and carrying on their daily activities.

Despite the dramatically different circumstances, the infants' behavior toward the color photographs was remarkably similar to that of the American children. More specifically, 6 of the 8 Beng infants, who ranged between 8 and 18 months of age, manually investigated the pictures in much the same way as the 9-month-old American children had done.⁴ Figure 2 shows the behavior of 2 of the Beng babies. The cultural familiarity of the depicted objects did not appear to affect the infants' behavior.

These observations indicate that the tendency to actively explore a depicted object is a very general one, exhibited both by infants from the midwest of the United States and by Beng babies from West Africa. The phenomenon first documented in Study 1 is thus an extremely robust one.

STUDY 4

The final study reported here examined the developmental course of manual exploration of pictures. Having established that 9-month-old infants actively explore depicted objects, we asked how this behavior changes with age. We tested three age groups of infants to see if they differed in the frequency of the investigative behaviors reported in the previous studies. We also assessed the occurrence of a different, culturally appropriate manual behavior—pointing at the pictures.

Method

Subjects

The participants were 48 children, with 8 girls and 8 boys in each of three age groups: 9-month-olds (8.6–9.8 months, $M = 9.1$), 15-month-olds (14.3–15.9 months, $M = 15.2$), and 19-month-olds (18.2–20.0 months, $M = 19.3$).

Materials

The books used were similar to those in Study 1 except that we varied the size of the pictures (3 cm × 3 cm or 6 cm × 6 cm) and whether they appeared on the right or left (opposite a blank page).

3. For more on Beng society, see Gottlieb (1992) and Gottlieb and Graham (1993).

4. The videotapes were not of sufficient quality for us to do the highly detailed coding that we did in Study 1.



Fig. 2. Manual exploration of pictured objects by Beng infants from the Côte d'Ivoire (West Africa). Despite great differences in the testing situations, the Beng infants' response to the pictures was very similar to that of the American infants.

Procedure and coding

Everything was the same as in Study 1, except that a third category of behaviors, pointing, was also coded. This behavior was coded when the infant extended an index finger toward the picture.

Results and Discussion

Figure 3 shows opposite developmental trends for manual investigation and pointing. The level of manual investigation of depicted objects (grasping and other investigative behaviors combined) differed substantially as a function of age: Among the 9-month-olds, such behaviors were common (thus replicating the results of Study 1),⁵ but among the 19-month-olds, they were very rare. The opposite pattern occurred for pointing to depicted objects. The older infants frequently pointed to the pictures, often looking at an adult and vocalizing as they did so, but the younger infants almost never pointed.

For the number of manual investigative behaviors, a significant main effect was found for age, $F(2, 26) = 7.714, p < .01$, in a 3 (age) \times 2 (gender) \times 2 (picture size) \times 2 (picture position: left vs. right) mixed analysis of variance with picture position as the within-subjects variable. The main effect of age was also significant in a similar analysis of pointing, $F(2, 26) = 7.985, p < .01$. Post hoc analyses indicated that the 9-month-olds investigated significantly more than the older infants,

5. Given the well-known right bias in infant attention and reaching (Kinsbourne & Hiscock, 1983), the slightly lower rate of manual behaviors in this study compared with Study 1 may well have been due to the fact that half the stimuli were presented on the left.

whereas the 19-month-olds pointed significantly more often than did the younger two groups.

We also found main effects for picture position (left vs. right) for both manual investigation, $F(1, 36) = 8.990, p < .01$, and pointing, $F(1, 36) = 5.238, p < .05$, as well as an interaction between age and picture position, $F(2, 36) = 4.673, p < .05$. The 9-month-olds investigated the pictures on the right substantially more than those on the left, but the other two age groups showed no left or right preference. There were no significant effects for gender or picture size.

The divergent trends for manual investigation and pointing indicate that the direct response to pictures that is so common for the younger infants does not stem from an inability to inhibit a manual response. Although the overall level of manual behavior directed to depicted objects remained constant across age groups, the nature of that activity changed dramatically.

These results indicate that the tendency to respond directly to the surface of a picture is gradually replaced by culturally conventional behavior with pictures. Instead of attempting to pick depictions off the page as their younger counterparts did, the older children pointed to them. Pointing was often accompanied by labeling (e.g., exclamations such as "ooh, beh!" or "ahh, teltone" while pointing to the picture of the bear or the telephone). As they pointed, the children often looked up to a parent or the experimenter, apparently attempting to initiate an interaction about the picture.

