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Egocentric or allocentric frameworks for the evaluation of other people's reachability

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ABSTRACT

The adoption of egocentric and allocentric frameworks in the perception of other people's reachability was investigated. In study 1, 24 adults (12 experienced and 12 inexperienced dealing with children) judged vertical reachability for themselves and for two children. In study 2, 37 parents judged vertical reachability for themselves and their children. Absolute errors (|estimate-actual reachability|), absolute percent errors (|1-judgement/actual reachability| × 100), and error tendency (underestimations, right judgments, or overestimations) were calculated. Adults were quite accurate in perceiving their own reachability (absolute percent errors ranging from 2.20% in study 1 to 3.12% in study 2) and clearly less precise when estimating children's reachability. Results indicated a tendency for adults to overestimate reachability of the younger child (study 1) and a tendency for parents to overestimate their children's reachability (study 2). No correlation between judgement errors for the self and for the children in any of the studies was observed. Results support the existence of an allocentric and not an egocentric framework when evaluating other people's affordances.

1. Introduction

The information that specifies affordances is public (Gibson, 1979), which means that it is available not only to the perceiver but also to other people. Some studies (Mark, 2007; Rochat, 1995; Stoffregen, Gorday, Sheng, & Flynn, 1999) indicated that humans can make use of that information to perceive

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other people's affordances, suggesting that observers are capable of taking the perspective of another person and switch from a mode centered on the self (egocentrism), when perceiving affordances for their own actions, to a mode centered on the other (allocentrism), when perceiving affordances for others. The ability to shift from an allocentric to an egocentric framework has been reported in children (Rochat, 1995), which supports Gibson's idea that "The evidence about the earliest visual experiences of infants does not suggest that they are confined to surfaces seen-now-from-here... I therefore suspect that the supposed egocentricity of the young child is a myth" (Gibson, 1979, p. 201). The assertion "I can put myself in your position" (Gibson, 1979, p. 200) is not a mere figure of speech; it means that an observer can perceive the information available to another person, without having to occupy his/her point of observation. The perception of other people's maximum capabilities, specifically of children's action boundaries, such as the highest place a child can reach, is of paramount importance in terms of child safety. It is important for parents and caregivers to correctly judge whether an object is within vertical reach of a child. The role of parents and educators in the management of environmental conditions has been widely reported in the literature about child safety and prevention of childhood injuries (Morrongiello, 2005).

Studies on the perception of self-reachability indicate that judgments of this action capability are quite accurate, but present a systematic overestimation bias (Carello, Grosofsky, Reichel, Solomon, & Turvey, 1989; Fischer, 2005; Gabbard, Ammar, & Lee, 2006; Gabbard, Ammar, & Rodrigues, 2005; Pepping & Li, 2000; Rochat & Wraga, 1997). Some studies (Cordovil & Barreiros, 2010, in press; Fischer, 2003; Ramenzoni, Riley, Shockley, & Davis, 2008b; Rochat, 1995) also indicate that individual's can be reasonably accurate in the perception of other people's reachability. However, the overestimation bias is not as consistent as in the judgment of self-reachability. Some studies have detected an underestimation bias for some selected sample groups (Cordovil & Barreiros, in press; Ramenzoni et al., 2008b; Rochat, 1995).

In a recent study Chang, Wade, and Stoffregen (2009) addressed the interesting issue of perceiving affordances within an environment-adult-child system. Adults were required to determine the minimum passable aperture width for the dyad when the adult and the child walked side by side. Results indicated that adults were able to perceive affordances for aperture passage for the environment-adult-child system on the basis of the body-scaled information of each adult-child dyad, perceiving their own plus the child's characteristics. However, some adults underestimated while other adults overestimated the action capabilities of the dyad, which supports the idea of a non-systematic overestimation of action capabilities.

The perception of other people's affordances might be influenced by several factors, such as the characteristics of the model, the position of the observer relative to the model and to the context, the observer's characteristics (e.g., level of experience), or the morphological and functional differences between the observer and the model (Fischer, 2003; Ramenzoni et al., 2008b; Rochat, 1995). There are indications that perceiving affordances for another person may not be independent of the observer's capacity to act in the environment at a given moment, suggesting an influence of the egocentric framework in allocentric judgments (Ramenzoni, Riley, Shockley, & Davis, 2008a). A strong argument for this perspective was provided by Ramenzoni et al. (2008a) in a study about the effects of sudden changes in body weight characteristics in the perception of the affordances for the self and for the others. The results showed that the participants adjusted the judgments for their own reachability, but they did so also for the other persons who were not wearing additional weights.

