

How Does It Look? Level 2 Perspective-Taking at 36 Months of Age

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Previous research has found that children engage in Level 2 visual perspective-taking, that is, the understanding that others may see things in a different way, between 4 and 5 years of age (e.g., J. H. Flavell, B. A. Everett, K. Croft, & E. R. Flavell, 1981). This ability was reexamined in 36-month-olds using color filters. In Experiment 1 ($N = 24$), children had to recognize how an object looked to an adult when she saw it through a color filter. In Experiment 2 ($N = 24$), a novel production test was applied. Results of both studies show that 36-month-olds know how an object looks to another person. The discussion focuses on the psychological requirements of visual perspective-taking and its relation to other “theory of mind” abilities, such as the distinction between appearance and reality and understanding false belief.

Among the most important social-cognitive abilities is the ability to take another’s perspective. Humans can put themselves in the “mental shoes” of others and imagine how others perceive, think, or feel about an object or event. Importantly, a full appreciation of perspectives goes beyond the understanding of what a specific person perceives, thinks, or feels in the here and now. It reflects a general and fundamental comprehension that one and the same object or event can be seen or construed in multiple ways, depending on one’s point of view. From a developmental perspective, the question arises when and how children come to acquire an understanding of perspectives.

A good deal of developmental research in this area has focused on children’s appreciation that others can believe something different from their own knowledge about the world. This understanding emerges between 4 and 5 years of age when children acknowledge that people can hold false beliefs (see Wellman, Cross, & Watson, 2001)—reflecting an

understanding that people’s *epistemic* perspectives can differ. Another line of research has investigated children’s ability to distinguish between what an object appears to be at first sight (“looks like”) from what it really is. This distinction is also mastered at the developmental juncture of 4–5 years, when children understand, for instance, that a deceptive object can look like a rock, but at the same time really be a sponge (Flavell, 1986; Flavell, Green, & Flavell, 1986). What this indicates is an understanding that one and the same object can come under different conceptual perspectives.

Less work has been devoted to the emergence of understanding *visual* perspectives, although the term *perspective* has its origin in the visual domain (from Latin *per-spicere* = “to see through something” or “to see clearly”). Visual perspective-taking, according to Flavell (1978, 1992) and colleagues’ framework, comes in two levels. In “Level 1 visual perspective-taking,” children can judge *what* a person can and cannot visually perceive from her viewpoint. A child who has reached this level knows whether a given object can be seen from a specific viewpoint. For instance, she comprehends that another person does not see an object she herself sees because the other’s view to it is blocked by a barrier. Research suggests that Level 1 visual perspective-taking develops at around 2–2.5 years of age (Flavell, Shipstead, & Croft, 1978; McGuigan & Doherty, 2002; Moll & Tomasello, 2006), although an implicit Level 1 ability may be

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available in the 2nd year of life (Luo & Baillargeon, 2007; Sodian, Thoermer, & Metz, 2007).

Level 2 visual perspective-taking is achieved when a child comes to understand not only *what* is visible from a certain point of view but also *how* a given object is seen or presented. In philosophical terms, the child can now specify an object's *mode of presentation* or *aspectual shape* (Perner, Brandl, & Garnham, 2003; Searle, 1992). Piaget and Inhelder's (1967) classic three-mountain problem is a test for Level 2, because the child has to judge *how* another agent (a doll) perceives the three-dimensional model from her specific visuospatial position. In a task specifically designed for preschoolers, Masangkay et al. (1974) presented subjects a picture of a turtle placed on the table in front of them. The children correctly identified that the turtle was "right side up" when the turtle's feet were facing them, and that it was "upside down" when the picture was turned so that the turtle's back was facing them. However, children below 4–5 years of age did not understand that although they themselves saw the turtle right side up, an adult sitting across the table simultaneously saw it upside down. Flavell, Everett, Croft, and Flavell (1981) replicated these results with a series of modifications, such as using the more child-friendly terms "standing on its feet" and "lying on its back." Other studies have looked at children's understanding of how an observer's distance from an object affects its perceived clarity and size (Flavell, Flavell, Green, & Wilcox, 1980; Pillow & Flavell, 1986). All of the results are highly consistent: By 4½ to 5 years of age children are generally successful in identifying how an object looks from perspectives other than their own.

According to the "unitary view" (e.g., Perner, 2000), the developmental synchrony of Level 2 perspective-taking with other theory of mind skills is not a coincidence but reflects a common cognitive denominator shared by false belief understanding, alternative naming, the appearance–reality distinction, and visual perspective-taking, and so on. What these tasks have in common is that they all require an understanding that one and the same object or event can be looked at, conceptualized, or interpreted in multiple ways depending on one's perspective—whether it is a visual, conceptual, or epistemic perspective (see also Flavell, 1986; Gopnik & Astington, 1988, for similar accounts). Evidence supporting this view comes from the fact that these skills are known to (a) correlate highly (e.g., Doherty & Perner, 1998; Flavell et al., 1986) and (b) partly recruit the same brain areas; for

example, the dorsal part of the temporoparietal junction is activated in both, false belief and visual perspective-taking tasks (Aichhorn, Perner, Kronbichler, Staffen, & Ladurner, 2006).

