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Development of Self and Other's Body Perception; Effects of Familiarity and Gender on How Children Perceive Adults.

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Abstract

Our ability to perceive our own and other people's bodies is critical to the success of social interactions. Research has shown that adults have a distorted perception of their own body and those of other adults. However, these studies ask perceivers to estimate for adults that have similar bodily make-up. This study explored the developmental progression in how children perceive their own body (5-12-yrs-olds) (Exp1) and whether children have similar distortions as adults when estimating the dimensions of adult bodies both unknown (Exp2) and familiar to them (Exp3). Overall, children showed similar distortions to those found in adult's estimations for own body perception (i.e., limbs with a smaller density of sensory receptors showed a larger error than those with a higher density) and perception of adult's bodies showed less distortion when perceiver and model were of the same gender, but not when the adult was familiar to the child.

Keywords: Body Perception; Cognitive Development; Perceptual Distortions; Social Perception

We have almost unrestricted access to visual information about our bodies and the relative size of its limbs, either directly or through reflection. Moreover, we also have access to information about other people's bodies and their action possibilities. This allows us to engage in joint actions with others, such as moving an object, and to ask for help from others when we cannot reach a goal (Ramenzoni & Liszkowski, 2016). Ramenzoni et al. (2008a; Ramenzoni et al., 2008b) argued that information about our action system's ability to act within a given environment influences how we perceive other people's. In a nutshell, when our ability to act in the world changes this change is transferred to how we perceive another person's ability to act. This suggests how we perceive our own body and its action capabilities is in some ways linked to how we perceive other people's. Findings by Linkenauger and colleagues (2017) that show that there is more similarity in how we estimate our own and another person's body proportions when we are of the same gender lend some support to this notion. However, participants in these studies are often of similar anthropometric proportions and possess similar action capabilities, which makes it hard to disentangle the role of biological and social components on body perception. This project aimed at studying this issue by asking school-age children to estimate their own and an adult's relative body proportions. In three experiments we used the method developed by Linkenauger and colleagues (2015) to establish whether children produce the same type of perceptual distortions observed in adults and whether they produce similar distortions when looking at familiar and unfamiliar adult bodies.

Body perception—that is the perception of our own bodies—relies on visual information, on constant feedback about the body's movements provided by proprioception and haptics, and on the tactile sensitivity of each body part. It is believed that reliance of tactile and proprioceptive sensitivity carries with it a distortion on how different parts of the body are perceived: less tactilely sensitive body parts, such as the torso, are perceived as proportionally longer relative to more sensitive body parts, such as the hand (Linkenauger et al., 2015). Consequently, body perception studies that ask people to estimate the size of different limbs find that the amount of overestimation of each body part varies inversely with the size of the area on the somatosensory cortex associated with it. Linkenauger et al. (2015) termed this effect *reverse distortion*, whereas body parts with small and dense somatosensory receptive fields have a larger representation on the somatosensory cortex than other less sensitive body parts (Powell & Mountcastle, 1959; Sur, Merzenich, & Kaas, 1980).

Perception of other people's bodies and their action capabilities is determined by cognitive mechanisms that exceed mere information pick-up from the senses. Authors have suggested that we rely on a *representation* of our own body to identify and interpret the bodies of others (Jeannerod, 2001). Research has shown that we use our own motor system to simulate the movements of others in order to interpret and predict their actions (Aron, Aron, & Smollan, 1992) and to understand the intentions behind them (Jeannerod, 2001). It is possible, therefore, for distortions in the perception of our own body to be transferred to how we perceive other people's bodies, if they are intrinsic to how we represent our own. A reasonable hypothesis is that when our body and that of another person share similarities in their relative proportions, it should be more easily mapped onto our body representation compared to that of a person that has different proportions from our own. One of the axes of similarity that affects body proportions is gender; women's bodies tend to share more similarities to other women's than to men's. Estimating the body proportions of a person of the same gender (gender consistent) may modulate perceptual distortions, because males and females' bodies differ proportionally. Linkenauger and collaborators (2017) compared individuals' estimations of their own body proportions and those of a model of the same or different gender. Results showed that while people perceive other people's bodies as distorted to a similar degree as their own body, distortions were modulated by interpersonal similarity (i.e., overestimations were greater when perceiver and model were of the same gender).

