

REPORT

Very young children are insensitive to picture- but not object-orientation

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Abstract

In two experiments on very young children's response to the orientation of pictures and objects, 18-, 24- and 30-month-old children showed no preference for upright pictures over inverted ones. More importantly, we found that children in all three age groups were equally accurate and equally fast at identifying depicted objects regardless of orientation. These studies further established that young children's insensitivity to picture orientation does not extend to objects. These results, in combination with the earlier ones, indicate that only gradually do young children come to share the picture orientation preference of adults and older children and that their adoption of the orientation convention is not based on changes in their ability to process upright and inverted images.

Pictures are ubiquitous in the modern world, and they serve many functions – as a source of pleasure, amusement, information, reminding, and so on. Regardless of the purpose they are serving, pictures are universally displayed in a canonical – upright – orientation. Depicted persons appear with their heads nearest the top of the picture, just as in everyday life their heads are usually higher than their bodies. For objects with a particular orientation, the uppermost surface of the object is uppermost in the picture, just as the real object would be in the world.

A moment's reflection reveals that adults have a robust preference for viewing pictures in their canonical orientation. Imagine how odd and unsettling it would be, for example, to find realistic paintings hung upside down in an art gallery or to look through a magazine with half the pictures inverted. If we do happen to pick up a book or photo that is upside down, we reorient it to look at it. If for some reason we must examine a picture that is inverted, we turn our head in an effort to better align our eyes with the orientation of the depicted objects.

In addition to their preference for upright pictures, adults are more skilled at processing information in pictures that are right-side-up than in upside-down pictures. For example, adults show better recognition memory for

upright pictorial stimuli, especially for faces (e.g. Carey & Diamond, 1994; Diamond & Carey, 1986; Rock, 1974; Yin, 1969). The greater the level of experience that individuals have with a given domain, the more their memory performance is affected by inversion (Diamond & Carey, 1986).

Do children share their elders' preference for and superior processing of upright pictures? Long ago, Wilhelm Stern (1924) believed they did not: 'It seems to make little difference to small children whether a picture is put before them right way up or upside down' (p. 190). However, subsequent research with young children and infants offered little support for Stern's supposition. For example, the performance of preschool-age children is better on a variety of perceptual discrimination and recognition memory tasks with right-side-up than with upside-down pictures (Braine, 1978; Brooks & Goldstein, 1963; Ghent, 1960; Hunton, 1955). By 10 years of age, children show a particularly large disparity in recognition memory for upright and inverted faces (Carey & Diamond, 1977, 1994; Carey, Diamond & Woods, 1980).

Do much younger children show the same effects of picture orientation? The answer is not so clear for infants and toddlers as it is for older children. We do

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know that *discrimination* of the orientation of simple patterns is present early in infancy. From 6 weeks of age on, infants who have been habituated to a shape or pattern look longer when presented with the same stimulus in a different orientation (Atkinson, Hood, Wattam-Bell, Anker & Tricklebank, 1988; Bornstein, Gross & Wolf, 1978; Bornstein, Krinsky & Benasich, 1986; McGurk, 1970, 1972). Orientation also affects the efficiency of *information processing* in infancy. Infants habituate more rapidly to patterns that are oriented vertically than to horizontally oriented ones (Bornstein & Krinsky, 1985; Bornstein, Ferdinandsen & Gross, 1981).

Orientation *preferences* have also been shown in very young infants. Babies as young as 1½ months of age typically look longer at abstract patterns whose elements are organized in a vertical orientation than at the same shapes in a horizontal or oblique orientation (Bornstein *et al.*, 1981). With respect to realistic pictures of people or objects, 2- to 4-month-olds look longer and smile more at face photographs presented in an upright orientation than at upside-down or horizontal face pictures (Hayes & Watson, 1981). This result may be at least partly determined by lower-level stimulus features, as Simion, Cassia, Turati and Valenza (2001) have recently shown that young infants look longer at face-like patterns as long as the stimuli have more eye-like blobs in the upper part of the figure than in the lower part. Thus, there is some evidence for a general preference for looking at upright pictures of people and objects in early infancy.