Yet, some researchers have argued for an "asymmetry view," stating that particular mental states, such as desires, are understood before epistemic states (e.g. Astington & Gopnik, 1991; Bartsch & Wellman, 1995). On this account, children come to understand and explain actions by reference to desires (and perception) much earlier than by reference to knowledge and beliefs (see Gopnik, Slaughter, & Meltzoff, 1994). In accordance with this view, Rakoczy, Warneken, and Tomasello (2007) found that 3-year-olds know that different people can have conflicting desires about the outcome of the same event. It may be that not only motivational or volitional perspectives (desires), but also perceptual (visual) perspectives are grasped by children before they solve the classic false belief task when less verbal sophistication is demanded than in the classic turtle task.

In the current studies we aimed to explore this possibility and reexamined the nature and development of Level 2 perspective-taking using a novel color filter technique. Color filters have already been used to explore the understanding of appearance–reality (e.g., Flavell, Flavell, & Green, 1983; Taylor & Flavell, 1984; Taylor & Hort, 1990) and false beliefs (Gopnik & Astington, 1988). An advantage of adopting this approach to visual perspective-taking is that children at this age know the basic color terms, whereas perspectival word pairs such as left–right and in front of–behind are not yet well understood by children this young (Wanska, 1984). Children in our studies were asked to perform a manual action (such as choosing an object or placing an object in a certain location) instead of responding verbally. In Experiment 1 a *recognition* task was applied: Can 36-month-olds recognize the visual perspective of another person when it differs from their own? In Experiment 2 we used a *production* task: Children responded by placing an object on either side of a color filter, so that the object looked in a certain way to the adult.

Experiment 1

In this experiment, 36-month-old children received two tasks. In one task, the children were presented with two white objects, one of which was seen through a blue color filter by an adult (*Color Task*).

In the other task, children were presented with two blue objects one of which was seen through a yellow color filter by an adult, resulting in the perception of green for this object (*Color Mix Task*). The adult ambiguously requested either: (a) the unfiltered object (i.e., the “white one” in the Color Task and the “blue one” in the Color Mix Task) or (b) the filtered object (e.g., the “blue one” in the Color Task and the “green one” in the Color Mix Task). The children’s task was to determine which object the adult referred to in her (ambiguous) request by taking into account the adult’s visual perspective on the objects.

Method

Participants

Participants were 24 (12 females and 12 males) 36-month-old children ($M = 36.13$, range = 35.72–36.59). The children were recruited by telephone from the university’s subject list. Preestablished criteria for participation in the experiment were no known physical, sensory or mental disabilities, full term (40 ± 3 weeks gestation, by parental report), and normal birth weight (2,500–4,500 g). According to parental report, 23 children were White and 1 was Asian. An additional four children were tested but excluded from the final sample due to: noncompliance with the task (2), parental interference (1), and experimenter error (1).

Materials

Pretest for color comprehension. In order to test for basic color comprehension vocabulary, a pretest was administered using four laminated, flower-shaped color samples (approximately 9×9 cm) in blue, green, white, and yellow. A gift bag (33 cm high \times 26.5 cm wide \times 15 cm deep) served as a container in which children were asked to put objects upon request.

Screens and color filters. Two screens (46 cm high \times 61 cm wide \times 6 mm thick) were used to hold the color filters. Each screen consisted of two transparent sheets of acrylic plastic with a paper-thin slot into which color filter sheets could be slid.

Color Task. The screen used in this task contained a blue color filter (46 cm high \times 30.5 cm wide), which filled half of the screen. Two pairs of white objects functioned as stimuli (see Figure 1a). One pair consisted of two identical white plush rabbits (16 cm high \times 7 cm wide) and the other of white candles (13.5 cm high \times 7 cm in diameter).

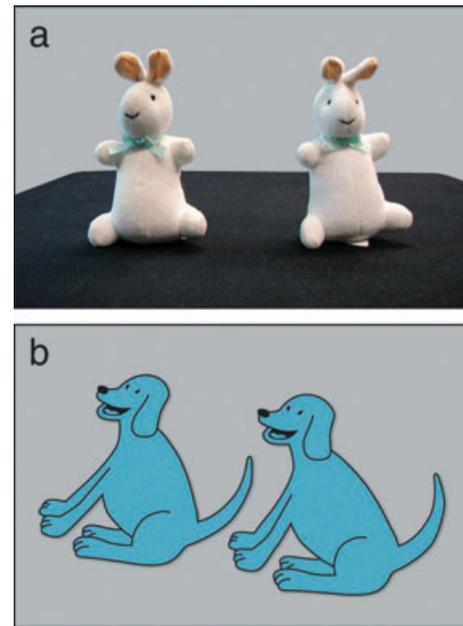


Figure 1. Samples of the objects used in Experiment 1: (a) one of the pairs of white objects used in the Color Task and (b) one of the pairs of blue pictures used in the Color Mix Task.

Color Mix Task. The screen used in this task contained a yellow color filter (46 cm high \times 30.5 cm wide), which filled one half of the screen. Two pairs of blue laminated animal pictures functioned as stimuli (see Figure 1b). One pair consisted of two identical pictures of a blue dog (18 \times 16 cm) and the other consisted of identical pictures of a blue horse (22 \times 16 cm). Pictures instead of three-dimensional objects were used because the demonstration of the color mixing worked best with surfaces that could be placed flat against the screen. For the test, pictures were placed flat on the table—thereby ensuring that adult and child looked at an identical surface instead of different parts of an object.

