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Perceived Reachability for Self and for Others by 3- to 5-Year-Old Children and Adults

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Ability to perceive the distance at which an object is within reach was assessed in 3-, 4-, and 5-year-old children and adults. In different situations, subjects had to judge whether an object placed in the vertical or horizontal plane was reachable for themselves or for someone else (the experimenter). Adults as well as children differentiated between the limits of their own prehensile space and those of another person. At all ages, children tend to attribute systematically more reachability to the adult experimenter. Furthermore, both children and adults systematically underestimate reachability for others in a horizontal presentation of the object. For all age groups, judgments of reachability for self are bodily scaled and based on perceived degrees of behavioral freedom for self and for others. From 3 years of age, children are shown to resemble adults in their ability to perceive what objects afford for action, either for self or for others. These results are interpreted as further evidence of early allocentrism (i.e., spatial decentration and perspective taking) in the context of a practical task. © 1995 Academic Press, Inc.

In his ecological approach to perception, Gibson (1979) proposes that from the origins of development, what is perceived are the affordances of the environment: ". . . what it offers the animal, what it provides or furnishes, for ill or for good" (p. 127). Gibson's theory of affordances calls for the inseparability of perception and action. It is based on the premise that perceptual information is primarily constrained by the meaning for action: whether for example a surface is walkable, an object is mouthable, graspable, or reachable. The affordances of the environment

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are invariant properties specified in reference to what a perceiver/actor can do. They refer to the compatibility between an object, its particular physical characteristics, and its location in space and those of a perceiver/actor interacting with it.

From a developmental perspective, the concept of affordance raises important questions regarding the calibration or scaling of perceptual information in relation to what the child can or cannot do, as well as to what the child perceives that other people can or cannot do. Although numerous studies demonstrate that from the onset of development perception is oriented toward the detection of affordances (Gibson, 1982; Gibson, Riccio, Schmuckler, Stoffregen, Rosenberg, & Taormina, 1987; Rochat, 1987), little is known about the relative accuracy of young children to perceive what objects afford for themselves or for others. In particular, what is the ability of the child to differentiate affordances for themselves and for others, between the effectivities of their own body and those of others? The present research investigates the ability and relative accuracy of children ages 3–5 years, as well as of a comparison group of adults, to detect what is reachable for self and for others. The aim is to study perspective taking and the planning of an action for self or for others within the context of a well developed practical task young children perform frequently in their transactions with objects and people in the environment. The action is *reaching* and the task pertains to the perceptual judgment of what is *reachable.*

Recent studies demonstrate that early in development infants perceive and discriminate objects' reachability for themselves. Six-month-olds reach selectively and in anticipation of particular manual contacts with the object (Clifton, Rochat, Litovsky, & Perris, 1991; von Hofsten & Ronnqvist, 1988). Five-month-olds perceive the distance at which an object is either within or beyond their reach (Rochat & Goubet, 1993; Yonas & Hartman, 1993). By 12 months, infants perceive that their reach is extended by the use of a long tool (McKenzie, Skouteris, Day, Hartman, & Yonas, 1993). Although there is now clear evidence that early in development children are able to perceive what is reachable for themselves, no data exist regarding young children's ability to differentiate between what is reachable for themselves versus what is reachable for others.

Three empirical questions guide the present research: Do young children differentiate between what is reachable for themselves and what is reachable for others? Do young children perceive the effectivities of their own body as unique compared with the effectivities of others in reaching? As a function of age and in comparison with adults, how accurate are children in perceiving what is reachable for themselves and for others? Based on the recent findings in the domain of infancy demonstrating the early ability to detect object affordances for reaching, it was expected that children as young as 3 years of age are capable of differentiating between what is

reachable for themselves and what is reachable for others. In particular, based on the perceived characteristics, effectivities, and situation of another person in the environment, young children were expected to detect the particular affordances for this person, independently of what they perceive for themselves. From 3 years of age, and in the context of a perceptual task requiring judgments about reachability for self and for others, it was hypothesized that young children would resemble adults in demonstrating scaling and perspective taking.

METHOD

Subjects

Three- to 5-year-olds and a group of adults were tested. Following pilot trials, 3 years was the youngest age that could be tested using the experimental paradigm described below, which requires a clear understanding of relatively complex verbal instructions. A total of 67 predominantly caucasian subjects with middle- to upper middle-class SES status participated in the experiment. The group of 3-year-olds included 14 41- to 53-month-old children (6 boys and 8 girls, all right handed, with a mean age of 3 years and 10 months). The group of 4-year-olds included 15 54- to 65-month-old children (9 boys and 6 girls, one left handed, with a mean age of 4 years and 11 months). The group of 5-year-olds included 14 66- to 78-month-old children (8 boys and 6 girls, one left handed, with a mean age of 5 years and 10 months). The group of adults included 24 adults (12 men and 12 women, all right handed, ages 17–21 years). The children were preschoolers, tested at their public preschool (Ecole Maternelle) in Paris, France. Adult subjects were freshmen students recruited from a large introductory class at Emory University.