Little is known about the development of body perception; whether infants and children have a similarly distorted perception of their own bodies as adults, and whether they transfer such distortions to their perception of other people's bodies. Toddlers have a basic representation of the typical human form, which continues to develop over infancy (Gliga & Dehaene-Lambertz, 2005; Heron-Delaney, Wirth & Pascalis, 2011; Slaughter & Heron, 2004; Slaughter, Heron-Delaney & Christie, 2011). A study explored 1-to-3-year-olds' acquisition of knowledge about their own body's layout. Children were asked to put stickers on specified body parts, copying an experimenter, and to imitate meaningless gestures. Younger children were able to locate two or three common body parts (e.g. hand and foot), while by 30 months of age children were able to locate twice as many body parts including less common ones (e.g. neck). These findings indicate that knowledge about the body becomes increasingly sophisticated with age (Le Cornu Knight, Cowie, & Bremner, 2017). This knowledge, in turn, plays an important role in the type of social interactions, including songs and games (e.g. 'Head, shoulder, knees and toes'), that children engage in early childhood.

In the current study, we tested whether children (5-12 yrs olds) show similar body distortions as adults and whether there is a developmental progression in how the body is perceived (Experiment 1). Additionally, we investigated if children show body distortions in the perception of adults both unknown (Experiment 2) and familiar to them (Experiment 3). Different samples of children were recruited for each experiment.

Methods and Results

Experiment 1

The objective of this experiment was to test whether children (5-12-year old's) show similar body distortions as adults, and whether there is a developmental progression in how the body is perceived.

Participants 138 children (mean age = 9.35 yrs.; SD age = 1.96 yrs.) participated in this experiment. All children were recruited at the Science Cultural Center in Buenos Aires, Argentina, had normal or corrected to normal vision, and had no visible morphological abnormalities. Parents of all participants provided written informed consent before the beginning of the study. Protocol and consent forms were approved by the ethics review board of the Argentinean Society for Clinical Analyses (SAIC). Participants received no monetary or other compensation for participating in the study.

Materials and Procedure At the beginning of the experiment children were randombly assigned to one of two groups: a hand group that provided estimations using their own hand as a metric and a baton group that provided estimations using a baton as a metric. The baton was selected to correspond to the size of the child's hand. Participants hands were measured (from the intersection of the palm and wrist to the longest fingertip) using a tape measure. Children were instructed to use the length of the metric (hand or baton) to estimate the lengths of their own body parts by saying how many multiples of the metric they were. The body parts that participants in both groups were instructed to estimate the length of: leg, torso, arm length, head, the entire body, and foot. The oral instruction was for each group: for example, "how long is your leg in 'hands'?" and "how long is your leg in 'batons'?". Children gave 2 estimations for each body part in random order. We asked for two estimations to increase the reliability of the estimations provided. When estimations were either uncommonly large or small, the experimenter queried the child on the instructions to ensure that their correct understanding. Participants stood facing front with their feet apart and were encouraged to look at their different body parts while making their estimates without bending or producing large movements. Also, participants did not have access to a mirror or any other reflecting surface that could provide additional information about their body's dimensions. In all conditions, participants were prevented from physically measuring their own body parts with the hand or the baton. All responses were given verbally.

Results Children showed different degrees of distortion depending on the body part they were asked to estimate [F (5, 680) = 36.68, p < .0001, η^2=.21]. Children that used a baton as a metric showed less distortion than those that used their hand [main effect: F (1, 136) = 19.02, p < 0001, η^2=. 12].