Design and Counterbalancing

The study involved two adult experimenters (E1 and E2). For the color comprehension pretest, the four color samples were placed in front of each child in the same spatial arrangement (see below). The order in which E1 asked the child to show the colors was different for every child. Each child received both the Color Task and the Color Mix Task. Participants were randomly assigned either to have the Color Task or the Color Mix Task first. Children received two trials per task, one in which E1 requested the “unfiltered” object (unfiltered request condition) and one in which E1 requested

the “filtered” object (filtered request condition). The order of trials (unfiltered request first vs. filtered request first), order of the object pairs (rabbits vs. candles first), and spatial position of the color filter (right vs. left) were counterbalanced within each task. One male and one female child were randomly assigned to each combination.

Procedure

Upon their arrival at the laboratory, the children and their families were escorted to a family lobby where the necessary forms were completed. They were then brought to the testing room (3.7×3.23 m). Parents were given the choice to sit quietly outside of the child’s visual field in the testing room or to observe the experiment on video from an adjacent room. E1, E2, and the child sat down at a table (114 cm long \times 76 cm wide \times 72 cm high) with E1 sitting opposite the child and E2 sitting to the child’s right (see Figure 2). In order to acclimate the child to the situation, they played with a green coil-shaped plastic toy for about 1–3 min until the child seemed comfortable.

Pretest of color comprehension. The toy was withdrawn and the four flower-shaped color samples were placed in front of the child. E1 then asked the child to show her “the [name of color] flower” one by one. Children responded by pointing to or touching the flowers. All children successfully identified the four colors correctly. E1 then announced that she had to leave. She said good-bye and left the room. At this point the demonstration phase of the first task on the schedule began.

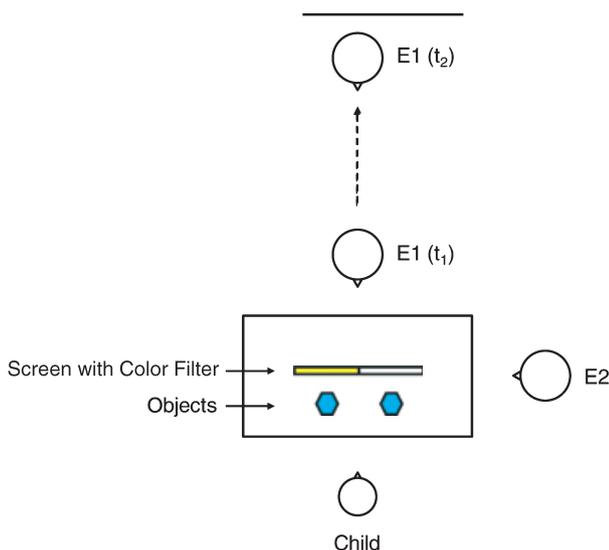


Figure 2. Aerial view of the setup in Experiment 1.

Demonstration phase. For the Color Mix Task, E2 brought out the screen with the yellow color filter and placed it on the table in front of the child (see Figure 2). The yellow half of the screen was either to the child’s left or right (counterbalanced). E2 then placed one picture from the first pair (e.g., a blue dog) between the child and the screen. She then asked the child to come around the table to see what the picture looked like from there. Children walked around the table and sat down in the chair in which E1 had previously sat. E2 first held the picture behind the clear part of the screen, and then she moved it behind the yellow filter saying “Look!” She then held up the green flower saying “Now it looks like this!” to highlight that the picture now looked green. E2 moved the picture (e.g., the blue dog) back behind the clear half of the screen, this time holding up the blue flower saying “Now it looks like this!” The picture was moved three times behind the filtered and three times behind the unfiltered half of the screen. Every time a change in color perception took place, E2 highlighted this by holding up the corresponding color sample and saying “Now it looks like this!” Finally, E2 moved the picture very slowly behind the screen saying “Look!” as the picture progressively turned green as it was moved behind the edge of the yellow filter and progressively turned blue again as it was moved back. Again, it was held behind each half of the screen three times. No color terms were used throughout the demonstration.

Test phase. After this demonstration, E2 asked the child to walk back around the table to sit in her initial position to E2’s left (see Figure 2). For 50% of the children, E2 rotated the screen 180° so that the yellow and the clear sides reversed. E2 then brought out the second picture from the pair, and placed both blue pictures on the table directly in front of the child: one on the child’s side of the clear half of the screen, and one on the child’s side of the yellow half of the screen. From her position, the child thus saw two blue pictures.

E1 entered the room, and while still standing near the door (at a distance of about 2.2 m from the pictures), she excitedly exclaimed “Look! Look at that dog/horse! That one looks blue/green from over here! I really like the blue/green one! Can you please put the blue/green one in the bag for me?” E2 held up the bag next to the child. While making her request, E1 first fixated the middle of screen (the edge where the yellow and clear halves met) and then looked up in the child’s face. She thus did not indicate by gaze or pointing cues which picture she referred to in her request; there were no spatial

cues to disambiguate the request. The child had to determine which of the two identical colored pictures (e.g., two blue dogs) in front of her the adult was referring to by taking the adult's visual perspective on the two objects. E1 repeated her excited request if children (a) chose both objects simultaneously (three trials), (b) asked "This one?" while pointing at one of the pictures (four trials), or (c) showed no response at first (two trials). The trial was finished when a child placed a picture in the bag.