GENERAL DISCUSSION

We have presented systematic evidence of a hitherto undocumented phenomenon—manual exploration of depicted objects by infants. Although references to such behavior have occasionally

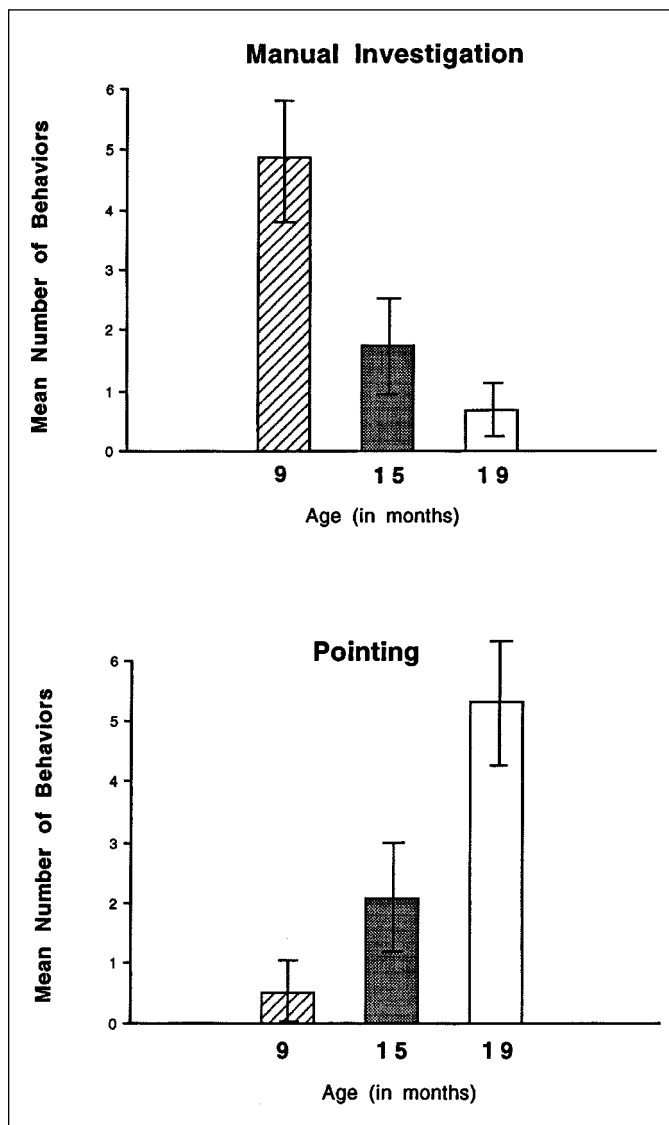


Fig. 3. Average frequency of manual investigation (investigative behaviors and grasping combined) and pointing directed toward pictured objects as a function of age.

appeared in the psychological literature, picture-directed manual activity has not previously been investigated. Our results are clearly replicable, as evidenced by the data reported in Studies 1 and 4. Furthermore, similar results have been found in a series of recent studies (Pierroutsakos, 1994; Pierroutsakos & DeLoache, 1997).

The phenomenon is also quite robust. Manual investigation of pictures was displayed by almost all the young infants we observed, whether they were from a pictorially rich society or from a culture in which pictures are rare.

Why do young infants routinely try to feel, hit, rub, and pick up depicted objects? Two aspects of the infants' behavior in our studies help answer this question. First, Study 2 ruled out the possibility that infants cannot distinguish depictions from real objects, a finding that agrees with research showing visual discrimination between two- and

three-dimensional stimuli by younger infants (DeLoache et al., 1979; Slater et al., 1984). Second, our participants never appeared upset or even particularly surprised at the fruitlessness of their efforts. Even the most persistent infants, who repeatedly tried to grasp picture after picture, were relatively matter-of-fact about their failure.

We surmise that the manual response to pictures that we have documented is the investigation of novel and somewhat puzzling stimuli. In many ways, a picture looks like an object; in many ways, it does not. Because young infants do not know what a picture is, that is, because they do not understand the two-dimensional nature of pictures and all that implies, they investigate. They treat a depiction as though it were an object, not because they firmly believe it is, but because they are unsure that it is not.

Further support for this line of argument comes from recent studies showing that 9-month-olds do not manually investigate nonpictorial elements of two-dimensional displays and that less realistic pictures (black-and-white photographs, line drawings) elicit substantially less manual response (Pierroutsakos & DeLoache, 1997). We would expect even less manual interaction with nonrepresentational "markings" (Ittelson, 1996) such as abstract designs or writing.

We propose that through experience, infants learn a great deal about pictures, including that pictures are not real objects—that they are not manipulable, smellable, eatable, and so forth. Infants also presumably learn something about how pictures are used, including the fact that parents talk and ask questions about them. Children learn to point to depicted objects both in response to parental directives and queries and as a means of initiating or directing an interaction. Thus, children learn to behave cognitively and emotionally to depicted objects as if they were real, while inhibiting physical responses to them. To paraphrase Werner and Kaplan (1967), children learn to treat pictures as objects of contemplation and communication, not action.