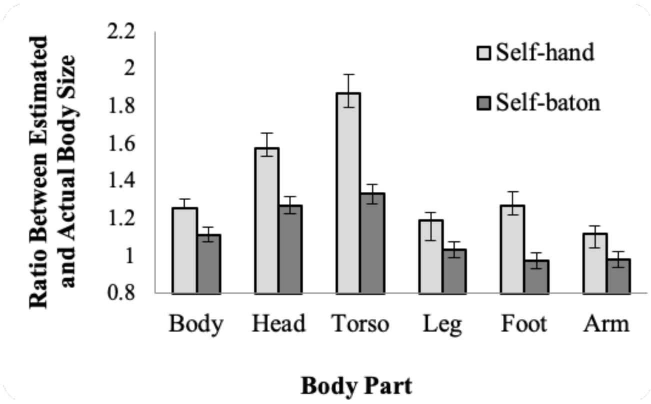

Figure 1: Mean estimation of each body part for Experiment 1. Bars show SEMs.

Estimation error was not predicted by age. Regression analyses were carried out on the mean estimation provided for each body part with either the baton or the hand to investigate whether responses were affected by age. None of the analyses were significant. Unequal distribution of children prevented us from doing a group comparison across different ages.

Discussion

Results indicate that children produce the same pattern of distortions as adults when asked to estimate the size of their own body parts (Linkenauger and cols., 2015, 2017). This pattern seems to be stable across ages. Though discrepancies in the frequency of ages prevented us from carrying out a age group comparison, regression analyses showed that age did not predict differences in the estimations for any of the body parts regardless of the metric used. This lack of significant effects suggests that there is no developmental progression on the ability to estimate the size of our own limbs. Additional studies that compare groups of children of different ages are necessary to further support this conclusion.

In sum, the results of experiment 1 replicate those of Linkenauger and cols. (2015) in that children that used the baton as a metric for providing their estimations were in general more accurate than those that used the hand. The pattern of distortions observed (i.e., more overestimation for body parts that have less receptors compared to body parts with a larger receptor presence) was more pronounced when the hand (i.e., an embodied ruler) is used as a metric. This effect suggests that more ecological minded rulers might provide a more accurate measure of how the body is perceived in everyday interactions with the world both from an early age.

In the following experiment, we aimed at testing the reliability of this effect and to investigate if as in adults it also extends to the perception of other people's bodies as observed by Linkenauger and cols. (2017).

Experiment 2

In this experiment we investigated if children show body distortions in the perception of adults they don't know of their same (congruent) or different gender (incongruent).

Participants 40 children (mean age = 9.49 yrs.; SD age = 1.83) participated in this experiment. A female (age = 22 yrs., height = 1.68 m; weight = 62 kg) and a male model (age = 22 yrs., height = 1.78 m; weight = 74 kg) assisted in the experiment.

Materials and Procedure At the beginning of the experiment, participants' hand lengths were measured as in Experiment 1. Children were instructed to use their own hand as a metric to estimate the lengths of the body parts of, in one group, a model of the same gender (congruent condition) and in another group of a model of the opposite gender (incongruent condition). The lengths body parts participants estimated the length of were the same as those followed in Experiment 1. Children also gave 2 verbal estimations for each model's body part in random order, first for one and then for the other model. Half of the sample provided estimations for the congruent model first and half of the sample for the incongruent model first. Participants were allowed to move and look at the model from various viewpoints, while maintaining a 4 feet distance. They were not allowed to compare directly their limbs to those of the model. The model stood straight, eyes closed, with his or her feet apart facing forward. Children were prevented from physically measuring the model's body parts with the hand, comparing their own bodies with the model, and children and model were asked not to talk to each other during estimations.

Results Children showed different degrees of distortion for each body part [F (5, 190) = 6.83, p < .0001, η^2= .18], and were more accurate when estimating for a model of the same gender as themselves [main effect: F (1, 39) = 15.73, p < .0001, η^2=.19]. There was no gender effect.

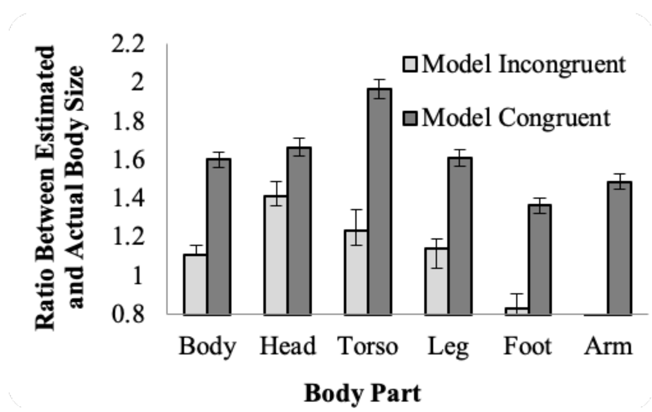

Figure 2: Mean estimation of each body part for Experiment 2. Bars show SEMs.