Between the first and second trials, E1 turned away from the table toward the door as if she was busy doing something. During this interval, E2 brought out the second pair of blue pictures and placed them directly in front of the child. As in the previous trial, one picture was placed in front of the yellow half of the screen and one in front of the clear half of the screen. E1 then turned back around toward the table and, from the distance, made an excited request for a picture as in the first trial—but this time she asked for the picture that she had previously not requested (i.e., the "green" object if she had previously asked for "blue" and vice versa).

When the response phase of the second trial was terminated, E1 said good-bye and left the room. This marked the beginning of the second pair of trials belonging to the other task. While E1 was gone, E2 brought out the screen with the blue color filter and started the demonstration of the Color Task using a white object (the order of the Color Task and Color Mix Task were, as previously noted, counterbalanced). For the Color Task everything was exactly analogous to the previously described Color Mix Task. In the demonstration phase, E2 showed the child the effect of the filter in the exact same way—this time by moving a white object behind a blue filter. Then at test, E1 ambiguously requested the "blue object" in the filtered request condition, and she requested the "white" object in the unfiltered request condition. Again, her request was spatially ambiguous, because she gazed at the midpoint of the screen where the clear and the blue halves joined, followed by a look to the child's face. No pointing gestures were used. The entire experiment was video-recorded for subsequent scoring.

Scoring and Reliability

The videotaped trials were scored by an independent observer who was unaware which object E1 had requested (the sound was turned off). For

each trial she coded which object was placed in the bag. If a child placed both objects in the bag, the first object placed in the bag was scored (this happened in two trials). To assess interobserver reliability, a second independent observer, also unaware of E1's request, coded a random sample of 25% of the children. There were no disagreements, leading to a Cohen's Kappa of 1. We tested for order effects using Cochran's Q , which revealed that incorrect choices occurred particularly on the first and last (fourth) trials, $Q = 12.7, p \leq .003$. This is unlikely to affect the overall results given that task order and order of conditions was counterbalanced and the error rate was low.

Results and Discussion

Table 1 shows the percentage of children who received a certain combination of scores in the two tasks. On average, children in the Color Task chose the object that looked blue to E1 87% of the time when E1 requested the blue object. In contrast, the same children chose the blue object only 17% of the time when E1 requested the white object. A McNemar test (Siegel, 1956) showed that children chose the blue object significantly more often when "blue" was requested than when "white" was requested, $p < .001$. We also examined for both conditions whether the number of children who correctly chose the requested object exceeded chance (50%) using the binomial procedure. As expected, children chose the object that looked blue to E1 significantly more often than chance when E1 requested the blue one, $p < .001$, and they chose the object that looked white to E1 significantly above chance when E1 requested the white one, $p < .01$.

In the Color Mix Task, children on average chose the picture that looked green to E1 79% of the time when E1 requested the green object. In contrast, the same children chose the picture that looked green to E1 only 21% of the time when E1 requested the

Table 1
Experiment 1: Percentage of Children Who Received a Given Combination of Scores in the Two Tasks

Color mix task	Color task			Total
	0	1	2	
0	0	4%	0	4%
1	0	4%	29%	33%
2	0	21%	42%	63%
Total	0	29%	71%	100%

picture that looked blue to her. A McNemar test showed that children chose the filtered picture significantly more often when the filtered picture was requested than when the unfiltered one was requested from them, $p = .001$. As expected, children chose the picture that looked green to E1 significantly more often than chance when E1 requested the picture that looked green to her, $p < .01$, and they chose the object that looked blue to E1 significantly more often when blue was requested, $p < .01$.

To compare the difficulty of the Color Task with the Color Mix Task, we used each child as his or her own control and compared the number of successful trials (0–2) for each of the two tasks using a Wilcoxon test. Children's performance in the Color Task and the Color Mix Task did not differ significantly, $z = .83$, $p > .40$ (all p s two-tailed).

In this experiment, 36-month-old children were presented with an ambiguous verbal request for an object (i.e., a three-dimensional object in the Color Task and a picture in the Color Mix Task) and had to take an adult's visual perspective in order to disambiguate it. There were two candidate objects, both of which the children saw in their true, same color: either white (Color Task) or blue (Color Mix Task). However, an adult saw one of them through a tinted filter—resulting in a perception of a different color for this object for the adult. Despite the fact that the children themselves saw two identically colored objects, they systematically chose the object that the adult requested. For example, in the Color Task, when the adult requested the blue object, the children chose the object that looked blue to the adult. In the Color Mix Task, when the adult requested the green object, the children reliably chose the object that looked green to the adult through the filter, although the object was blue and looked blue for them.

It thus seems that by 36 months of age, young children are able to recognize how an adult sees something when this differs from how they themselves see it. Moreover, children succeeded in the opposite case in control questions when they had to determine which of two objects looked the same to the adult and to themselves. In the control question for the Color Task (the adult asked for the "white" object), the children correctly chose which of the two objects looked white to the adult—even though children saw both objects in this color. Similarly, in the control question for the Color Mix Task (the adult asked for the "blue" object), children correctly determined which of the two objects they saw as blue also looked blue to the adult.

It may seem surprising that children solved the Color Mix Task equally well as the Color Task—even though the former involved subtractive color mixing—a phenomenon that most 3-year-olds are probably not familiar with. But note that prior to the test, the children were shown that a blue object looks green when seen through a yellow filter; so they were given self-experience that they could use as a basis for generalizing about the other's visual experience (cf. Meltzoff & Brooks, 2008).

