Exploring the effects of visuomotor synchrony, touch, and human form on the embodiment of virtual hands in children

Hayley Dewe¹, Janna Gottwald², Laura-Ashleigh Bird¹, Harry Brenton³, Marco Gillies⁴ & Dorothy Cowie¹

¹ Durham University, ² Uppsala University, ³ BespokeVR Ltd, ⁴ Goldsmiths, University of London

Introduction

Embodiment is the sensation of ownership and control (agency) over one’s body. This is driven by the successful integration of multisensory signals (e.g., visual, tactile, proprioceptive) and top-down knowledge about the body [1]. Embodiment typically occurs when signals are congruent (i.e., synchronous movement or a similar form (appearance). Yet, adults embody non-human body parts like a robot hand [2]. The role of multisensory processes develop across childhood [3] but little is known about the effects of such processes on children’s own-body representation.

Methods

The effects of movement, touch and form on children’s embodiment for virtual hands.

In two experiments, participants played a virtual reality bubble-popping game. A virtual hand moved synchronously with the participant’s own movements, and asynchronously (the hand was temporally and spatially incongruent).

Questions
“During the game did you sometimes feel”:

EXP. 1 scale 0-1 (No-Yes)
Ownership: the hand was your hand or belonged to you
Agency: you were moving the hand?

EXP. 2 scale 0-10 (Not at all-Yes lots and lots)
Ownership: the hand/block felt like my own hand
Ownership: the hand/block felt like part of my own body
Agency: I was in control of moving the hand/block
Location: my own hand was in the same place as the hand/block
Tool: the hand/block felt more like a mouse than part of my body.

Results

EXP. 1
N = 117 (4-14 years, \(X = 9\))
3 haptic feedback groups:
Congruent (on bubble hit) N = 40
Delayed (1-2 secs delay) N = 37
No haptics N = 40

EXP. 2
N = 80 (5-14 years, \(X = 9\))
2 virtual form groups:
Hand (human) N = 40
Block (non-human cross) N = 40

(Figs present data from Exp. 2, medians and IQRs.)

Discussion

Visuomotor synchrony influenced embodiment for virtual hands
Children embodied a non-human block to some degree — provided visuomotor signals were congruent
Yet, only the hand in the synchronous movement condition was described as feeling like part of the body, rather than like a tool (e.g., a mouse).

Overall dominance of visuomotor synchrony for children’s embodiment.
Children embody non-humans forms to some degree
Embodiment is constrained by prior information about body form (i.e., tool-use).
Both bottom-up and top-down processes are important for driving children’s body representation.

References

The work has been recently published doi: 10.1109/TVCG.2021.3073906.