This interpretation of the results reported here is consistent with the view of theorists who have emphasized the dual nature of pictures. Gregory (1970) noted that "pictures are unique" in that "they are seen both as themselves and as some other thing" (p. 32). Gibson (1979) pointed out that "a picture is both a surface in its own right and a display of information about something else" (p. 282). Because of this dual nature, picture perception "always requires two kinds of apprehension that go on at the same time" (p. 283). To interpret a picture, the viewer must both see the picture—an object composed of markings on a flat surface—and "see through" the picture to its referent (Ittelson, 1996). Both are necessary; neither is sufficient.

Young infants with no pictorial experience can be said to see through pictures; their ability to recognize pictures of familiar objects indicates that a picture activates their mental representation of the object itself. As infants begin to comprehend words, adult labeling directs their attention to pictures just as it directs their attention to real objects. Young infants can also be said to see the surface of pictures in that they can discriminate between pictures and objects. Nevertheless, they do not fully understand how pictures and objects differ; they do not understand the nature of pictures as objects. Several months later—by 19 months in our sample—infants typically respond appropriately to the dual nature of pictures; as per Gibson's (1979) dictum, they exhibit "two kinds of apprehension" at the same time.

This achievement, we believe, involves the development of a concept of "picture" (DeLoache & Burns, 1994; DeLoache, Pierroutsakos, & Troseth, 1997). This concept includes features such as two-dimensional, nontangible, and nonreal, as well as some representation of the contexts in which pictures typically occur and the uses to which they

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are put. A two-part, or dual, mental representation then occurs when a picture is encountered: A picture of entity X is represented as “picture of” and “X.” Some or all of the viewer’s existing representation of X is activated, just as it would be by seeing the real entity X. The “picture of” tag specifies that *this X* is not a real X, but rather a picture of X. It signifies that some of the attributes in the child’s mental representation of X—specifically, those having to do with its three-dimensionality—do not apply. The “picture of” tag inhibits direct physical action toward the depicted X. This two-part representation thus, to use Ittelson’s (1996) term, “decouples” the informational content of the picture from its source—the surface of the picture.

Acquisition of the picture concept is necessary for developing pictorial competence, but it is far from the whole story. For example, it takes several years for children to sort out the full nature of picture-referent relations. Preschool children sometimes confuse the properties of objects and pictures, indicating, for example, that a photograph of an ice cream cone could be cold to touch and even occasionally lapsing into manual behavior toward pictures (Beilin & Pearlman, 1991). Children of this age often think, on the one hand, that an action carried out on a picture will affect its referent (Flavell, Flavell, Green, & Korfmacher, 1990) and, on the other hand, that an action on a real object will transform a picture of the object (Robinson, Nye, & Thomas, 1994; Zaitchik, 1990). Further, children only gradually acquire various representational conventions, such as the use of lines to represent speed (e.g., Friedman & Stevenson, 1975; Gross et al., 1991).

In conclusion, we have presented evidence of a very early step in achieving pictorial competence. The results reported here help us to resolve the long-standing controversy alluded to in the beginning of this article. Gibson and his colleagues were clearly right that learning is not necessary for the perception of simple pictures: Infants automatically perceive pictures, seeing through them to the objects depicted. However, Goodman and his supporters were also right that infants must learn about pictures; although they can see a picture’s surface (its two-dimensionality), they have to learn what that surface signifies. Physically grasping at pictures helps infants begin to mentally grasp the true nature of pictures.