One might object that children could produce correct responses in the Color Task by a simple association: When hearing the adult utter "blue," the children's attention was drawn to the blue filter behind the target. They could then simply choose whichever object stood closest to this blue "background." Hence, a low-level understanding of the situation such as "When the person requests 'blue' she must mean the object close to the blue filter" would have yielded positive results. Maybe then, instead of taking the adult's visual perspective on the objects, children simply responded on the basis of their *own* visual perspective.

Another potential objection to the Color Task is that Level 1 perspective-taking may have done the job. The objects used in this task were three-dimensional and so different sides of the objects were visible from the child's and the adult's viewpoint. In the case of the rabbits, for instance, the children saw the fronts while the adult saw their backs—that is, they saw different parts of an object. Maybe the children did not need to use Level 2 perspective-taking because they and the adult did not see one and the same thing in different ways but rather saw two different things (different parts). This could render a Level 2 task into a Level 1 task similar to the one designed by Flavell et al. (1981) in which children have to understand that a person sitting across from them sees an animal's back, while they see the animal's feet.

Importantly though, neither one of these objections can be made with respect to the Color Mix Task. In this task, nothing in the child's visual field matched the adult's request for a "green" object, and so the children's responses could not be driven by simple perceptual association: There was no "green" in the child's perceptual environment. From the child's perspective, there were simply two blue objects before her eyes. Also, by using pictures that were placed flat on the table, we ruled out that the task could be solved by Level 1 perspective-taking of different sides or parts of an entity. The object did not reveal different parts to the child and the adult; instead, the same surface

was seen differently from two perspectives. This is what characterizes Level 2.

One may still object, however, that when hearing a “green” request, children chose the correct object only because this was the “more likely” candidate: Unlike the other one, this object could be associated with some color other than blue in the background (the color of the filter). We do not think that this is likely given the same children’s successful responses to “blue” requests: In this situation, the two objects match the adult’s request equally well from the child’s point of view. Egocentric responses would have therefore resulted in choices at chance level. However, children did not choose objects randomly but reliably chose the one which looked blue from the *adult’s* perspective. Nonetheless, to rule out the possibility that the children correctly responded to filtered requests in both tasks because of a simple perceptual association, we conducted a follow-up study.

Experiment 1B

In this control experiment, we investigated whether 3-year-olds, when hearing a request for a colored object, preferably choose whichever of two objects is closer to a color filter, irrespective of any alternatives.

Participants

The participants were 12 (6 boys, 6 girls) 36-month-olds ($M = 36.17$, range = 35.76–36.56), none of whom participated in the previous experiment.

Procedure

Children received two blue request trials in the Color Task and two green request trials in the Color Mix Task. The procedure was exactly the same as in the previous filtered request trials. In the Color Task, as before, the object in front of (from the child’s perspective) the blue half of the screen was white, but this time the object in front of the clear half of the screen was blue. Likewise in the Color Mix Task, the object in front of the yellow half of the screen was blue, but the object in front of the clear half was green. From the adult’s perspective, therefore, *both* candidate objects were seen in the requested color (blue in the Color Task and green in the Color Mix Task). In this situation, children should no longer prefer the object associated

with the filter because the unfiltered object matches the adult’s request just as well or possibly better: It corresponds to the adult’s request objectively (under any normal viewing conditions) and not only under the ephemeral conditions of seeing it through the filter.

Results and Discussion

The results showed that children clearly preferred the unfiltered object—they chose this object in 94% of the trials (100% in the Color Task and 87% in the Color Mix Task). Thus, in the presence of an alternative that matches the adult’s requests *objectively*, and not only temporarily when viewed through the filter, children no longer prefer the filtered object.

This result is in line with the hypothesis that in Experiment 1A children did not just base their responses on a simple perceptual association with the background filter. It remains an open question whether children also display this ability in the context of a production task, which, as we will see, also provides an additional way of addressing the simple association account. We investigated this in the next experiment.

Experiment 2

In this experiment, 36-month-old children were asked by an adult to place a blue object on the table such that it looked “green” or “blue” to the adult. To comply with this request, the children had to choose which side of a yellow filter to put the object: Placing it *behind* the screen (from the adult’s perspective) would make the adult to see it green; placing it *in front of* the screen (from the adult’s perspective) would allow the adult to see it blue. This setup left no possibility for children to respond simply on the basis of proximity between filter and object.

Method

Participants

Participants were 24 (12 females and 12 males) 36-month-old children ($M = 36.13$, range = 35.66–36.76), none of whom participated in the previous experiment. Children were recruited from the same subject list as the children in Experiment 1 and the same criteria for participation were applied. According to parental report, 22 of the children

were White, 1 was Asian, and 1 was of mixed ethnicity. One additional child was tested but excluded because she did not pass the color comprehension pretest—which was consistent with the parent's previously expressed concern that the child might be color-blind.

Materials

For the color comprehension pretest, the same flower-shaped color samples were used as in the previous experiment. For the production task, a transparent acrylic screen was used that was half as wide as the one in Experiment 1 (46 cm high \times 30.5 cm wide \times 6 mm thick). It contained a yellow color filter, which filled the entire screen. A picture of a blue dog and a picture of a blue horse from Experiment 1 served as stimuli. The pictures were mounted vertically on a small base, which facilitated manipulation and placement by the child.