Apparatus

A moveable object was placed on a bench and subjects were asked to estimate the distance at which it was reachable. The object consisted of a red plastic apple, 6.5 cm in height, 5.5 cm in width, with a 1.5-cm-long by 0.2-cm-wide stem. The apple was affixed to a black wooden bench, 129 cm long and 7 cm wide. The apple was fastened to a metal plate (2.5 $\times$ 3.5 cm) fitted to slide along a track running the length of the bench. A system of pulleys on the underside of the apparatus enabled the experimenter to move the apple back and forth on the bench. Metric measuring tapes (124 cm long) were attached along both sides of the bench, not visible to the subject. The apparatus is presented in Fig. 1.

Design

Subjects were asked to estimate the distance at which the apple was reachable under two conditions: a horizontal condition under which the

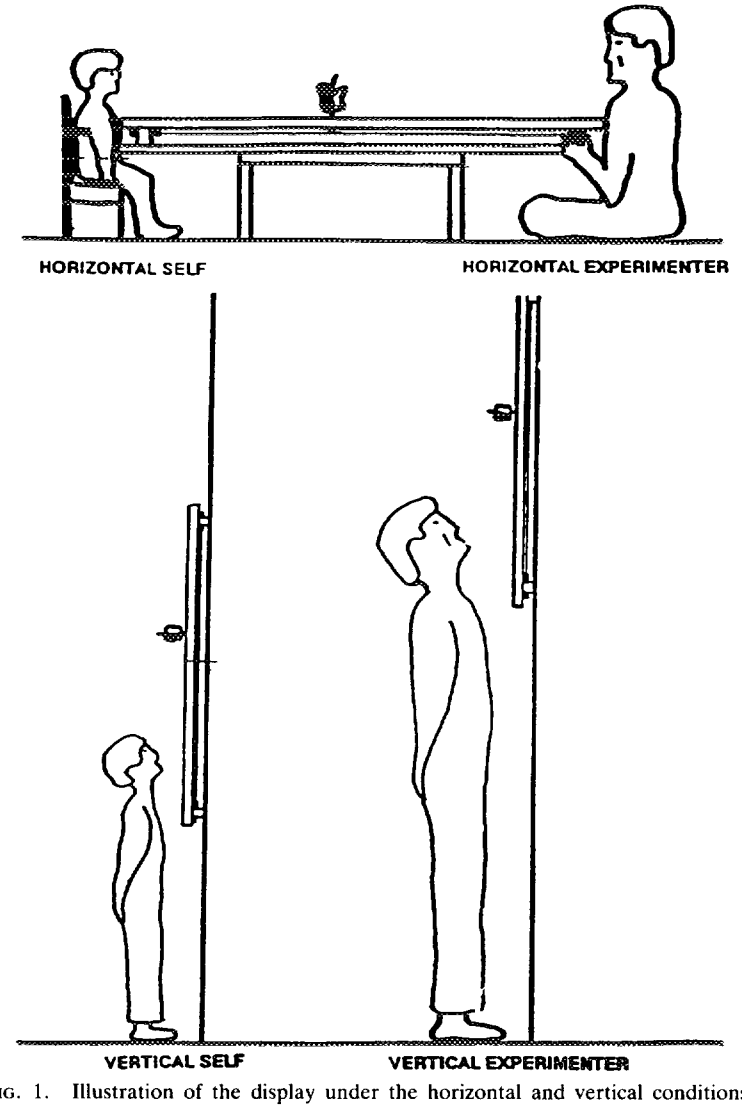

FIG. 1. Illustration of the display under the horizontal and vertical conditions. Under the horizontal condition, the subject (a child in the illustration) is facing the experimenter across from the bench supporting the object (apple). Under the vertical condition, either the experimenter or the subject was situated under the bench supporting the apple for reachability judgments.

apple was situated in the horizontal plane relative to the reacher and a vertical condition under which the apple was situated in the vertical plane relative to the reacher. Under both conditions, subjects provided reachability judgments, either for themselves (Self) or for the experimenter (Other). Figure 1 illustrates the horizontal and vertical conditions under which subjects were tested.