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REFERENCES

- Beilin, H. (in press). Understanding the photographic image. In I.E. Sigel (Ed.), *Theoretical perspectives in the development of representational thought*. Hillsdale, NJ: Erlbaum.
- Beilin, H., & Pearlman, E.G. (1991). Children’s iconic realism: Object versus property realism. In H.W. Reese (Ed.), *Advances in child development and behavior: Vol. 23* (pp. 73–111). New York: Academic Press.
- Church, J. (1961). *Language and the discovery of reality*. New York: Random House.
- DeLoache, J.S., & Burns, N.M. (1994). Early understanding of the representational function of pictures. *Cognition*, 52, 83–110.
- DeLoache, J.S., Pierroutsakos, S.L., & Troseth, G.L. (1997). The three Rs of pictorial competence. In R. Vasta (Ed.), *Annals of child development* (Vol. 12, pp. 1–48). London: Jessica Kingsley.
- DeLoache, J.S., Strauss, M.S., & Maynard, J. (1979). Picture perception in infancy. *Infant Behavior and Development*, 2, 77–89.
- Deregowski, J. (1989). Real space and represented space: Cross-cultural perspectives. *Behavioral and Brain Sciences*, 12, 51–119.
- Dirks, J.R., & Gibson, E. (1977). Infants’ perception of similarity between live people and their photographs. *Child Development*, 48, 124–130.
- Flavell, J.H., Flavell, E.R., Green, F.L., & Korfmacher, J.E. (1990). Do young children think of television images as pictures or real objects? *Journal of Broadcasting & Electronic Media*, 34, 399–419.
- Friedman, S.L., & Stevenson, M.B. (1975). Developmental changes in the understanding of implied motion in two-dimensional pictures. *Child Development*, 46, 773–778.
- Gibson, J.J. (1971). The information available in pictures. *Leonardo*, 4, 27–35.
- Gibson, J.J. (1979). *The ecological approach to visual perception*. Boston: Houghton Mifflin.
- Gibson, J.J. (1980). Foreword: A prefatory essay on the perception of surfaces versus the perception of markings on a surface. In M.A. Hagen (Ed.), *The perception of pictures: Vol. 1* (pp. xi–xvii). New York: Academic Press.
- Gombrich, E.H. (1969). *Art and illusion: A study in the psychology of pictorial representation*. Princeton, NJ: Bollingen Series/Princeton University Press.
- Gombrich, E.H. (1974). The visual image. In D.R. Olson (Ed.), *Media and symbols: The forms of expression, communication, and education* (pp. 241–270). Chicago: University of Chicago Press.
- Goodman, N. (1976). *Languages of art: An approach to a theory of symbols* (2nd ed.). Indianapolis, IN: Hackett Publishing.
- Gottlieb, A. (1992). *Under the kapok tree: Identity and difference in Beng society*. Bloomington: Indiana University Press.
- Gottlieb, A., & Graham, P. (1993). *Parallel words: An anthropologist and a writer encounter Africa*. New York: Crown/Random House.
- Gregory, R.L. (1970). *The intelligent eye*. New York: McGraw-Hill.
- Gross, D., Solken, N., Rosengren, K.S., Pick, A.D., Pillow, B.H., & Melendez, P. (1991). Children’s understanding of action lines and the representation of locomotion. *Child Development*, 62, 1124–1141.
- Ittelson, W.H. (1996). Visual perception of markings. *Psychonomic Bulletin & Review*, 3, 171–187.
- Kennedy, J.M. (1974). *A psychology of picture perception*. San Francisco: Jossey-Bass.
- Kinsbourne, M., & Hiscock, M. (1983). The normal and deviant development of functional lateralization of the brain. In P.H. Mussen (Series Ed.) & M.M. Haith & J.J. Campos (Vol. Eds.), *Handbook of child psychology: Vol. 2. Infancy and developmental psychobiology* (pp. 157–280). New York: Wiley.
- Murphy, C.M. (1978). Pointing in the context of shared activity. *Child Development*, 49, 371–389.
- Ninio, A., & Bruner, J. (1978). The achievement and antecedents of labeling. *Journal of Child Language*, 5, 1–15.
- Perner, J. (1991). *Understanding the representational mind*. London: MIT Press.
- Pierroutsakos, S.L. (1994). *Do infants grasp the nature of pictures?* Unpublished master’s thesis, University of Illinois, Champaign.
- Pierroutsakos, S.L., & DeLoache, J.S. (1997, April). *Infants’ manual investigation of pictures as a function of picture type and referent*. Paper presented at the biennial meeting of the Society for Research in Child Development, Washington, DC.
- Robinson, E.J., Nye, R., & Thomas, G.V. (1994). Children’s conceptions of the relationship between pictures and their referents. *Cognitive Development*, 9, 165–191.
- Sigel, I.E. (1978). The development of pictorial comprehension. In S. Bickar, B.S. Randhawa, & W.E. Coffman (Eds.), *Visual learning, thinking and communication* (pp. 93–111). New York: Academic Press.
- Slater, A., Rose, D., & Morison, V. (1984). New-born infants’ perception of similarities and differences between two- and three-dimensional stimuli. *British Journal of Developmental Psychology*, 2, 287–294.
- Werner, H., & Kaplan, H. (1967). *Symbol formation*. New York: Wiley.
- Yonas, A., & Granrud, C.E. (1985). Development of visual space perception in young infants. In J. Mehler & R. Fox (Eds.), *Neonate cognition: Beyond the blooming, buzzing confusion* (pp. 45–67). Hillsdale, NJ: Erlbaum.
- Yonas, A., & Hartman, B. (1993). Perceiving the affordance of contact in four- and five-month-old infants. *Child Development*, 64, 298–308.
- Zaitchik, D. (1990). When representations conflict with reality: The preschooler’s problem with false beliefs and “false” photographs. *Cognition*, 35, 41–68.

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