Design

The pretest for color comprehension was the same as in the previous experiment. For the production task we used a within-subject design, with each child receiving two conditions: One in which the adult requested to see a blue object (Blue Request Condition) and one in which she requested to see a green object (Green Request Condition). There were two trials per condition (one with the picture of a dog and one with the picture of a horse), yielding a total number of four trials. The relevant factors were completely counterbalanced: Order of conditions (Green Request first vs. Blue Request first), order of pictures (dog first vs. horse first), and spatial position of the adult during the test phase (left vs. right from the child), with one male and one female child randomly assigned to each cell.

Procedure

After the families were greeted and the required forms completed, testing took place in the same room as Experiment 1. The parent either sat quietly in the testing room outside of the child's visual field or observed the study on video in an adjacent room. The experimenter (E) and the child sat at a table (92 cm long \times 75 cm wide \times 53 cm high) with E to the child's left. The warm-up period and color pretest were the same as in the previous experiment.

Demonstration phase. The experimenter brought out the yellow screen and placed it on the table facing the child. She then placed the blue picture of a dog/horse between the child and the screen. Holding up the blue flower, E said, "Now it looks like this!" E then moved the picture to the other side of the screen, where it looked green to the child. She held up the green flower toward the child saying "And now it looks like this!" E brought the picture back to the right side of table between the child and the screen. The demonstration continued in a similar fashion; Figure 3 shows the aerial layout of the study. What is important to note is that each child was systematically shown how changing the position of (A) the picture, (B) the viewer, and (C) the filter changed the color perception. Thus, all three critical elements (object, perceiver, filter) were separately manipulated, with E highlighting each change in color perception by holding up the matching color sample saying "Now it looks like this!"

Test phase. The child was asked to sit in E's chair. Depending on the counterbalancing schedule, E sat down either to the child's right in position A or to the child's left in position C (see Figure 3). From either position she looked straight ahead at the yellow filter in front of her. E then handed the child an open box containing the same picture that was used for the demonstration and announced "I would like to see a green/blue dog/horse now! Can you make the dog/horse look green/blue for me?" Children responded by placing the object on either side of the screen—left or right. The trial ended as soon as the child positioned the object on either side of the screen and released the object from their hands. Note that from the child's point of view, the object looked blue irrespective of where she placed it on the table.

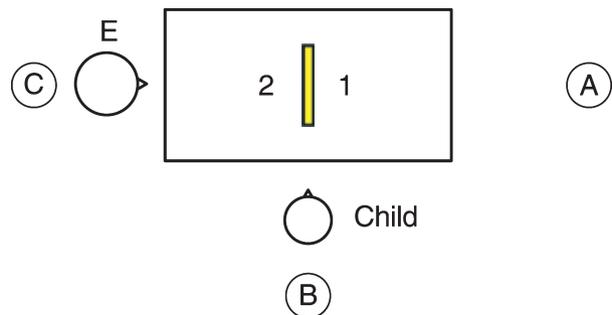


Figure 3. Aerial view of the setup in Experiment 2. Note. The three locations (A, B, and C) were occupied by E or the child during different steps in the procedure. Their locations as shown in this picture represent the test phase.

To start the next trial, E placed the object back into the box, gave it to the child again, and said "I would like to see a blue/green dog/horse now!"—this time requesting to see the color she had not requested in the previous trial. After the child responded in this second trial, E brought out the second picture (dog or horse) and placed it in the box. She handed the box to the child and again requested to see a blue/green dog/horse. After the child responded, E placed the object back into the box, and in a final, fourth trial she requested to see the same object in the other color. The experiment was video-recorded for subsequent scoring.

Scoring and Reliability

The videotaped trials were scored by an independent observer who was unaware of the experimental condition (the sound was turned off). There were no artifactual cues on the videotapes as to the correct answer. For half the trials the correct answer was for the child to place the object between E and the screen, and for the other trials the correct answer was to place it behind the screen from E's perspective. The observer recorded for each trial whether the child placed the object, from E's perspective, *in front of* the screen (resulting in the perception of "blue") or *behind* the screen (resulting in the perception of "green"). If a child placed the object in one position first but then changed the position without releasing the object from her hands, the final position of the object was coded. To assess interobserver reliability, a second independent research assistant, also unaware of the condition, coded a randomly selected sample of 25% of the children. There were no disagreements between the two observers, so Cohen's Kappa was 1. We tested for order effects using Cochran's Q; no such effects were found, $Q = 2.44$, $p = .56$.

Results and Discussion

We determined for each condition the mean number of trials in which children made the object look green for E—which is the correct response in the green request condition but the wrong response in the blue request condition. Scores could range from 0 to 2. Table 2 shows the percentage of children who received a given score in the two conditions. Children made the object look green to E on 79% of the trials when E requested to see it green ($M = 1.58$ trials, $SD = 0.72$). In contrast, they placed the object so that it looked green to E on only 39.5% of the trials when E requested to see it

Table 2
Experiment 2: Percentage of Children who Received a Given Combination of Scores in the Two Conditions

Green request	Blue request			Total
	0	1	2	
0	4%	8%	0%	12%
1	8%	4%	4%	16%
2	13%	17%	42%	72%
Total	25%	29%	46%	100%

blue ($M = 0.79$, $SD = 0.83$). A Wilcoxon test showed that children made the object look green to E significantly more often in the green request than in the blue request condition, $z = 2.70$, $p < .01$ (two-tailed).

