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Body representation does not lag behind in updating for the pubertal growth spurt

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ABSTRACT

Both making perceptual judgments about your own body and successfully moving your body through the world depend on a mental representation of the body. However, there are indications that moving might be challenging when your body is changing. For instance, the pubertal growth spurt has been reported to be negatively correlated to motor competence. A possible explanation for this clumsiness would be that when the body is growing fast, updating the body representation may lag behind, resulting in a mismatch between internal body representation and actual body size. The current study investigated this hypothesis by testing participants ranging from aged 6 to 50 years on both a tactile body image task and a motor body schema task. Separate groups of participants, including those in the age range when pubertal growth spurt occurs, were asked to estimate the distance between two simultaneously applied tactile stimuli on the arm and to move their hand through apertures of different widths. Tactile distance estimations were equal between participants before, during, and after the age range where the pubertal growth spurt is expected. Similarly, Bayesian evaluation of informative hypotheses showed that participants in the age range of the growth spurt did not move through the apertures as if their representation of the hand was smaller than its physical size. These results suggest that body representations do not lag behind in updating for the pubertal growth spurt.

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Introduction

Most of us can easily perform tasks such as reaching for our coffee while looking at our phone and stepping over a puddle without paying much attention. But for these seemingly simple tasks, you actually need to know quite a lot about your own body dimensions and about the position of your body parts in relation to the objects around you. Most of the time, we are unaware of this. Sensory information is unconsciously combined with mental body representations to perform the movement (Holmes & Spence, 2004). However, as an adult, your body is not changing in size very often and you have had much feedback about its size and form from the experience of moving it many times a day.

Healthy adults are indeed usually competent at moving their body through the world and can adequately change their movements depending on the current possibilities for action (e.g., Cole, Chan, Vereijken, & Adolph, 2013; Day, Wagman, & Smith, 2015) or affordances (Gibson, 1979). Some of your action possibilities are dependent on your body size and form. If you are very slender, you will fit through smaller doorways, and if you are very tall, you will need to be more careful about not hitting your head. However, your body size and form change considerably during your lifetime. This raises the question of how a veridical body representation is updated and maintained when your body is changing. Children in early puberty, when they are in the middle of a growth spurt, are often described as somewhat clumsy (Tanner, 1962). Indeed, Hirtz and Starosta (2002) found that the onset of the growth spurt was linked to an impairment in coordination in 75% (girls) to 90% (boys) of their participants. Visser, Geuze, and Kalverboer (1998) also found that being in a growth spurt was negatively related to motor competence. Starting at 11 years of age, they tested general motor skills of 16 boys, plus 15 relatively clumsy children, every 6 months for 2.5 years. They found that whereas the clumsy child group on average became less clumsy, for the control group the faster children had been growing in height, the worse their motor skills were (see Beunen & Malina, 1988, for a review of similar results). Bisi and Stagni (2016) reported less smooth walking patterns in teenagers that grew faster than in their similarly aged peers, but the difference between both groups on most measures was in fact nonsignificant.

At the same time, strength and speed of movements increase during the growth spurt (Beunen & Malina, 1988), suggesting that this apparent clumsiness does not originate at the level of the muscles. One possible explanation for the decline of motor competence, therefore, could be that updating the body representation during the pubertal growth spurt lags behind physical growth. With a fast growth rate, the body representation may get insufficient time to adapt, resulting in a body representation that is smaller than the actual body. This is actually often suggested in the media (e.g., "Teenagers shoot up so fast that their brains can't keep up"; British Broadcasting Corporation, n.d.) and has been mentioned in the scientific literature (Longo, Azañón, & Haggard, 2010). Is there any support for this idea? The current experiment aimed to investigate this question while considering that body representation is in fact a collective term for many different concepts (De Vignemont, 2007). Thinking that you are smaller than you actually are does not immediately imply that you will move as if you are smaller than you actually are. The current study investigated both aspects in separate experiments. In body representation research, the mental representations of the body are often divided between *body schema*, the unconscious and constantly updated sensorimotor representations of the body that are directly used for making movements, and *body image*, which groups the more conscious and perceptual representations (Dijkerman & de Haan, 2007; Gallagher, 2005; Paillard, 1999; Rossetti, Rode, & Boisson, 1995). The term *body image* here includes all representations not directly used for making movements (covering all modalities), whereas the same term may be used in specific research areas to describe subsets (such as only visual representations or affective components) and has been used rather ambiguously in general (Tiemersma, 1989).

The current study focused on metric components of body image (i.e., representation of size, length, and width of body parts). Previous research on metric body image during development has mostly used visual tasks such as scaling an image on a computer screen to match the perceived body size (Neves et al., 2017). Results are variable and have shown slight over- and underestimations of body size as well as correct estimations, depending on the specific task, and no systematic differences between age groups (e.g., Gardner, Friedman, Stark, & Jackson, 1999; Gardner, Sorter, & Friedman,