Horizontal condition. Subject and experimenter sat across from each other at a table with the object placed between them. Subjects gave four reachability judgments: two for themselves (Self judgments) and two for the experimenter (Other judgments). Self vs Other judgments were provided in an alternate order, counterbalanced among subjects of each age group. Note that under the horizontal condition, the subject reachability judgments for Self and for Other are provided from the same vantage point, subject and experimenter facing one another in both situations. This is not the case in the vertical condition described below.

Vertical condition. Either subject or experimenter was placed under the apparatus with the object positioned vertically above the head. In this condition, subjects provided a total of eight reachability judgments in two situations (four judgments per situation, i.e., two Self judgments and two Other judgments). In one situation, subjects were asked to provide reachability judgments either with both feet flat on the ground (Vertical Situation), or by "imagining" themselves or the experimenter standing on tip toes (Vertical/Toes Situation). In either situation, no actual raising of the feet took place, as subjects and experimenter were instructed to remain with both feet flat on the ground. Self vs Other judgments were provided in an alternating order in each condition. The alternating order of Self vs Other judgments and the order of conditions were counterbalanced among subjects of each age group.

Procedure

For each judgment under all conditions, subjects were asked to judge whether the stem of the apple was reachable with the tip of the extended right hand's index finger. The main task constraint was that subjects could not actually perform a reach and never saw the experimenter reach for the object. The task required an exclusively perceptual judgment from the subject, with no feedback from the experimenter. In each situation within a condition, subjects provided two judgments in two successive test trials ($N = 12$ test trials). For each test trial, the apple was moved by successive steps of 1 cm away from the subject or the experimenter (ascending presentation), or closer to the subject or experimenter (descending presentation). In the ascending presentation, the apple was placed 20 cm away from the reacher, and in the descending presentation 120 cm away. Each subject had either an ascending or a descending

presentation for all 12 test trials. Type of presentation was counterbalanced among the subjects of each age group.

In each test trial, the apple was moved until the judged critical point of the apple's reachability was established. The critical point was the limit at which subjects thought either they or the experimenter could still *just* touch the stem of the apple. At this response change ("yes" to "no" or "no" to "yes" depending on the presentation) the apple was moved one step back or forward by the experimenter two times to confirm the critical point which was recorded in centimeters on the measuring tape affixed to the side of the apparatus.

As illustrated in Fig. 1, under the horizontal condition, subject and experimenter sat across from each other at a table. The bench was placed across the table and extended beyond the table so that its edges contacted the torsos of both the experimenter and the subject at shoulder height. Keeping the bench at shoulder height and in contact with the torsos imposed a particular perspective on the apple and set a postural constraint on the reaching potential of both subject and experimenter, preventing them from reaching with a leaning of the trunk. A reach was potentially possible with the engagement of the arm only. Under the horizontal condition, the view of the experimenter from the subject's perspective was a frontal view of his head and shoulders, excluding the forearms and hands controlling the movements of the apple from underneath the bench. The experimenter's arms were bent with his elbows at his sides while controlling the pulleys under the bench.

Under the vertical condition, the subject or the experimenter was placed under the moveable apple with the bench positioned vertically above their heads against a wall, 30 cm away from them (see Fig. 1). The bottom edge of the apparatus was located 58.5 cm from the ground for the children and 154 cm for the adult subjects. When judging the experimenter's reach, subjects were placed 2 m away to the right side of the experimenter. From this position, the bent right arm and hand of the experimenter controlling the motion of the apple from under the bench were visible to the subject.

Following completion of all test trials, the subject's actual reach was measured on the bench in all the experimental situations. For the measure of actual reach, subjects extended their right arm and the apple was moved until the stem touched the tip of their index finger. A mark on the metal plate supporting the apple (not visible to the subject) was in vertical alignment with the apple's stem, enabling the experimenter to record its exact distance in centimeters on the measuring tape. For the measurement of actual reach under the horizontal condition, subjects were seated with the apparatus at shoulder height and lightly touching their torsos. For the measurement of actual reach under the vertical condition, subjects stood either flat footed or on tip toes with their right arm and index finger

extended toward the stem of the apple hanging above their heads. In all measures made under the vertical condition, the distance from the bottom edge of the apparatus to the ground was added to the measurement made on the bench's measuring tape.

RESULTS

Results were analyzed in terms of both *absolute judgments* and *relative accuracy* of the judgments provided by each subject in a particular experimental situation. The absolute judgment measure corresponded to the average, in centimeters, of the two judgments provided by the subject in each experimental situation. The relative accuracy measure was computed as the percentage ratio of the absolute judgment measure (estimate) for a situation over the actual reachability measure in that situation (estimate/actual reachability × 100). A subject's reachability judgment ratio greater than 100 indicated an overestimate and a judgment ratio of less than 100 indicated an underestimate.