There is also some evidence of very early *processing* differences. Even newborns look longer at more attractive faces (Slater, Quinn, Hayes & Brown, 2000). However, when the face stimuli are upside down, this preference is no longer expressed, suggesting that the infants do not process the relevant facial information as well in inverted faces (Slater *et al.*, 2000). In addition, 7-month-olds are better able to discriminate facial expressions in upright than in inverted orientation (Kestenbaum & Nelson, 1990).

In contrast to the research showing sensitivity to orientation in infants and young children, recent research from three studies involving several different tasks has revealed almost no evidence of an orientation preference for pictures by 18-month-old children (DeLoache, Uttal & Pierroustakos, 2000). When two picture books were simultaneously handed to 18-month-olds, one upright and the other inverted, they chose randomly. When a picture book was handed to them upside down, they typically looked at it without reorienting it. Most 18-month-olds also failed to acknowledge or protest when an adult – an experimenter or their own mother – read to them while holding a picture book upside down.

In addition to showing little preference for upright pictures, the processing of depicted information was also

orientation independent for these 18-month-olds. They were presented with a complex scene in a picture book and asked to identify (point to) some of the depicted objects ('Where's the cow?', 'Show me the barn'). There was no difference at all in the accuracy of their identification of items in the upright pictures (33%) versus the upside-down ones (32%).

A developmental trend was apparent in the studies reported by DeLoache *et al.* (2000), some of which included 24- and 30-month-olds. Unlike the 18-month-olds, a group of 30-month-olds reliably chose an upright over an inverted book, and, more importantly, they usually reoriented books that were handed to them upside down. They were also more likely than the younger children to acknowledge or protest being read to from an upside-down book. Some fussed or commented on the unusual orientation, and a few simply turned it around. Thus, by 30 months of age, some of the children in this research had come to share their parents' orientation preference with respect to pictures. The 24-month-olds were less consistent than either the older or younger children; on some measures they showed an orientation preference, whereas on others they did not.

We report two studies further investigating the effect of orientation on picture preference and processing in very young children. The primary goal of Experiment 1 was to probe further the surprising finding that the *identification* of depicted objects was independent of orientation for 18-month-old children (DeLoache *et al.*, 2000). We were particularly interested in whether a more sensitive measure of picture processing might reveal an orientation effect. Accordingly, we recorded the *latency* of the children's pointing to the pictures.

To examine age differences in the accuracy and latency of identification of upright and upside-down depictions, the pictures were presented to 18-, 24- and 30-month-old children. We expected that the youngest age group would not be affected by orientation, replicating the result reported previously (DeLoache *et al.*, 2000). However, we thought that the picture processing of 30-month-old children, who had exhibited some preference for upright pictures, might be sensitive to picture orientation. If so, they should respond more quickly to right-side-up than to upside-down pictures.

Another theoretically important goal of Experiment 1 was to see whether young children's lack of an orientation preference is specific to pictures. To do so, we examined children's response to real objects presented to them either right side up or upside down. In the previous studies, 18-month-olds rarely reoriented upside-down pictures to look at them. Here, we ask whether the children would reorient an upside-down object. This information is critical to interpreting young children's failure to turn

around inverted pictures. If children reorient inverted objects, but not pictures, it would indicate a dissociation in their behavior toward pictures and objects.

A final goal of the first experiment was to see whether the previously reported results would be replicated with a different type of picture. Instead of the complex scenes containing many objects used in the previous research, books depicting just a few isolated objects on each page were presented to the children in Experiment 1.

Experiment 1

Method

Participants

The participants were 36 children (20 girls, 16 boys), 12 in each of three age groups: 18–21-month-olds ($M = 19.8$), 23–26-month-olds ($M = 24.8$) and 29–32-month-olds ($M = 30.7$). Approximately half the children of each age and gender were assigned to one stimulus order and half to the other. The children's names came from files of newspaper birth announcements or from lists of families who had volunteered to participate in research, and their parents were contacted by telephone. The sample was predominantly white and middle class.