The assumption that we apprehend the actions afforded to another person with regard to our own capacity to produce action suggests a relationship between egocentric and allocentric frameworks in the perception of other people's affordances. The relationship between the two frames of reference seems influenced by perceptual experience and tuned in relatively short learning periods (Ramenzoni et al., 2008a).

The preset study was conducted in an attempt to clarify the contrast of egocentric and allocentric frameworks in adults' perception of children's vertical reachability, the influence of adult's experience dealing with children (Experiment 1), and the effects of child specific knowledge by parents (Experiment 2).

2. Experiment 1

2.1. Method

2.1.1. Participants

Twenty-four adults, between 20 and 64 years old (M = 37.76, SD = 11.15), with maximum reachability ranging from 197.80 cm to 250.20 cm (M = 219.75, SD = 13.90), and with normal or corrected-to-normal vision, participated in the experiment. The adults were divided in two groups according to their level of knowledge about the children: (i) Inexperienced – 12 adults (5 males and 7 females), with ages between 20 and 54 years (M = 31.2, SD = 9.5), with no children or younger brothers in the family, and with no experience or daily contact with children; (ii) Professional caregivers – 12 female adults, between 31 and 64 years old (M = 44.3, SD = 8.7), with prolonged experience (more than two years) dealing with children. Ethical approval from the Faculty of Human Kinetics (Technical University of Lisbon, Portugal) and informed consent from the parents of the children and the observers that participated in the study were obtained.

2.1.2. Models

Two boys, 1.7 and 3.6 years old, 83.2 cm and 99.5 cm tall, and with maximum reachabilities of 100.2 cm and 127.4 cm, served as models.

2.1.3. Procedures

A shelf that could be raised or lowered (1.6 cm intervals, from 65 cm to 228.2 cm for children, and from 95 to 258.2 cm for adults) was used to estimate the children's and adults' reachability. Identification numbers between 1 and 103 were marked on the side of the shelf with no direct correspondence to the real height in centimeters to avoid the association to a well-known metric reference. A toy (3.5 cm high, 3 cm wide, and 6.5 cm long) was placed on the shelf at its minimal height.

The child entered the room and stood close to the shelf, in front of it, facing the observer, with the arms at the sides. The order of presentation of the children was randomized. Observers stood 2 m away from the shelf and were instructed to look at the child and register on their record form the maximum height which they thought he would be able to take the toy off the shelf. To register that measure (i.e., maximum vertical reachability), they were instructed to look at the marked side of the shelf and write down the highest number they thought the child would reach. The observers were told that the child was allowed to stand on tip-toes and touch the shelf, but was not allowed to climb or jump to complete the task. After that, each observer was asked to estimate his/her own maximum vertical reachability in the same conditions and from the same place previously occupied by the child. Finally, the maximum vertical reachability of each child and of the observers was determined. The actor (child or adult) extended his/her arm and the shelf was adjusted starting from that position, being raised 1.6 cm after each successful attempt and lowered 1.6 cm after each failure. The maximum vertical reachability was the highest value in centimeters, at which the actor was able to successfully take the toy off the shelf, in the previously described manner (i.e., being allowed to stand on tip-toes and touch the shelf, but not to climb or jump).

2.1.4. Data collection and analysis

The following variables were considered: judgment error in centimeters (i.e., difference between the estimated and the real maximum vertical reachability) and intrinsic errors (i.e., the ratio between the judgment and the real maximum vertical reachability) (cf., Ramenzoni et al., 2008b). The intrinsic error is expressed in "intrinsic" units of the model's own capabilities, and it represents: (i) perfectly accurate judgments (ratios equal to 1.0) when perceptual judgment equals the actual reaching height; (ii) underestimations for ratios lower than 1.0, and (iii) overestimations for ratios greater than 1.0. Absolute errors (AE) (i.e., |judgment error|) and absolute percent errors (APE) (i.e., |1-intrinsic error|$\times$100) were calculated. Error tendency (i.e., underestimation, accurate judgment, or overestimation) was also determined for each observation.

For the statistical analysis of perceiver's accuracy, Friedman's test was used to compare AE and APE for the children and for the observers. As post hoc, the Wilcoxon test, with Bonferroni correction, was employed. Error tendency was analyzed through frequency distributions. To analyze the correlation between errors for self-reachability and for children's reachability, the Spearman correlation was employed.