Absolute Judgments

Overall, remarkably little variation is observed when comparing the two reachability judgments provided by a subject in each experimental situation. The comparison of these judgments demonstrate a high degree of confidence in all subjects. For all age groups and in all situations, the average agreement between judgments was above .95. The next analyses are based on an average of the two reachability judgments obtained in the different conditions.

Horizontal condition. Results regarding absolute judgments for the four groups of subjects in the Horizontal condition are presented in Fig. 2.

For the three groups of children and independently of age, the reachability judgments for self are markedly reduced compared to the judgment for the experimenter. In contrast, adult subjects provide comparable estimates for self and for other. On average, children attribute 30% *more* reachability to the experimenter on the bench compared to themselves. The same calculation for the adult subjects show that they attribute 5% *less* reachability to the experimenter on the bench compared to themselves. This first result indicates clearly that children do not generalize the perception of their own reachability to what they perceive in another, larger individual situated differently in relation to the object. This result is a first demonstration that within the context of this task, from 3 years of age, children demonstrate allocentrism and are not operating in a purely egocentric mode.

With respect to age, the results presented in Fig. 2 show that in the Self situation, judgments are scaled to the actual arm length of either the child or the adult's subject. On average, the actual reachability for 3-year-olds was 41.4 cm; for 4-year-olds, 46.0 cm; for 5-year-olds, 49.4 cm;

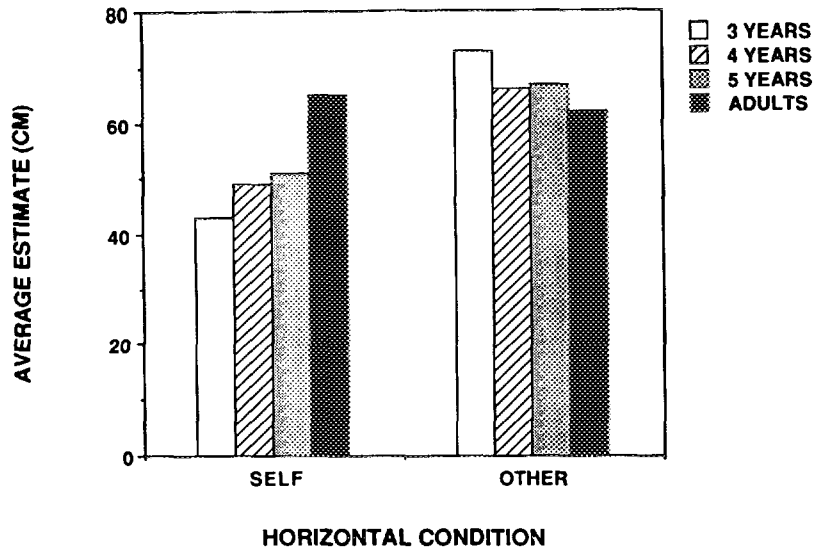

FIG. 2. Average absolute reachability judgments (estimate in centimeters) for the three groups of children and the group of adults under the Horizontal condition for Self and for Other (the experimenter).

and 64.2 cm for the adults. As shown in Fig. 2, in the Self situation, the average value of absolute judgments increases according to age, hence to actual reachability. In contrast, no such covariation is found in the Other situation. These results indicate that children, like adults, scaled their judgment to their own physical characteristics when judging reachability for themselves, and not for others. They take the perspective of the *other* potential actor, demonstrating that depending on the situation, they are capable of switching from a mode centered on the self (egocentrism), to a mode centered on the other (allocentrism).

In support of the trend illustrated in Fig. 2, a 4 (age) $\times$ 2 (Self or Other situation) mixed design analysis of variance with age as a between factor and situation as a within factor yields no significant main effect of age ($F(3, 63) = 1.37$), but a significant main effect of situation ($F(1, 63) = 128.67$, $p < .0001$) and a significant age-by-situation interaction ($F(3, 63) = 33.09$, $p < .0001$). Post-hoc analyses of the simple effects show that this significant interaction rests on the fact that all groups of children demonstrate a significant increase in their reachability judgments for Other compared to Self ($p < .0001$), whereas no such difference is found with the group of adults ($p < .13$). These results confirm the systematic attribution by all children of more reachability to the experimenter than to the self. In general, children scale their judgments according to their own physical characteristics in the Self situation and not in the Other situation.