Materials

For the *picture identification trials*, two books were constructed by affixing 32 color pictures (each approximately 50 square cm) to 16 cardboard pages (15×20 cm), which were then laminated and bound with plastic binding. As shown in Figure 1, the pictures included both color photographs of individual objects and colored drawings or paintings from children's books. All the depicted objects had a specific typical orientation. When the book was opened, four pictures appeared, one above the other on each page, with one pair to the left of the binding and the other to the right. No two objects in a set were of the same conceptual category, and all were chosen to be familiar to young children. The two books were assembled so that all four pictures that were visible at one time were either right side up or upside down. Overall, half the pictures were right side up and half were upside down, and half the pictures in each orientation were photographs and half drawings. The upright and inverted pages appeared in one order in one book and in the reverse order in the second book. As shown in Table 1, one of the pictures in each of the eight sets of four pictures was designated as the target (the picture the children were asked to identify). Half the targets

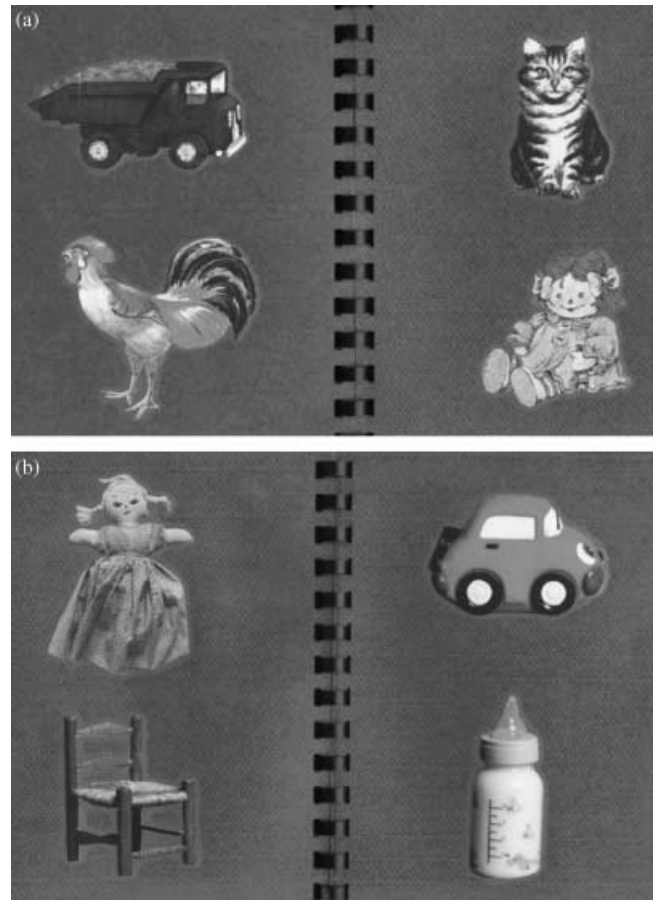


Figure 1 Two pages from the picture book used in Experiment 1.

Table 1 Pictorial stimuli used in Experiment 1

Target item	Foil items		
Bed	Squirrel	Duck	Truck
Dog	Teapot	Barn	Truck
Bottle	Doll	Car	Chair
Truck	Doll	Bear	Blocks
Bunny	Boat	Flower	Truck
Chair	Barn	Squirrel	Duck
House	Bear	Bunny	Car
Bus	Rooster	Flower	Cat
Car	Horse	Teapot	Lamp
Shoe	Truck	Bear	Squirrel
Cup	Dog	Lamp	Bear
Doll	Truck	Cat	Rooster
Teddy bear	Car	Cup	Chair
Bird	Lamp	Boat	Flowers

appeared on the left and half on the right side of the binding

For the *object choice trials*, 8 pairs of identical objects were used, selected to be familiar to 18-month-olds. The objects included a toy duck, bottle, birdhouse, bucket, car, teapot, shoe and cup.

Procedure

The two parts of the study were conducted in the laboratory with the parent present. When the parent and child arrived, the child was given time to become comfortable with the surroundings and the experimenter before being invited to look at a book with the experimenter. In the first part of the study, the experimenter and the participant sat together on a sofa, looking at the book of pictures. For each set of four pictures, the experimenter asked the child to identify one target picture (e.g. 'Show me the dog'). Neither the experimenter nor the parent commented on the orientation of the pictures. In both studies, the sessions were videotaped for later coding of which picture the child pointed to and the latency of the points. Latency was measured from when the experimenter said the name of the target object to when the child's finger contacted a picture.