2.2. Results

Accuracy of judgments was analyzed through the values of absolute error (AE), which indicate the deviation in centimeters from accurate judgments, and through the values of the absolute percent errors (APE), which indicate the deviation percentage from accurate judgments (see Table 1).

Mean errors in the perception of reachability ranged from 4.87 cm, or 2.20%, for self-judgments and 6.93 cm, or 5.44%, for the taller child's judgments. There were no significant differences in the absolute error for the children and for the observers in the whole sample ($\chi^2(2) = 1.640$, $p = .440$), in the inexperienced group ($\chi^2(2) = 4.578$, $p = .101$), or in the teachers' group ($\chi^2(2) = 0.409$, $p = .815$). However, Friedman's test revealed significant differences in APE for the whole sample ($\chi^2(2) = 7.000$, $p = .030$) and for the inexperienced group ($\chi^2(2) = 6.176$, $p = .046$). Wilcoxon test, with Bonferroni correction, was used as post hoc, and revealed that, when considering the whole sample, APE in child 2 judgments was significantly greater than APE in self-judgments ($Z = -2.857$, $p = .004$), and there was a marginal significant tendency for APE in child 1 to be greater than APE in self-judgments ($Z = -2.200$, $p = .028$). In the inexperienced group, post hoc tests only indicated a marginal significant tendency for APE in child 2 to be greater than APE in self-judgments ($Z = -2.197$, $p = .028$).

Values of AE and APE were always smaller in the teachers group than in the inexperienced group, but those differences were not significant. Due to the broad range of observer's age, we investigated the influence of age in AE and APE but no significant differences were found between younger and older adults for any of the two children.

Error tendency was analyzed based on the percentage of underestimations, accurate judgments, and overestimations (Table 2).

There was a tendency to overestimate reachability of child 1 (66.67%) and to underestimate reachability of child 2 (58.33%), which was due to a strong tendency of the inexperienced group to underestimate the older child (75.00% of underestimations). Inexperienced adults had a slight tendency to underestimate self-reachability (50.00% of underestimations), while teachers revealed a tendency for overestimation regarding self-reachability (66.7% of overestimations). In the whole sample there was a tendency to overestimate affordances for one's own action (54.70% of overestimations and 37.50% of underestimations).

We found no significant correlations between errors for self-reachability and for children's reachability. The non-existence of correlation is systematic and was verified in the whole sample and for the two sample groups (inexperienced and teachers), for judgment errors, intrinsic errors, absolute errors, and absolute percent errors.

In the whole sample we found a significant correlation between judgment errors for child 1 and child 2 ($r_s = .531$, $p = .008$), and between intrinsic errors for child 1 and child 2 ($r_s = .531$, $p = .008$). However, when considering the two sample groups separately, such correlation was not observed.

Table 1
Mean (*M*) and standard-deviation (*SD*) of absolute error (AE) and absolute percent error (APE) in the estimations of reachability for the two children and for the observers. Values for the whole sample and for the two sample groups (inexperienced and teachers).

Error	Group	Child 1		Child 2		Observer	
		M	*SD*	*M*	*SD*	*M*	*SD*
AE (cm)	Whole sample	5.00	4.51	6.93	5.48	4.87	3.79
	Inexperienced	5.20	5.42	8.67	6.52	5.87	4.79
	Teachers	4.80	3.61	5.20	3.68	3.87	2.21
APE (%)	Whole sample	4.99	4.50	5.44	4.30	2.20	1.74
	Inexperienced	5.19	5.41	6.80	5.12	2.57	2.22
	Teachers	4.79	3.60	4.08	2.89	1.82	1.05

Table 2
Percentage of underestimations (% Under), accurate estimations (% Ac) and overestimations (% Over), for both children and for the observers, in the whole sample and for the two sample groups (inexperienced and teachers).