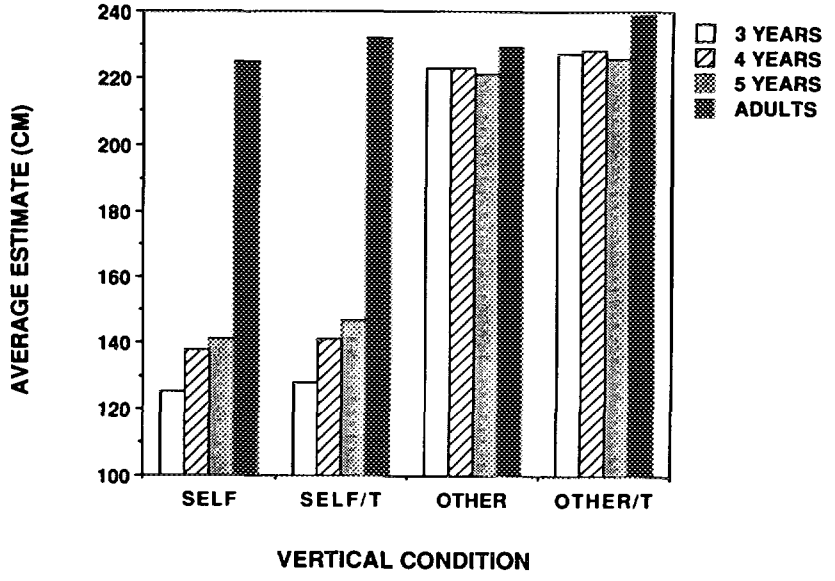

FIG. 3. Average absolute reachability judgments (estimate in centimeters) for the three groups of children and the group of adults under the vertical condition for Self or for Other with feet flat on the ground (Self, Other) or on tip toes (Self/T or Other/T).

Vertical condition. Results regarding absolute judgments for the four groups of subjects in the four situations in which they judged reachability for themselves or for the experimenter with feet flat on the ground (Self or Other) or on the tip of the toes (Self/Toes or Other/Toes) are presented in Fig. 3.

Overall, Fig. 3 shows that the average estimate for Self increases with age, reflecting each groups' average height. As under the horizontal condition, children and adults scale their judgments for Self according to their action capabilities. In contrast, children's average estimate for Other does not depend on their own action capabilities or height attached to their age. Furthermore, children as well as adults show an increase in their estimate when the actor (either Self of other) is said to be standing on tip toes compared to flat feet (Self/Toes or Other/Toes compared to Self or Other). A 4 (age) × 2 (Self or Other situation) × 2 (flat feet or tip toes) mixed design with one between and two within factors analysis of variance confirms the overall trend shown on Fig. 3. The analysis of variance yields a significant main effect of age ($F(3, 63) = 68.95$, $p < .0001$), a highly significant main effect of Self vs Other situation ($F(1, 63) = 2866.5$, $p < .0001$), and a significant age-by-situation interaction ($F(3, 63) = 266.2$, $p < .0001$). Post-hoc analyses of the simple effects show that this interaction is due to the fact that all groups but the adults

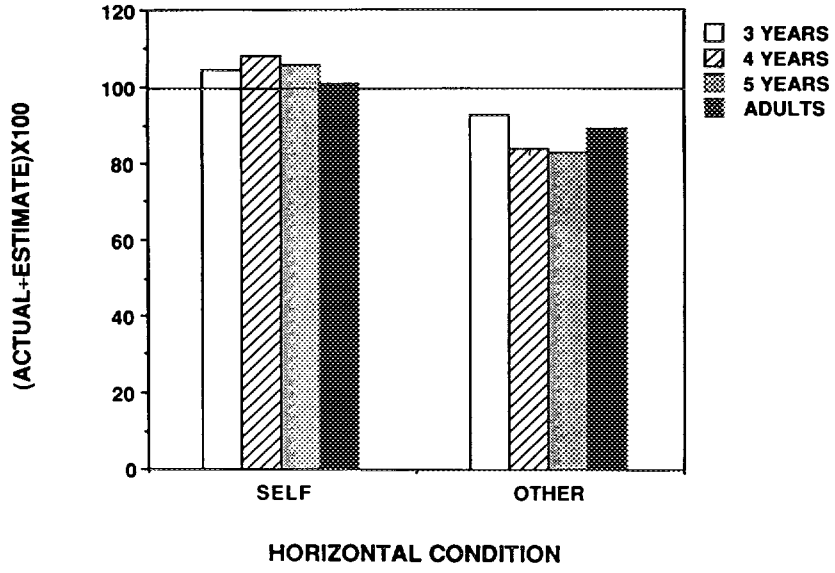

FIG. 4. Average ratio (%) of estimate over actual reachability measure for the three groups of children and the group of adults under the horizontal condition for Self and for Other (the experimenter).