Similar to experiment 1, regression analyses carried out on the mean estimation provided for each body part for each of the models showed no significant effects.

Discussion

Consistent to studies with adults (Linkenauger et al., 2017), children produce a pattern of distortions when estimating the relative size of other people's body parts that reflects the relative distribution of receptors on the body and their correspondent relative size in the sensory brain areas. Furthermore, as is the case in adults, children are more accurate when providing estimations for somebody of the same versus a different gender. For the congruent condition, this effect could be explained in terms of the gender similarity in body shape, in spite of age and developmental differences. The pattern observed in the congruent condition more closely aligns with that observed for self-hand estimations in experiment 1. The incongruent condition, however, seems to track less closely with the pattern observed in previous studies with adults estimating other people's body parts and those of the self-hand estimations of experiment 1. In particular, estimations for the torso of the incongruent model are more accurate than those produced for the congruent model. Further studies that employ a larger sample of models both congruent and incongruent are necessary to investigate to what extent this might be a stable finding. It would be particularly interesting to explore whether these effects replicate when children are asked to estimate the body dimensions of children that share similar body anthropometrics (i.e., height and weight) as their own.

Finally, adding to the lack of age effects observed for self-estimations, the fact that age does not predict the pattern of estimations indicates that there is no developmental progression on the ability to estimate the size of other people body parts.

Experiment 3

In this experiment we investigated if children show body distortions in the perception of adults familiar to them (their parents) of the same (congruent) or opposite gender (incongruent).

Participants 46 children (mean age = 9.49 yrs.; SD age = 1.83) participated in this experiment.

Materials and Procedure The same procedure as in Experiment 2 was followed. The only difference between studies is that one of the child's parents served as a model. If the child was a female the mother acted as the model for the congruent condition and the father was the model for the incongruent condition. The opposite was true for male children. As in experiment 2, children provided two estimations for each of the model's limbs on random order and the presentation of the congruent or the incongruent model condition was counterbalanced.

Results Children showed different degrees of distortion for each body part [F (5, 220) = 10.52, p = .002, η^2= .19] but showed no differences depending on whether they were estimating for a parent of the same or opposite gender and no gender effects. Similar to experiments 1 and 2, regression analyses carried out on the mean estimation provided for each body part for each of the models showed no significant effects.

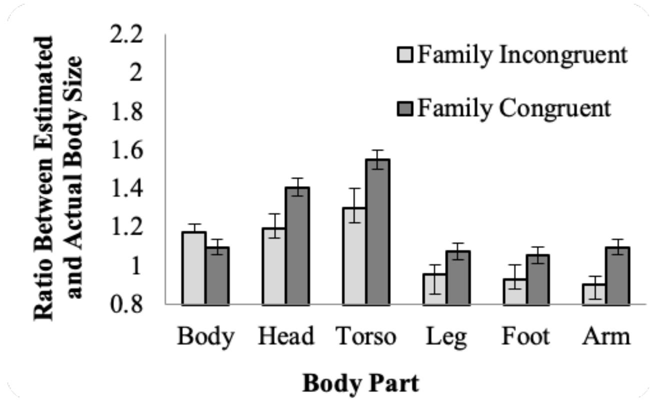

Figure 3: Mean estimation of each body part for Experiment 3. Bars show SEMs.

Discussion

The results of experiment 2 are consistent with those observed in the previous experiments. However, children seem to be overall more accurate when providing estimations for models they are familiar with: their own parents. It is likely that familiarity observing them might explain that they are similarly accurate when estimating the relative size of the body parts of both parents irrespective of their gender. While the pattern of distortions tracks with that observed in the other studies, it is attenuated almost certainly due to the improved overall accuracy in estimations. Finally, egression analyses' results are in line with the results of the previous experiment and provides further evidence of the lack of a developmental progression for the ability to estimate the size of other people's body parts.