The children's success rate across conditions as well as in each condition separately was compared to chance (50%) using one-sample *t*-tests. Across conditions, children responded correctly on 70% of the trials—which is significantly above chance level, $t(23) = 3.02$, $p < .01$. In the Green Request Condition alone, children's productions of a green-looking object exceeded chance significantly, $t(23) = 3.99$, $p = .001$. In the Blue Request Condition alone, children's productions of a blue-looking object were in the predicted direction, but did not significantly exceed chance, $t(23) = 1.23$, $p = .23$ (all *p*'s two-tailed).

In this study, visual perspective-taking in 36-month-olds was assessed with a novel production task. Children were asked by an adult who sat 90° left or right from them to place a blue object on either side of a yellow color filter so that the object looked green (or, in a control condition, blue) for her. When an adult requested a green-looking object, children reliably placed the object behind the screen (from the adult's perspective) so that it looked green to the adult. Conversely, they tended to place it in front of the screen (from the adult's perspective) when the adult asked for a blue object; however, their productions of a blue object taken in isolation did not differ significantly from chance. The reason for this may lie in the awkward pragmatics of this condition: The object already *is* blue but nonetheless the adult asks the child "to make it look" blue (to make the request in this condition comparable to the Green Request condition). Such a request normally implies an action that makes the object undergo some sort of change—some children may have therefore figured that the adult must have meant "green." One child in fact replied that she will "make it green" instead (and indeed made

it look green for the adult), and so produced an incorrect response despite showing some understanding of how to produce a certain way of seeing the object.

With this limitation in mind, the results suggest that beyond their comprehension that a person looking through a tinted filter sees an object in a different color (as the results from Experiment 1 have shown), 36-month-olds begin to know how to bring the altered perception about. The children in this study showed a nascent understanding that for the color filter to have its effect, the spatial arrangement has to be “viewer–filter–object.” They start to become aware that the object has to be seen *through* the filter for the color perception to change. This makes it unlikely that the children solved the comprehension tasks in Experiment 1 by a simple association of an object with a nearby color filter. In this production task, what was crucial was not an objects’ proximity to the color filter—instead, what mattered was which side of the filter the object was on from the adult’s perspective. In order to succeed on this task, children had to take into account the observer’s visual perspective on the object.

General Discussion

We investigated Level 2 visual perspective-taking in 36-month-old children using two different response measures. In Experiment 1, a verbal request was made by an adult. In order for children to comply, they had to recognize how the adult saw the objects. In Experiment 2, children had to produce the perception of a certain color in an adult by placing an object in a particular spatial arrangement on either side of a color filter. The findings of both these studies suggest that by 36 months of age, children have a grasp of how others see things when this differs from how they themselves see them. In both tasks, children reliably took an adult’s viewing position into account and reasoned about (a) how an adult saw two objects in a recognition task (Experiment 1) and (b) how to alter an adult’s color perception of an object in a production task (Experiment 2).

These findings prompt a revision of theory about the development of visual perspective-taking. Three-year-olds have consistently failed the traditional Level 2 tasks (Flavell et al., 1981; Masangkay et al., 1974). Moreover, they have performed poorly even when similar color change procedures to ours were used in the context of appearance–reality and false belief understanding. Specifically, children

younger than 4–5 years have been unable to understand that an object is “really and truly” white but looks red when covered by a red filter (Flavell, Green, Wahl, & Flavell, 1987; Flavell et al., 1983). Preschoolers mostly judge phenomenistically, stating that the object not only *looks* red behind the filter but really *is* red—even after they were taught the words “look like” and “really and truly” (Taylor & Hort, 1990; but see Deák, 2006). In a similar vein, Gopnik and Astington (1988) established that 3-year-olds do not acknowledge that: (a) they themselves had a false belief about an object’s true color (before they found out that the object was covered by a color filter), or (b) a naïve person, who has not discovered the color filter, would assume that the object really has the color that it appears to have.

One chief developmental question then is why the 36-month-olds in the present studies performed so well. One possibility is that 3-year-olds’ understanding of visual perspectives has simply been underestimated because of extraneous task demands, such as the verbal ability to use perspectival word pairs. The tasks designed for the current studies may be more sensitive measures for the same perspective-taking competence tested with the classic tasks. On this view, the same visual perspective-taking ability has now been brought down by about 1–2 years, to 36 months of age.

If this were true, it would have profound theoretical implications. Most importantly, it would undermine the idea of a strong ontogenetic tie among the classic set of theory of mind abilities such as reasoning about beliefs, distinguishing between appearance and reality, accepting alternative names for a given object, and Level 2 visual perspective-taking—as has been claimed by the unitary view (e.g., Perner, 2000).