show a significant increase in their reachability judgments for Other compared to Self. Results of the analysis of variance also demonstrate that at all ages, subjects tend to attribute systematically more reachability to Self and to Other in the Vertical/Toes (tip toes) situation. The analysis of variance yields a significant main effect of posture (i.e., flat feet vs tip toes; $F(1, 63) = 73.29$, $p < .0001$). Children as well as adults show that despite the fact that they were not allowed to stand on tip toes and never saw the experimenter standing on his tip toes, they correctly adjusted their judgments to this new task requirement. These results further suggest that in the context of this task, all subjects including children as young as 3 years of age detect and differentiate the reachability of the object for Self or for Others as a function of various postural conditions, hence demonstrate appropriate allocentrism.

Relative Accuracy

Horizontal condition. Figure 4 presents the results obtained with children and adults under the horizontal condition regarding the average ratio of estimate over actual reachability measure. Remember that a judgment ratio greater than 100 indicated an overestimate of the reachability for either self or other. A judgment ratio of less than 100 indicated an underestimate.

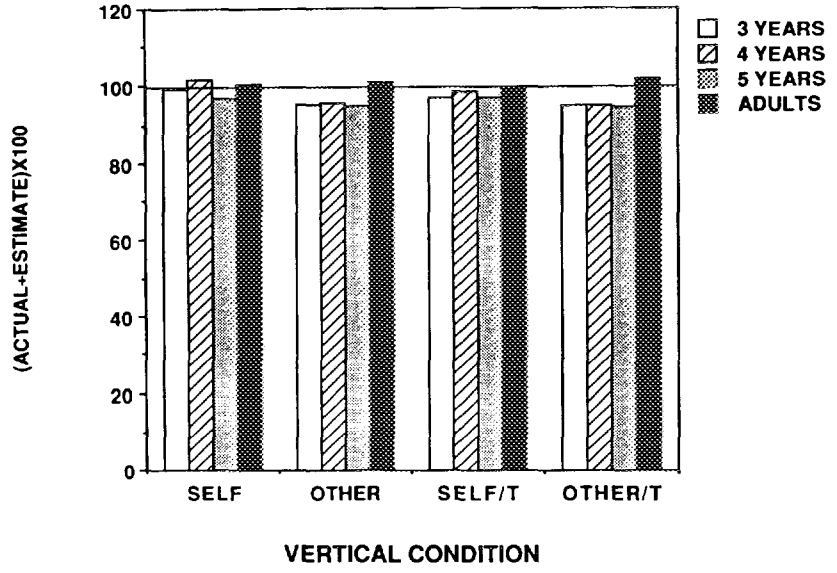

FIG. 5. Average ratio (%) of estimate over actual reachability measure for the three groups of children and the group of adults under the vertical condition for Self or for Other with feet flat on the ground (Self, Other) or on tip toes (Self/T or Other/T).

Figure 4 shows that under the horizontal condition, adults as well as children of all age groups tend to overestimate their own reachability in the Horizontal Self situation. In contrast, children and adults alike tend to markedly underestimate the reachability of the experimenter in the Horizontal/Other situation. A 4 (age) × 2 (Self vs Other situation) mixed design analysis of variance yields no significant main effect of age ($F(3, 63) = 0.349$), but a significant main effect of situation ($F(1, 63) = 76.26$, $p < .0001$) with a marginally significant age-by-situation interaction ($F(3, 63) = 2.302$, $p < .09$). Post-hoc analyses of the simple effects show a significant effect of situation for all groups of subjects ($p < .01$). The general phenomenon of an overestimate in the Horizontal/Self situation and of an underestimate in the Horizontal/Other situation suggests that the same processes underlie the judgments of children and adults. Compared with adults, children from 3 years of age do not operate in a different (i.e., more egocentric) mode. Reasons underlying this general underestimate are considered in the discussion.

