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Body schema activation for self-other matching in youth

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ABSTRACT

The purpose of the present study was to assess the degree to which children and adolescents represent and match the observed body parts of others onto the internal representation of their own body parts. Male and female participants of different age groups (7–9, 10–12, and 13–16 years old) completed a body-part compatibility task in which they responded to coloured targets (relevant feature) presented over the hand or foot (irrelevant feature) of pictures of male models of different ages (7, 11, and 15 years old). Body-part compatibility effects emerged for the males in the 10–12 and 13–16-year-old age groups, which only occurred when viewing models of their own age-group peers (i.e., 11 and 15 year old models, respectively). In contrast, no body-part compatibility effects were found for males in the 7–9-year-old group nor in any of the three groups of females. Based on these data, it is suggested that children and adolescent males seem to develop the ability to match the bodies of other males to their own after 9 years of age and this matching process seems strongest for their age-matched peers.

1. Introduction

In daily life, humans are constantly interacting with each other. One process that likely facilitates these social interactions is one in which the bodies and body parts of the other person are represented, mapped, and interpreted with respect to their own body. In doing so, the internal representation of the person's own body can be used as an anchor point for modelling the actions and intentions of other people (Lombardo et al., 2010). Specifically, individuals may use information from their bodies and action capabilities to understand the bodies, bodily states, and actions of other people (Decety & Sommerville, 2003). The focus of the present study is on the self-other matching process in which young males may or may not map the bodies of others against the representation of their own body. The present study focussed on young males because of a yet-to-be tested hypothesis that, in addition to poor imitation and action observation abilities (Stewart, McIntosh, & Williams, 2013; Williams, 2008), self-other body matching processes may not be fully functional amongst individuals with autism spectrum disorder. Thus, the present study was initially designed to be used as control data for a larger study involving individuals with autism, which is much more prevalent in young men (Baird et al., 2000).

The findings of studies exploring the coding of bodies and body-parts has centered on the cognitive and neural processes underlying the ability of the adult human to represent the bodies of other adult humans relative to non-human animals and objects like tools (e.g., Ogden, 1985; Peelen & Downing, 2007; Reed & Farah, 1995; Sirigu, Grafman, Bressler, & Sunderland, 1991). Evidence for the ability to code body parts was initially derived from neuropsychological studies. These studies found that humans possess a representation of the human body or a mental construct devoted to the dynamic spatial organization amongst parts of the body of the self and its relations to that of other bodies (Ogden, 1985; Semenza & Goodglass, 1985; Semenza, 1988; Sirigu et al., 1991). It is

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thought that this representation of the body (or body schema) is used for the unconscious encoding of body position for both the self and others and that this cognitive representation is separate from representations used to identify and understand objects (Peelen & Downing, 2007; Reed & Farah, 1995). Neurophysiological studies revealed a consistent and selective pattern of neural activity within the extrastriate visual cortex (extrastriate body area [EBA]) during the perception of bodies (Downing, Jiang, Shuman, & Kanwisher, 2001). The EBA: 1) exhibited the strongest response when subjects viewed images of human bodies and body parts, 2) was less active when viewing animals, and 3) least active during the perception of inanimate objects such as tools. These findings suggest the EBA is involved in the processing of bodies – in particular human bodies (see Peelen & Downing, 2007 for a review). In sum, neuropsychological and neurophysiological research indicates that the body schema can encode body parts of both the self and other. It is thought that this body schema is what supports self-other matching, at least with respect to body parts.

Evidence for self-other body-part mapping comes from different sets of studies revealing a facilitatory effect in responses to observing body parts in static (e.g., Bach, Peatfield, & Tipper, 2007; Thomas, Press, & Haggard, 2006) and dynamic (e.g., Brass, Bekkering, & Prinz, 2001; Catmur & Heyes, 2011; Wiggett, Downing, & Tipper, 2013; Wiggett, Hudson, Tipper, & Downing, 2011) displays. In a study involving adults, Bach et al. (2007) analyzed the response times (RTs) of adults to coloured targets that were the relevant stimulus feature, which were superimposed over the picture of an adult model's body that were an irrelevant stimulus feature. Participants were to respond as quickly as possible with a foot press every time a blue circle was presented and a hand press every time a red circle was presented, regardless of the location of the target on the body of the model. The researchers reported that RTs for hand and foot responses were shorter when targets were presented over the model's hand and feet, respectively, relative to when the targets were presented over another body part of the model (see also Jovanov, Clifton, Mazalek, Nitsche, & Welsh, 2015; Thomas et al., 2006). The authors suggested that these body-part compatibility effects emerged because viewing and attending to a target on a body part of another person can automatically increase the activation and sensitivity of perceptual and motor areas coding that body part in the observer's body representation (body schema). This body-part specific activation subsequently primes and facilitates responses involving the same body part of the viewer, or interferes with responding when the response involves a different body part.