Group	Child 1			Child 2			Observer		
	% Under	% Ac	% Over	% Under	% Ac	% Over	% Under	% Ac	% Over
Whole sample	16.67	16.67	66.67	58.33	4.17	37.50	37.50	8.33	54.17
Inexperienced	25.00	16.67	58.33	75.00	0	25.00	50.00	8.33	41.67
Teachers	8.33	16.67	75.00	41.67	8.33	50.00	25.00	8.33	66.67

2.3. Discussion

The magnitudes of AE and APE of the present study indicate that adults are capable of predicting their own affordances quite accurately. The judgment of children's affordances also seemed to be adjusted to children's real action capabilities, but with less accuracy (i.e., greater APE values), mainly in child 2 judgments. The evaluation of child 2 also had contradictory results as regards the error tendency of the two sample groups, as most inexperienced adults (75.00%) underestimated this child's capabilities, while there was a slight overestimation tendency in the teachers group (50.00%). The underestimation tendency of children's reachability by inexperienced adults had already been found in previous studies (Cordovil & Barreiros, in press) and it is of concern as regards child safety since it might result in relaxed supervision behaviors. On the other hand, there was an overestimation tendency of child 1's reachability in both sample groups (66.67% overestimations in the whole sample). The tendency to overestimate the youngest child's reachability might indicate a difficulty of adults to consider children's body proportions (i.e., larger heads and smaller arms), considering them as small adults, as suggested by previous studies (Cordovil & Barreiros, 2010).

The teachers group had lower values of AE and APE than the inexperienced group in the evaluations of both children's affordances and of adults' own affordances, suggesting that adults who had daily professional experience with different children might have undergone a perceptual learning process that resulted in more accurate judgments than inexperienced adults.

The absence of correlation between errors in self-reachability and in children's reachability indicates that there was a shift to an allocentric referential in the judgment of other people's affordances. The significant positive correlation between judgment errors for child 1 and child 2 ($r_s = .531$, $p = .008$) was expected, since the perceptual processes inherent to the judgment of other people's reachability must be identical, particularly if the morphological differences between the models are not too discrepant, as it is the case of the difference between the two children.

3. Experiment 2

In Experiment 2, we investigated the influence of great knowledge of the model in the participation of the egocentric and the allocentric frameworks, in the perception of children's vertical reachability. The experimental procedures were similar to Experiment 1, but we analyzed dyads of parents and children, in which each parent evaluated their son's or daughter's reachability.

3.1. Method

3.1.1. Participants

Thirty-seven adults (22 mothers and 15 fathers), between 24 and 43 years old ($M = 34.11$, $SD = 3.88$), with maximum reachability ranging from 194.6 cm to 245.5 cm ($M = 218.38$, $SD = 13.31$), and with normal or corrected-to-normal vision, participated in the experiment. Informed consent from the participants and ethical approval from the University were obtained.

3.1.2. Models

Thirty-seven children (21 boys and 16 girls), who were sons or daughters of the participants, were between 1.2 and 4.5 years old (M = 3.19, SD = 0.96), and had a maximum reachability between 92.2 cm and 138.6 cm (M = 118.32, SD = 14.06), served as models in the experiment.

3.1.3. Procedures

The same apparatus as used in Experiment 1 was used in this experiment. Each parent estimated their son's or daughter's reachability. The experimental procedures were similar to Experiment 1.

3.1.4. Data collection and analysis

The following variables were analyzed: judgment error, intrinsic error, AE, APE, and error tendency.

For the statistical analysis of perceiver's accuracy, the Wilcoxon test was used to compare AE and APE for the children and for the parents. Error tendency was analyzed through frequency distributions. Pearson correlation was employed to analyze the effect of children's body dimensions on their parent's judgments. The Spearman correlation was used to investigate the relationship between errors for self-reachability and for children's reachability.

3.2. Results

AE values were similar in the judgment of children's reachability (M = 6.40 cm, SD = 4.49) and the observer's reachability (M = 6.78 cm, SD = 4.51), which suggested a greater APE in the judgment of children's reachability (M = 5.47%, SD = 3.84%) than in the judgment of self-reachability (M = 3.12%, SD = 2.13%), due to adult's greater body dimensions. The APE for parent's reachability was indeed significantly lower than the APE for their children's reachability ($Z = -3.064$, $p = .002$).

To study the effect of children's body dimensions on their parent's judgments, the correlation between the ratio reachability/height of the children and their parent's judgment errors was analyzed. A significant negative correlation between this ratio and judgment errors ($r = -.337$, $p = .042$), and between this ratio and intrinsic errors ($r = -.392$, $p = .016$), was found. These results indicate that judgment errors and intrinsic errors tended to be positive in younger children (whose ratio reachability/height presented the smallest values) and negative in older children (whose ratio reachability/height presented the greatest values).

Most parents underestimated their own reachability (89.12% of underestimations and 8.11% of overestimations) and overestimated their son's or daughter's reachability (62.16% of overestimations and 8.11% of underestimations).