In the second part of the study, the experimenter and child sat facing each other at a child-sized table. The experimenter held two *identical* objects, one right side up and one upside down, in front of and out of reach of the child. After calling attention to both of them, the experimenter then moved the objects toward the child, inviting him or her to take one of them. The child was permitted to examine and play with the toy for a brief period, and the experimenter commented casually on what the child was doing with it (e.g. 'are you pretending to drink from the cup?') before requesting that it be handed back so the next pair of toys could be presented. The experimenter noted which of the two objects was selected and whether the child subsequently reoriented the item.

Results and discussion

In the picture-identification trials, no age group showed any difference in the accuracy of their identification of upright and inverted depicted objects, nor did they differ in their latency to point to upside-down versus right-side-up pictures. In the object-choice task, the children chose upright and inverted objects equally often, but they almost always reoriented an upside-down object after selecting it, but not an upright one.

The accuracy data for the picture-identification task were evaluated in a 3 (age) \times 2 (picture orientation) mixed ANOVA, with orientation as the within-Ss variable. Preliminary analyses indicated no effects or interactions involving gender, stimulus order, or left-right position, so they were not included in this analysis.

The only significant result of the accuracy analysis was the main effect for age, $F(2, 33) = 17.54, p < .001$. As shown in the top panel of Figure 2 the 18-month-olds

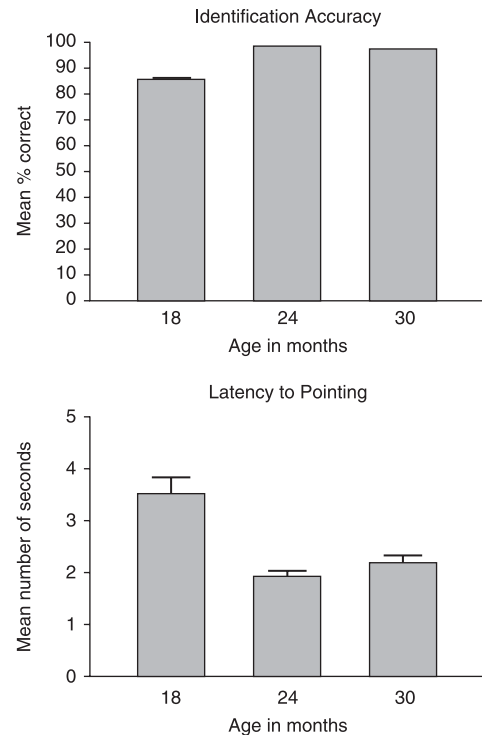


Figure 2 In the top panel, the accuracy (% correct) and, in the bottom panel, the latency (mean sec) of identification of depicted objects by three age groups. (Error bars represent mean square error.) In no case was there a difference as a function of orientation.

identified 85% (SD = 9%) of the depicted objects named by the experimenter and the 24- and 30-month-olds both pointed correctly 98% of the time (SD = 3% for both ages). Overall, the children's identification accuracy for upright pictures ($X = 95\%$, SD = 9%) and upside-down ones ($X = 93\%$, SD = 12%) did not differ.

The latency data for the picture-identification task were evaluated in a 3 (age) \times 2 (gender) \times 2 (picture orientation) mixed ANOVA, with orientation as the within-Ss variable. The only significant result was a main effect for age, $F(2, 33) = 17.43, p < .001$. As shown in the bottom panel of Figure 2, the 18-month-olds took longer to point to the named pictures ($X = 3.51$ s, SD = 1.08 s) than did the 24-month-olds ($X = 1.92$ s, SD = .35) and 30-month-olds ($X = 2.19$ s, SD = .93). Pointing latencies to upright ($X = 2.41$ s, SD = 1.21) and upside-down pictures (2.67 s, SD = .93) did not differ.

In the object-choice task, there was no effect of age on the likelihood of choosing the upright member of the pair of objects, so results were pooled across age. Children chose the upright object 57% (SD = 15%) of the time, which was significantly different from the chance level of 50%, $t(35) = 17.26, p < .001$.

A much stronger effect of object orientation appeared in the children's behavior after having chosen an object. When they had selected upside-down objects, the 18-, 24- and 30-month-olds reoriented them 85%, 92% and 89% of the time, respectively ($SD = 33\%$, 17%, 20%, respectively). However, after choosing an upright object, they *never* turned it over (0% for all age groups). Thus, in spite of the fact that orientation played no role in the children's choice between two identical objects, orientation did matter when they manipulated those objects.