Vertical condition. Figure 5 presents the results obtained with children and adults under the vertical condition regarding the average ratio of estimate over actual reachability measures. As shown on Fig. 5, in comparison to the adults, children tend to show underestimate in their reachability judgments. Furthermore, adults appear in general more accurate and consistent across situations. A 4 (age) × 2 (Self or Other situation)

× 2 (flat feet or tip toes) mixed design analysis of variance yields a significant main effect of age ($F(3, 63) = 3.53$, $p < .02$), a significant main effect of situation (i.e., Self vs Other, $F(1, 63) = 14.55$, $p < .0001$), and a significant age-by-situation interaction ($F(3, 63) = 4.69$, $p < .005$). Post-hoc analyses of the simple effects show that this significant interaction is due to a significant difference between the judgments in the Self and Other situations for the groups of 3- and 4-year-olds. Three- and 4-year-old children show a significant increase of their underestimate when judging reachability for Other compared to Self. These results suggest that in terms of accuracy, 5-year-olds and adults are more consistent across situations compared to the groups of younger children. The analysis of variance also yields a significant posture (flat feet vs tip toes) main effect ($F(1, 63) = 25.89$, $p < .0001$), and a significant age-by-posture interaction ($F(3, 63) = 4.39$, $p < .007$). In general, post-hoc analyses of the simple effects reveal that only 3- and 4-year-olds show a significant increase of their underestimate in the tip toes situations ($p < .01$).

DISCUSSION

From 3 years of age, children differentiate what an object affords for self and for others. Their judgments indicate that they accurately predict more reachability to an adult compared to themselves. Regardless of the experimental situation, children do not assimilate what is reachable for others to what is reachable for themselves. These results indicate that in the context of a task involving a familiar and well developed action (i.e., reaching), young children are not rigidly confined to an egocentric perspective. They show no sign of an assimilation of others' perspective to their own. From 3 years of age, children are clearly capable of perspective taking, spatial decentration, and are flexible in adopting an egocentric or an allocentric perspective, depending on the requirements of the task (i.e., judging reachability for self or for others).

These results provide additional evidence that in the context of a practical and functional task, young children express allocentrism and perspective taking. Previous research demonstrated that preschoolers show rudiments of role taking in the context of a task where they are asked to infer whether a stimulus is visible for another person and whether this person sees the same thing from their own vantage point (Flavell, Botkin, Fry, Wright, & Jarvis, 1968). In the context of verbal communication, preschoolers show adaptation of their speech to the characteristics of the listener, whether for example the listener is younger, of the same age, or an adult (Shatz & Gelman, 1973). In general, spatial competencies are fully expressed when young children can relate their own experience to the spatial task they have to solve (Liben, 1981; Pick & Lockman, 1981). Interestingly, major differences are reported between the spatial cognition

kindergartners demonstrate while searching, moving, and acting in their classroom environment and the spatial cognition they demonstrate when asked to reconstruct a tabletop model of their classroom (Siegel & Schalder, 1977; Klaue, 1984). It appears that in comparison to the late expression of formal spatial relations studied by Piaget and Inhelder (1956/1948) in their seminal study of the child's conception of space, there is a clear developmental precedence of perception and cognition about what the environment affords for *action*. As suggested by Bremner (1993), Piaget underestimated what the children perceive of the environmental structure in relation to the repertoire of action that they are demonstrating at a particular moment of their development (i.e., unaided sitting or locomoting).

Although the context of the task was practical, it does not mean that subjects did not have to operate at a representational level. Their reachability judgments required some "imaging" to the extent that in none of the situations did subjects have the possibility of seeing their own arm or the experimenter's arm extended toward the object on the apparatus. In the Horizontal/Other situation, subjects could not see the arms of the experimenter. In the Vertical/Toes situation, subjects gave their reachability judgments based on the mental projection of the self or others standing on tip toes. Subjects were required to go beyond the perceptual information given, constrained to imagine themselves or the experimenter reach for the apple in the particular circumstances dictated by the experimental situation. In general, the constraints of the task called for more than direct perception of the object's affordance for reaching. Children as well as adults gave reachability judgments based on the complex integration of information regarding the object (apple), the actor (self or other), and their situation (actual or imagined) in the environment. In the context of the task, the process of this integration corresponds to perspective taking and spatial decentration.

Heft (1993) introduces a distinction between two types of judgments regarding objects' reachability: perceptual and analytical. According to Heft, perceptual judgments are based on skilled, unreflective perception–action process and are basically accurate. Perceptual judgments are subsidiary means of achieving a larger goal, not a focal task. These judgments correspond to the notion of direct perception proposed by Gibson (1979) in his ecological approach to visual perception. In contrast, analytical judgments are a focal task. They are reflective (indirect), explicit, and a source of errors. Following Heft's distinction, the judgments considered in the present research are analytical in the sense that they are a focal task and sometimes associated with systematic errors across ages. The reported results challenge Gibson's view in the sense that they demonstrate that the process underlying the perception of an object's affordance (i.e.,

its reachability) is not exclusively direct and veridical. In the Horizontal/Other situation, for example, both children and adults manifest a marked underestimate in their perceived reachability judgments.