Discussion

Results showed that children have similar distortions in the perception of their own body to those found in adult studies (Linkenauger et al., 2015, 2017). Parts of the body were in general overestimated and those that have the smaller density of sensory receptors (e.g., torso) showed a larger error than those with a higher density (e.g., hand). Experiment 1 found that these distortions were larger when using the hand compared to a baton as a metric, in line with Linkenauger and colleagues' findings (2015). The same pattern of distortions was found when estimating the length of the body parts of a model (Experiment 2) and a family member (Experiment 3). Finally, distortions in the perception of another person's body were more pronounced when estimating for a person of the opposite gender, but not when he or she was familiar to the child. Taken together, these results suggest that by school age children use similar mechanisms to perceive their own and other people's bodies as adults do.

These findings have several implications for our understanding of perception-action processes and social perception. On the one hand, they support the notion that perception is intrinsically body-scaled (Proffitt, 2006; Proffitt & Linkenauger, 2013). They suggest that from an early age perceptual processes use the body as a ruler to estimate what it can do in relation to the environment, even when it comes to the estimation of the relative dimension of self and other people's body parts. On the other hand, they support the notion that perception of our own action system modulates how we perceive that of others. In this respect, they are consistent with one the main tenants of action-based theories of social perception; that is, that information about our own perception-action systems is one of the determinant factors in how we perceive, anticipate, and predict other people's actions (Ramenzoni et al., 2008a; Ramenzoni et al., 2008b). The lack of age-related effects on any of the experiments further indicates that body perception might develop early in life. Further studies that investigate younger populations are needed in order to better understand the developmental trajectory of its acquisition. Of particular interest would be to determine to what extent perception processes follow the trajectory of action skill acquisitions and the progressive gain of social interaction skills during infancy and early childhood.

An additional finding of this study is that, for people children are not familiar with, gender congruency modulates their estimations. Congruency between the body of the perceiver and the model plays a role in how other people's bodies are mapped into one owns in adults (Linkenauger et al., 2017) and our study provides evidence that a similar effect is present from an early age and as in adults likely due to anthropometric similarities between perceiver and model of the same gender that are strong enough to overwrite other anthropometric differences due to differences in age an body development. Additional studies that ask children to provide estimations from other children that share similar anthropometrics to their own are needed to provide stronger evidence as to these effects being due to similarities in gender anthropometrics.

There are limits to how much congruency modulates estimations. Results of experiment 3 suggests that congruency effects might be overwritten by social factors, such as familiarity with the model. While in Experiment 2 children showed the same effect observed in adults of being more accurate when estimating for a model of the same gender, results of Experiment 3 showed that this effect disappears when the model is very familiar to the child. This lack of congruency effects might be explained by experience observing and interacting with the other person. Not only were estimations not affected by congruency, but distortions were overall smaller than those observed in Experiment 2 and even than those observed in experiment 1 for the perception of the children's own body. This finding suggests that children might be tuned to the action capabilities of those close to them. Such a result is consistent with the expectation that children have a better perception of those that engage in social interactions with them and are present whenever help is required. This issue should be addressed more directly with studies that explore how children perceive adults' affordances when they have prior experience interacting with them and when they do not know them. A good place to start would be affordances-based studies that ask children to estimate an adult's vs. a parent's ability to help them. That is studies that depart from the estimation of mere anthropometrics and explore how the body actually makes use of those in interaction with the world. Ramenzoni & Liszkowski (2016) study of how infant communicate to an adult's their need for help, suggests that even at 8 months infants rely on other people's action capabilities and do not discriminate between their parent and an unknown adult. It is likely that through development such discriminations might emerge and that older children might be more accurate in estimating whether a parent can help them compared to an unknown adult.

Overall, these findings bring light to a seldom researched aspect of perception development (i.e., body perception) and provide valuable information towards our understanding of social interactions between children and adults during childhood.

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