One contribution of Experiment 1 was to replicate and extend the previous finding that, in spite of extensive experience with pictures, 18-month-old children are unaffected by the orientation of pictures (DeLoache *et al.*, 2000). Consistent with the earlier research, the 18-month-olds in Experiment 1 were equally accurate and equally fast at identifying right-side-up and upside-down pictures. The fact that the pictures used in the present research were simpler than those used earlier testifies to the robustness of the phenomenon.

The major contribution of Experiment 1 was to establish that, like the 18-month-olds, 24- and 30-month-olds are equally accurate and equally fast when asked to identify upright and inverted depicted objects. Thus, even though our previous research has shown age differences in young children's preference for interacting with pictures in an upright orientation, there do not appear to be age differences in their ability to process pictorial information in different orientations.

Finally, the results indicated that young children are not generally insensitive to orientation. When presented with real objects, they chose the upright one somewhat more often. When they picked up an object that was upside down, the children almost always turned it upright, in contrast to their typical behavior with pictures.

Experiment 2

Although the results of Experiment 1 strongly suggest that young children's insensitivity to orientation is specific to pictures, the evidence for that inference comes from different groups of children tested with different stimulus sets. This important conclusion would be strengthened by a direct within-subjects comparison of children's tendency to reorient real objects and pictures of those same objects. Accordingly, in Experiment 2, children were presented with common objects and with pictures of those objects. Half the children were given the set of objects first to see if immediately prior experience with real objects would make them more likely to care about the orientation of the depicted objects.

Method

Participants

The participants were 17 18-month-old children (16–21 months, $M = 18.1$), nine girls and eight boys. Approximately half the children of each age and gender were assigned to one stimulus order and half to the other. Participants were recruited through newspaper advertisements and at library reading groups. The sample was predominantly white and middle class.

Materials

The stimuli were eight pairs of common objects, the same objects used in the object-choice trials of Experiment 1, and eight pairs of color photographs of those objects. Each object was approximately 8×8 cm, and the size of the depicted objects matched the size of the actual objects. The photographs were mounted on cardboard (12.5×17.5 cm).

Procedure

After an appropriate warm-up period, the study was conducted in the laboratory with the parent present. The experimenter and the participant sat at a table facing each other. As in Experiment 1, the experimenter held two identical items in front of and out of reach of the child, one right side up and one upside down. The inverted stimulus was presented equally often on the right and left. After calling attention to both stimuli, the experimenter invited the child to take one of them. Eight of the children received the eight pairs of objects first, followed by the eight pairs of photographs; the other nine children received the picture pairs followed by the objects. As in Experiment 1, the children were allowed to manipulate the stimuli for a brief period after selecting them. The experimenter noted which of the two objects or pictures was selected and whether the child subsequently reoriented the item.

Results and discussion

In the object-choice trials, the upright member of the pairs of objects was chosen 50% of the time, equal to chance. (This age group had selected the upright object 57% of the time in the previous study.) Thus, the orientation of the objects did not govern the 18-month-olds' choice between them. The same was true in the picture-choice trials: The upright picture was chosen 55% ($SD = 18\%$) of the time, which did not exceed the chance level of 50%. The order of presentation did not significantly

affect the children's choices: The upright photograph was selected 56% (SD = 14%) of the time when the picture-choice trials preceded the object-choice trials, and 54% (SD = 23%) when they came after.

As in Experiment 1, the more important measure was how often the children reoriented an object or picture after having chosen it. The children reoriented 85% of the upside-down objects they had selected (SD = 21%), but only 29% of the pictures (SD = 32%). This difference in the rate of reorientation was significant, $t(16) = 5.50$, $p < .0001$. As in Experiment 1, the children very rarely reoriented right-side-up objects (9%) or pictures (0%). The order of presentation did not affect children's tendency to reorient objects or pictures.

This result shows that 18-month-old children are not simply lacking in discernment with respect to orientation. The children in Experiment 2 reoriented almost all of the upside-down objects they got their hands on, but relatively few of the inverted pictures of the same objects. Combining the two experiments reported here with previous research (DeLoache *et al.*, 2000), young children's insensitivity to the orientation of pictures does not extend to objects.