There were no significant correlations between the judgment of self-reachability and the judgment of children's reachability. The absence of correlation was verified in all types of error considered (i.e., judgment error, intrinsic error, AE, and APE).

3.3. Discussion

Although the AE values for the judgment of children's and parents' reachability were quite similar, the APE was significantly lower in the judgment of adults' own affordances (i.e., parents) than in the judgment of other people's affordances (i.e., children). The error tendencies for adults' own affordances (89.12% of underestimations) and for children's affordances (62.16% of overestimations) were also distinct.

The results indicating a negative correlation between the proportionality ratio (reachability/height) of the children and judgment and intrinsic errors supported the results of Experiment 1. Although in Experiment 2 most parents overestimated their children's action capabilities, the greatest overestimation errors occurred in the youngest children.

The errors in the perception of parent's self-reachability and their child's reachability were not correlated, suggesting that a deeper knowledge of the model is not relevant to distinguish between egocentric and allocentric frameworks in the judgment of reachability.

4. General discussion

The findings of the two studies support Mark's (2007) statement that information about affordances is public and perceivable, whether for the actor or for other people, since adults were capable of predicting quite accurately their own reachability and that of their children.

The accuracy of self-judgment was higher than the judgment of children's reachability, indicating that the perceptual experience had resulted in a finer attunement to affordances. The better attunement to the environmental information that specifies our own affordances might have resulted from a process of education of attention (Jacobs & Michaels, 2007; Michaels, Arzamarski, Isenhower, & Jacobs, 2008). Our results suggest that the process of education of attention for children's affordances might also have occurred in the professional caregivers group, with daily professional experience with children, since their perceptual judgments were slightly more accurate.

In the present investigation, mean values for AE in reachability were similar to those in Fischer's first study (Fischer, 2003), that indicated mean errors of 6.75 cm for the short actor, and 10.10 cm for the tall actor. However, in Experiment 2, with a greater number of observers, Fischer (2003) reported a smaller magnitude of AE (i.e., 3.15 cm for the short actor, and 3.27 cm for the tall actor).

The experimental procedures that we adopted may explain the greater error magnitude that we reported in the two studies. In fact, we determined maximum vertical reaching height in a more functional and representative manner than previous studies, since in most studies actors were not allowed to stand on tip-toes. The adoption of functional measurements is critical in terms of child safety because they create a more realistic experimental scenario about real world settings.

It is also important to note that in this investigation the point of observation in relation to the context varied between the evaluation of adults' own affordances and children's affordances, since the observers were closer to the shelf when evaluating affordances for their own action. We think that this methodological option represents the most common situation in real settings. Perceivers usually judge their own affordances at the place where they act, but that is usually not the case when judging other people's affordances. As Gibson (1979) stated, an observer can perceive the information available to another person without having to occupy his/her point of observation.

In Experiment 1 there was a tendency to overestimate the youngest child's reachability, and in Experiment 2 a negative correlation between children's proportionality ratio (reachability/height) and judgment errors and intrinsic errors was found. These results are in accordance with previous studies (Cordovil & Barreiros, 2010), which indicate that there is a greater overestimation tendency when evaluating children whose ratio reachability/height is smaller, that is, children with more distinct proportions than those of the adults. Even though the error magnitude in the judgment of these children's affordances was not influenced, the error tendency seems to have been affected.

The tendency to overestimate other people's affordances reported in the literature (Fischer, 2003) was not confirmed in the judgment of the older child's reachability by the inexperienced group. This may have damaging consequences, because the judgment of safe conditions by inexpert adults may lead to erroneous options concerning what children can or cannot do.

Adults that were more accurate in estimating their own reachability were not necessarily better in the judgment of children's reachability. This was true for all the groups of adults, which means that the level of experience that adults have with children, or the specific knowledge that they have of the child they are evaluating, does not affect the nature of the relationship between egocentric and allocentric frameworks. Our investigation indicates that the allocentric framework is independent of the egocentric framework, which contradicts the results of Ramenzoni et al. (2008a). However, there are significant methodological differences between our investigation and Ramenzoni et al.'s study (2008a), since in the present study judgments of reachability were not mediated by action, but they were the result of static perceptual judgments. The results of our investigation indicate that the processes of attunement to the perceptual variables that specify affordances for one's own actions or other people's affordances are independent and probably result from different processes of education of attention.

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