Beyond Heft's distinction, why are these analytical judgments a source of systematic error? This underestimate could be explained by the perspective of the subject on the display which could entail either a conflict between judgments for self and for others and/or a problem of perceptual constancy. Remember that under the horizontal condition, the subject reachability judgments for Self and for Other were provided from the same vantage point, subject and experimenter facing one another in both situations. This was not the case under the vertical condition. Accordingly, it is feasible that the judged spatial extent separating the experimenter from the apple is systematically underestimated because subjects do not compensate for its apparent compression at a distance on the horizontal plane. However, a control study where adult subjects were tested in the Horizontal/Other situation viewing the experimenter facing the apple from the side rather than from across the bench shows that subjects persist in providing a lesser, but still pronounced underestimate of the experimenter's reachability (Rochat & Schneiderman, unpublished data). An alternative explanation is that in the Horizontal/Other situation, the assessment of the experimenter's arm length and degrees of behavioral freedom is drastically limited compared with that in the Vertical condition. The way the apparatus was placed against both the experimenter's and the subject's torsos (see Fig. 1) prevented any leaning of the trunk.

The systematic underestimate of the experimenter's reachability in the Horizontal/Other situation and the general tendency toward an overestimate of reachability for Self in the Horizontal/Self situation may be due to differences in the perception of postural constraints in a particular experimental situation. In the Horizontal/Self situation, subjects appear to overestimate their own degrees of behavioral freedom, in particular their ability to lean forward and stretch their arm. A recent study shows that the perceived reachability by adults does indeed depend on perceived postural constraints (i.e., the perceived ability to stretch forward in a particular situation), and that subjects tend in general to overestimate their stretchability (Carello, Grosofsky, Reichel, Solomon, & Turvey, 1989; Rochat & Wraga, 1994). Interestingly, the marked underestimate expressed by all subjects in the Horizontal/Other situation suggests a bias toward the perceived postural limitations of the experimenter as a potential actor. Further research is needed to test this explanation and try to clarify the opposite trend in judging reachability for Self and for Others under the horizontal condition.

From the point of view of development, the generality across age groups of both the overestimate in the Horizontal/Self and the underestimate in the Horizontal/Other situation suggests an isomorphism in the process

underlying the judgments provided by young children and adults. In the context of this task, young children and adults manifest analogous processing of spatial information. Aside from their similarity with children, adults are generally more accurate. In comparison with children, adults have many more experiences with others in reaching for objects. Furthermore, children are in the process of calibrating their perceived reachability as a function of their physical growth. Although this calibration takes place over years, it could be the source of more errors in judged reachability for the self, as well as for others. Another explanation that could account for the higher accuracy in adults is the fact that they had to judge the reachability of a peer, as children had to judge the reachability of an adult with drastically different physical characteristics compared with the self. For this reason also, children were at a clear disadvantage. Future research should consider the performance of children and adults, when both have to judge the reachability of a peer. Finally, results of the relative accuracy in the vertical condition indicate that by 5 years of age, children resemble adults in providing more consistent judgments across situations (Self vs Other, Flat feet vs Tip toes). These latter results point to an interesting developmental progression regarding the relative accuracy of reachability judgments involving Self or Other in different postures.

In conclusion, the results of this research provide further support to the hypothesis that in development, the emergence of allocentrism or spatial decentration is *task specific*. In the context of a perceptual task requiring judgments about reachability for self and for others, children resemble adults in demonstrating perspective taking and spatial decentration. Specifically, from 3 years of age, children differentiate between what is reachable for themselves and what is reachable for others. Based on the perceived characteristics, effectivities, and situation of another person in the environment, young children detect the particular affordances for this person independently of what they perceive for themselves. Prior to the formal conceptualization of space emerging by 9 years according to Piaget, young children develop spatial understanding of the environment in which they, as well as others, are *actors*. In development, spatial cognition refers first to the perception of potential actions in the environment. Early spatial cognition, which entails perspective taking and spatial decentration, is probably "redescribed" (Karmiloff-Smith, 1992) at a conceptual level by 8–9 years of age, when children start to provide allocentric solutions to conceptual spatial tasks (e.g., the three mountains task of Piaget and Inhelder, 1956/1948). Although conceptual knowledge about space within a metric system might become apparent by 8–9 years of age, the present research further demonstrates that similar knowledge can be expressed in the planning of a familiar action at a much earlier age. More research is needed to elucidate the intriguing developmental

progression of spatial competencies first expressed in practical space and later in conceptual space.

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