General discussion

This line of research was initially inspired by the astonishment of one of the authors upon discovering her toddler looking at an upside-down picture book. After months of picture book reading sessions on his parents' laps, during which the books were always upright, this child was perfectly content to gaze at inverted images. Although the phenomenon has been referred to before (e.g. Koffka, 1928; Stern, 1924; Vernon, 1954), there had been no empirical investigations of it.

The two experiments presented here, in combination with our previously reported research (DeLoache *et al.*, 2000), provide strong empirical support for very young children's insensitivity to picture orientation as a reliable phenomenon. Furthermore, they provide preliminary information about the developmental progression of the emergence of sensitivity to picture orientation.

Our research makes it clear that picture orientation is not important to most 18-month-olds even though they are growing up in a picture rich society and have substantial experience with picture books. (All the children in our research have had experience with picture books to some degree.) Although 18-month-olds show no sensitivity to picture orientation on any of several preference and processing measures, they do pay attention to the orientation of objects when interacting with them.

It is somewhat puzzling that young infants' preferences for pictorial stimuli are sometimes influenced by orientation (Bornstein, 1979; Bornstein *et al.*, 1986; Hayes & Watson, 1981), whereas toddlers' preferences are not. The answer may have to do with the development of knowledge about the nature of pictures (DeLoache, Pierroutsakos & Troseth, 1996; Troseth, Pierroutsakos & DeLoache, 2004). Although infants can perceive pictorial information, they do not know what pictures are. Nine-month-olds manually explore depicted objects, showing that they do not fully understand the difference between depicted and real objects (DeLoache, Pierroutsakos, Uttal, Rosengren & Gottlieb, 1998; Pierroutsakos & DeLoache, 2003; Yonas, Chov, Alexander & Jacques, 2003). By 18 months, presumably as a function of experience with pictures and picture books, infants understand that pictures are for looking at and communicating about, not for feeling or manipulating (DeLoache *et al.*, 1998). What they still do not realize, however, is that pictures are supposed to be viewed in a particular orientation.

A preference for upright pictures emerges and grows in strength over the next few years. The finding reported here of equal accuracy and latency in the identification of upright and inverted pictures is important for interpreting the emergence of this preference. This result strongly suggests that the emerging picture orientation preference is not based on changes in perceptual processing; that is, children do not begin to prefer upright pictures because they find them easier to process. Instead, the emergence of a picture orientation preference may primarily represent the gradual adoption of a social convention – the convention of looking at pictures in a particular orientation. We hypothesize that young children's adoption of this convention is based on their cumulative experience in joint picture book interactions in which the book is always held in the canonical upright orientation.

For adults and older children, this convention is multiply determined: Readers interact with books in a particular orientation not just because of their strong preference for viewing pictures in a particular orientation, but also because it is extremely difficult to read upside-down print. Thus, in adopting the convention of interacting with picture books in the upright orientation, young children take a step that will facilitate the important task in which they will soon be engaged – that of becoming literate.

An obvious prediction based on the literacy convention hypothesis is that the onset and early growth of a preference for upright pictures should be related to the amount of experience young children have had with pictures and picture books. The more pictorial experience children have, the sooner they should develop a strong orientation preference. We are beginning a long-term investigation of this prediction.