In a recent study by Pila, Jovanov, Welsh, and Sabiston (2017), it was found that the presence of the body-part compatibility effect moderated the participant's propensity for social comparisons and the body type of the person in the image being viewed. Young adult women participants completed the body-part compatibility task that used images of women with an "ideal" thin body, an "average" body, and an "above-average" body. The women were separated into "high" and "low" social comparison groups based on their responses to questionnaires, which assessed their tendency to feel negative emotions (e.g., shame or envy) when considering their body's appearance on its' own and in comparison to a "superior" body type. The women in the high social comparison group (i.e., women prone to negative body-related emotions) showed body-part compatibility effects when viewing all body types, but the women in the low social comparison group only showed body-part compatibility effects with the model with the "above-average" body type. Thus, it seems that the body-part compatibility effect can index a self-other matching process that is in turn influenced by social and body-related factors regarding the observer and the person being observed.

It is important to note the research reported above has focused on body-part compatibility processes in adults. The integrity of the processes leading to a child or adolescent's ability to understand the bodies of other children and adolescents has, to our knowledge, received no direct experimental attention. The present study was conducted to provide initial insights into the complex process of body-part matching in children and adolescents. There has been research related to the development of the body schema for understanding the spatial location of the child's own body parts in space relative to other body parts, the location of other objects in the environment, and gravity. Investigations of the developing body schema of the person's own body in childhood and adolescence have used methods in which there are transient disruptions of sensory information, in particular proprioceptive and visual perturbations, during sit-to-stand, tendon vibration, and illusory motion tasks (Eliasson, Forssberg, Ikuta, Appel, Westling, & Johansson et al. 1995; Schmitz, Martin, & Assaiante, 2002; Assaiante, Mallau, Viel, Jover, & Schmitz, 2005; Cignetti, Chabeauti, Sveistrup, Vougoyeau, & Assaiante, 2013; see Assaiante, Barlaam, Cignetti, & Vaugoyeau, 2014 for a review). These studies have highlighted the plasticity of the developing body schema for the maintenance of upright posture, focusing specifically on how the individual perceives and responds to transient postural disturbances (i.e., studying the development of the body schema from an intrapersonal and environmental frame of reference). Broadly speaking, the results of this research suggests that the body schema develops progressively throughout childhood and adolescence, with some developmental studies reporting that the body schema matures from 8-to-10 years old (Eliasson et al., 1995; Cignetti et al., 2013). As the brain associations transition from childhood to adolescence and consolidate in adulthood, the body schema is thought to continue to mature (Assaiante et al., 2014). Although this work on the development of the body schema of the individuals' own body has been insightful, little or no work has examined the development of associations created between children's own bodies and the bodies of other children. As such, it is not known how children understand the bodies of other people with reference to the schema of their own body.

The above gap in the literature exists despite the fact that childhood and adolescence would seem to be a time of particular relevance for studying the development of the intrapersonal and interpersonal body schema. The transition from middle-childhood to late-childhood and adolescence involves a great deal of peer socialization. Specifically, peer interactions at schools and community settings are formally structured to facilitate interactions amongst children of similar ages (Abrams, Rutland, Cameron, & Ferrell, 2007). Large amounts of time are spent with peers of one's own age and gender, thus shaping shared experiences. These shared experiences are often created through social play. In this way, peer interactions may have both a positive and negative influence on child and adolescent development (Martin, Fabes, & Hanish, 2014).

In particular, research has focused on the role of peers as socializers of adolescents' negative behaviours, such as drug use, smoking, and delinquency (Brechwald & Prinstein, 2011). As such, own-age and gender peer groups represent a potentially powerful