In order to accommodate the new findings, one could reject the idea of a common cognitive denominator and draw a stark distinction between different mental states such as perception and desire on the one hand and belief on the other—as the asymmetry view suggests. We would like to take an alternative route, which preserves the thrust of the unitary framework but does so by more finely differentiating levels of understanding perspectives that have been subsumed under Level 2. We think that the current studies may not capture perspective-taking at the same level as most classic theory of mind tasks, such as false belief, appearance–reality, alternative naming, or visual perspective-taking as measured by the turtle task. In all these other tasks, children have to simultaneously “confront,” to borrow Perner, Stummer, Sprung, and Doherty’s

(2002) term, two different perspectives on one and the same thing. In appearance–reality tasks, two different conceptual perspectives are confronted: The self-same object can be construed as a rock from an “appearance perspective” and as a sponge from a “reality perspective.” Similarly in the alternative-naming task, children have to acknowledge that a given object, for example, a rabbit, can be labeled both as a “rabbit” and as a “bunny” (Doherty & Perner, 1998). Likewise, in Masangkay et al.’s (1974) turtle task children have to acknowledge that the turtle can simultaneously look “upside down” from one visual perspective but “right side up” from another. In other words, what is put to a test in all these tasks is an understanding that there can be two different judgments, construals, or (re)presentations of one and the same object or event at the same time.

Such a simultaneous confrontation of perspectives, however, is not necessary in our tasks. To succeed in our tasks, the children needed to determine how an object looks from an adult’s perspective, but they did not have to simultaneously compare the adult’s visual perspective with their own. They could ignore the fact that what looked, for example, green to the adult looked blue to themselves—because they were not asked to consider how *they themselves saw the object at that time*. Or to put it another way, considering how the object looked to themselves did not have to enter the judgment of how it looked to the other or into achieving the correct answer. An analogous argument can be made for Sapp, Lee, and Muir’s (2000) version of the appearance–reality task. In their study, 3-year-olds easily identified the deceptive “rock-sponge” as an object that “looks like a rock” from among a cluster of different-looking things. But no confrontation of the object’s appearance with its true identity was required, and the children could ignore the fact that the object was truly a sponge. In line with our hypothesis, their performance dropped dramatically when they had to say what the object looked like *and* what it really was. Our contention is that the reason for this decrement in performance was not that the response format was switched from a manual to a verbal one but that the linguistic version involved a confrontation of perspectives.

A curious case in this regard is the false belief problem, which is solved at the typical theory of mind age. There are two standard variants: change of content and change of location. The first one creates no puzzle: The child is asked to state what she thinks is in a box (e.g., candy). After the box is

opened, the child is asked to say first what is in it (e.g., pencils) and what she previously thought was in it (candy). The clash in perspectives between what is really the case and what is the case according to the child’s past belief is thus explicit in this task. The other variant, however, does not fit this analysis. The child is only asked to say where another agent (e.g., Maxi) thinks an object is located, without having to contrast the false belief with her own knowledge. In this regard, there is a strong similarity with the present studies: The child only needs to *take* a view that is distinct from her own. Yet, 1–2 years lie between children’s success in these tasks. One possibility is that knowledge exerts a particular “pull”: Because of the way beliefs aim at truth, one’s knowledge of something may be especially hard to ignore (see Sabbagh, Moses, & Shiverick, 2006; Sabbagh, Xu, Carlson, Moses, & Lee, 2006, for the relation between belief understanding and executive functions). The pull may be normative in the sense that children understand the question as “where *should* one look for/expect the object?” While there can be a myriad of perceptual perspectives on something that are all equally veridical, false beliefs ought to be replaced with true ones—with knowledge. Future research has to investigate this potentially distinct role of epistemic relations.

A few comments also need to be made about implicit versus explicit knowledge concerning theory of mind. In looking-time studies that are offered as analogs of the verbal false belief tasks, infants at around 13–15 months of age may show an implicit understanding of where the adult expects an object to be (Onishi & Baillargeon, 2005; Surian, Caldi, & Sperber, 2007). Not only is there no confrontation of two perspectives that the infant needs to deal with in these tasks, but there is also no explicit judgment about the other’s perspective. The same holds true for the anticipatory looking paradigm introduced by Clements and Perner (1994). In the current studies, 3-year-olds *explicitly* (not verbally, but by choosing or placing an object) acknowledge another person’s point of view. But again, no contrast or clash in perspectives has to be explicitly referred to by the child.

To codify our current theoretical stance: The present studies indicate that children as young as 36 months old have knowledge of how a person sees an object when this differs from how they see it. They know how something looks from another’s visual perspective and decenter from their own. In this sense, the 36-month-olds engaged in a form of perspective-taking that clearly exceeds Level 1 visual

perspective-taking. At Level 1, children know *what* objects in a visual array can be seen from a standpoint other than their own. But in the present study, they had to understand *how* an object looks to another when this differs from how it looks to them. This fulfills the classic definition of Level 2 visual perspective-taking (e.g., Masangkay et al., 1974).

However, Level 2 perspective-taking has also been described as the understanding that two people may “have different perspectives or views of the same display” (Flavell, 1992, p. 119) or that a single object can simultaneously be viewed in multiple ways or conceptualized under multiple descriptions or representations. It has been taken for granted that this knowledge comes for free once a child acknowledges how another person sees an object from her perspective. But the ability to confront perspectives seems to be a more demanding, distinct form of understanding that develops later than the ability to take another’s perspective.

We thus would argue that what has been called “Level 2 visual perspective-taking” needs to be redefined and differentiated into two distinct levels: (a) the ability to identify or produce specific ways of seeing an object and (b) the understanding that an object may simultaneously look different from different perspectives. Hence, the classic Level 1 versus Level 2 distinction may have to be extended to a third level that allows children to “confront” perspectives and understand that a given object can simultaneously be seen/construed differently from different standpoints. Future research needs to investigate this further, not only in the visual domain but also in the context of conceptual, epistemic, and other forms of perspective-taking.

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