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References

- Atkinson, J., Hood, B., Wattam-Bell, J., Anker, S., & Tricklebank, J. (1988). Development of orientation discrimination in infancy. *Perception*, *17*, 587–595.
- Bornstein, M.H. (1979). Perceptual development: stability and change in feature perception. In M.H. Bornstein & W. Kessen (Eds.), *Psychological development from infancy: Image to intention* (pp. 37–81). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Bornstein, M.H., Ferdinandsen, K., & Gross, C.G. (1981). Perception of symmetry in infancy. *Developmental Psychology*, *17*, 82–86.
- Bornstein, M.H., Gross, C.G., & Wolf, J.Z. (1978). Perceptual similarity of mirror images in infancy. *Cognition*, *6*, 89–116.
- Bornstein, M.H., & Krinsky, S.J. (1985). Perception of symmetry in infancy: the salience of vertical symmetry and the perception of pattern wholes. *Journal of Experimental Child Psychology*, *39*, 1–19.
- Bornstein, M.H., Krinsky, S.J., & Benasich, A.A. (1986). Fine orientation discrimination and shape constancy in young infants. *Journal of Experimental Child Psychology*, *41*, 49–60.
- Braine, L.G. (1978). A new slant on orientation perception. *American Psychologist*, *33*, 10–22.
- Brooks, R.M., & Goldstein, A.G. (1963). Recognition by children of inverted photographs of faces. *Child Development*, *34*, 1033–1040.
- Carey, S., & Diamond, R. (1977). From piecemeal to configurational representation of faces. *Science*, *195*, 312–314.
- Carey, S., & Diamond, R. (1994). Are faces perceived more as configurations more by adults than by children? *Visual Cognition*, *1*, 253–274.
- Carey, S., Diamond, R., & Woods, B. (1980). Development of face recognition – a maturational component? *Developmental Psychology*, *16*, 257–269.
- DeLoache, J.S., Pierroutsakos, S.L., & Troseth, G.L. (1996). The three Rs of pictorial competence. In R. Vasta (Ed.), *Annals of child development*, Vol. 12 (pp. 1–48). London: Kingsley.
- DeLoache, J.S., Pierroutsakos, S.L., Uttal, D.H., Rosengren, K.S., & Gottlieb, A. (1998). Grasping the nature of pictures. *Psychological Science*, *9*, 205–210.
- DeLoache, J.S., Uttal, D.H., & Pierroutsakos, S.L. (2000). What's up? The development of an orientation preference for picture books. *Journal of Cognition and Development*, *1*, 81–95.
- Diamond, R., & Carey, S. (1986). Why faces are and are not special: an effect of expertise. *Journal of Experimental Psychology*, *2*, 124–130.
- Ghent, L. (1960). Recognition by children of realistic figures presented in various orientations. *Canadian Journal of Psychology*, *14*, 249–256.
- Hayes, L.A., & Watson, J.S. (1981). Facial orientation of parents and elicited smiling by infants. *Infant Behavior and Development*, *4*, 333–340.
- Hunton, V. (1955). The recognition of inverted pictures by children. *Journal of Genetic Psychology*, *86*, 281–288.
- Kestenbaum, R., & Nelson, C.A. (1990). The recognition and categorization of upright and inverted emotional expressions by 7-month-old infants. *Infant Behavior and Development*, *13*, 497–511.
- Koffka, K. (1928). *The growth of the mind: An introduction to child psychology* (2nd edn.). New York: Harcourt Brace.
- McGurk, H. (1970). The role of object orientation in infant perception. *Journal of Experimental Child Psychology*, *9*, 363–373.
- McGurk, H. (1972). Infant discrimination of orientation. *Journal of Experimental Child Psychology*, *14*, 151–164.
- Pierroutsakos, S.L., & DeLoache, J.S. (2003). Infants' manual investigation of pictured objects varying in realism. *Infancy*, *4* (1), 141–156.
- Rock, I. (1974). The perception of disoriented figures. *Scientific American*, *230*, 78–85.
- Simion, F., Cassia, V.M., Turati, C., & Valenza, E. (2001). The origins of face perception: specific versus non-specific mechanisms. *Infant and Child Development*, *10*, 59–65.
- Slater, A., Quinn, P.C., Hayes, R., & Brown, E. (2000). The role of facial orientation in newborn infants' preference for attractive faces. *Developmental Science*, *3*, 181–185.
- Stern, W. (1924). *Psychology of early childhood*. New York: Holt.
- Troseth, G.L., Pierroutsakos, S.L., & DeLoache, J.S. (2004). From the innocent to the intelligent eye: the early development of pictorial competence. In R.V. Kail (Ed.), *Advances in child development and behavior*, Vol. 30. San Diego, CA: Academic Press.
- Vernon, M.E. (1954). *A further study of visual perception*. Cambridge: Cambridge University Press.
- Yin, R.K. (1969). Looking at upside-down faces. *Journal of Experimental Psychology*, *81*, 141–145.
- Yonas, A., Chov, M., Alexander, A., & Jacques, J. (2003, April). Actions of 9-month-old infants directed at a real toy, a photographed toy, and surfaces. Poster presented at the meeting of the Society for Research in Child Development, Tampa.

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