Visual and Motor Information in the Rubber Hand Illusion

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Introduction

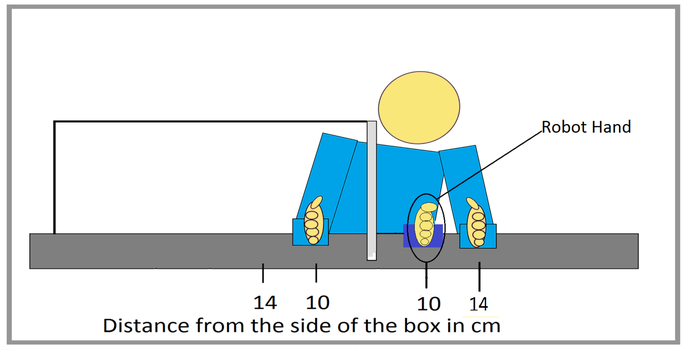
- Visual, tactile, proprioceptive, and kinematic information about one's body contribute to the body schema, or the mental representation of one's body dimensions and body part position and location.
- Normally visual, tactile and proprioceptive sources about body part position and location are consistent with one another.
- In the *rubber hand illusion* (RHI) visual and tactile information are placed into conflict with proprioceptive information about hand location (Botvinick & Cohen, 1998).
  - When individuals *observe* stimulation of a rubber hand while simultaneously *feeling* the same type of stimulation of their own unseen hand, they report feeling the touch on the rubber hand
  - The sense of ownership of a rubber hand can be assessed subjectively by having participants rate the extent to which they "feel" the rubber hand.
  - When participants are asked to point to the perceived location of their hand, participants point towards the rubber hand rather than the real hand.
- The RHI suggests that the body schema is flexible and can incorporate external appendages (like prosthetic limbs).

Present Research

- We attempted to replicate the rubber hand illusion and to extend the illusion to investigate how conflicts between motor movements and proprioception influence body schema.
- **Hypothesis**: we predicted that in cases of conflict between visual/tactile information and proprioception, visual and tactile information would override proprioception to lead to the misperception that a toy robot hand is part of the body.

Method

- Participants (15 University of Dayton students) were seated in front of a box with their unseen right hand positioned by the experimenter at 1 of 2 locations inside the box.
  - The unseen hand was positioned at 14 cm for 2 practice trials and at 10 cm for the remaining 20 trials.
  - The visible left hand was always placed at a fixed location 14 cm to the side of the box.
- Participants viewed a toy robot hand positioned in front of them, parallel to the unseen right hand.



- Participants viewed the robot hand being stroked by a brush while the experimenter simultaneously brushed the participant's unseen hand. The real and robot hands were brushed from knuckle to fingertip in synchrony for 20 sec.
- When prompted, participants closed their eyes and pointed with the left hand to where they believed the middle fingertip of their unseen hand to be located.
- The experimenter measured the distance between the indicated hand location and the actual unseen hand location.
- In a control condition the task was repeated but with no robot hand visible; only the unseen hand was stimulated.
- Participants completed a brief questionnaire assessing the degree to which they felt the robot hand was part of their bodies, on a 1 ("strongly agree") to 7 ("strongly disagree") scale.

Results

- Contrary to our predictions, there was no significant difference in the pointing error between the robot hand condition and the control condition, $t(14) = 1.174$, $p = .26$.
- Questionnaire data suggested that participants felt a sense of ownership of a robot hand.
  - Participants self-reported that it seemed as though the touch they felt was caused by the paintbrush touching the robot hand *($M = 3.86$), $p < .05$.*
  - Participants also reported feeling the touch of the paintbrush in the location where they saw the robot hand touched (*$M = 2.07$), $p < .05$.*

Discussion

- The results provide only equivocal support for our hypothesis.
  - Pointing data suggests that participants did not lose sense of the position of their actual unseen hand.
  - In contrast to earlier studies, participants did not point to the robot hand when asked to indicate the perceived location of their hand.
  - However, self-report data suggests that participants generally agreed that they could "feel" the robot hand as if it were part of their bodies.
- In this experiment visual and tactile information did not override proprioceptive information regarding the body schema; participants only partially incorporated the robot hand into their body schema.
- Current studies are assessing whether or not vision and *motor movements* can override proprioception to alter the body schema.
  - Participants flex the fingers on their unseen hand while viewing a robot hand flex its fingers in similar way. We predict that seeing the robot hand move in a manner consistent with felt finger movements will lead to a sense of ownership of the robot hand.