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Scriptwriter Name: Bridget Colvin
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Title: Virtual Hand with Ambiguous Movement between the Self and Other Origin: Sense of Ownership and 'Other-Produced' Agency

Authors and Affiliations: Mai Minoura[1], Kei Kojima[1], Shuusaku Nomura[2], Yuta Nishiyama[2], Takashi Kawai[1], and Yukio-Pegio Gunji[1]

[1]Department of Intermedia, Art and Science, School of Fundamental Science and Technology, Waseda University
[2]Human Informatics Group, Graduate School of Information and Management Systems Engineering, Nagaoka University of Technology

Corresponding Author:
Mai Minoura
mai.minoura@gmail.com

Co-Authors:
rainbowchaser94@gmail.com
nomura@kjs.nagaokaut.ac.jp
y-nishiyama@kjs.nagaokaut.ac.jp
tkawai@waseda.jp
yukio@waseda.jp

Author Questionnaire

1. Microscopy: Does your protocol require the use of a dissecting or stereomicroscope for performing a complex dissection, microinjection technique, or similar? **N**

2. Software: Does the part of your protocol being filmed demonstrate software usage? **N**

3. Interview statements: Considering the Covid-19-imposed mask-wearing and social distancing recommendations, which interview statement filming option is the most appropriate for your group? **Please select one**.

☒ Interviewees self-record interview statements outside of the filming date. JoVE can provide support for this option.

4. Filming location: Will the filming need to take place in multiple locations (greater than walking distance)? **N**

Protocol Length
Number of Shots: **42**

Introduction

1. Introductory Interview Statements

REQUIRED:

1.1. **Mai Minoura**: While previous research on bodily self-consciousness has assumed that self- and other-origin movements are perceptually distinguishable, this protocol allows the movements to be ambiguous on a virtual hand with unintentional slight movements **[1]**.

1.1.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

REQUIRED:

1.2. **Kei Kojima**: This method enables us to observe a participant's experience as formed by a Sense of Ownership and an "other-produced" Sense of Agency, rather than just the absence of these senses **[1]**.

1.2.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

Ethics Title Card

1.3. Procedures involving human subjects have been approved by the Institutional Review Board (IRB) or the Independent Ethics Committee at Nagaoka University of Technology.

Protocol

2. Video Preparation

2.1. To create videos for the pre- and experimental sessions, first set up a table and two chairs, a 35- x 60-centimeter white cushion hand rest tilted approximately 25 degrees, and a display in the room in which the experiment will be conducted **[1]**.

2.1.1. WIDE: Talent placing cushion and/or display onto table, with chairs visible in frame

2.2. Mark the position of each material to be able to accurately reproduce the placement in subsequent sessions **[1-1a]** and place a 360-degree camera to be at eye level when a Participant is sitting in one of the chairs **[2]**.

2.2.1. Talent marking position(s)

Added shot: 2.2.1a CU of tape

2.2.2. Talent placing camera onto table **TEXT: Record 20-30-s video with no one in chair to confirm participant visibility**

2.3. For the video for the male participants, have a male mock Participant sit in the chair wearing a lab coat **[1]** and put his left hand on the hand rest with the palm facing up with the fingers not touching each other or the hand rest **[2-3]**.

2.3.1. Mock Participant wearing coat sitting in chair

2.3.2. Hand being placed onto hand rest with fingers not touching each other or hand rest

Added shot: 3.3.3 adjust camera to eye level

2.4. Have a second Researcher, holding a paintbrush, sit in the other chair facing the mock Participant **[1]** and start the recording to capture the “stable” condition video **[2]**.

2.4.1. Researcher holding paintbrush sitting in chair

2.4.2. Talent starting recording

2.5. Play a reference tone **[1-TXT]** and have the Researcher stroke all of the mock Participant's fingers with the paintbrush for 80 seconds **[2-TXT]**.

2.5.1. Talent playing tone **TEXT: Tone is heard by Researcher through headphones**

2.5.2. Researcher brushing Mock Participant fingers **TEXT: Memorize stroke pattern**

2.6. Have a second Researcher place an approximately 30-centimeter kitchen knife with a 20-centimeter blade in the field of view of the camera **[1]** and have the Researcher quickly pretend to slash mock Participant's wrist before disappearing **[2]**.

2.6.1. Researcher placing knife in front of camera NOTE: This and next shot together

2.6.2. Researcher pretending to slash wrist

2.7. Then stop the recording **[1]**.

2.7.1. Talent stopping recording

2.8. For the "slow" condition video, have the Researcher stroke the mock Participant's hand again, changing the brush trajectory to avoid monotony **[1]**.

2.8.1. Talent stroking mock Participant hand

2.9. After 60 seconds, have the mock Participant close and open all five fingers at a consistent, slow speed for 20 seconds per open and close cycle **[1]**.

2.9.1. Fingers being closed and opened *Videographer: Important step*

2.10. Then have the second Researcher show the knife **[1]** and pretend to slash the mock Participant's wrist as just demonstrated **[2]** before stopping the camera **[3]**.

2.10.1. Talent showing knife NOTE: This and next shot together

2.10.2. Talent pretending to slash wrist

2.10.3. Talent stopping camera

2.11. Film the "fast" condition video in the same manner, but with the finger opening and closing performed in 2-second per open and close cycle **[1-TXT]**.

2.11.1. Fingers opening and closing quickly **TEXT: Record female participant in same manner but with female mock participant**

2.11.2. Maybe added shot?

3. Rubber Hand Illusion (RHI) With and Without Finger Movement Sessions and Skin Conductance Response (SCR)

3.1. Using the same Researcher as in the videos, have a Participant wear a lab coat **[1]** and sit in the chair **[2]**.

3.1.1. WIDE: Talent gesturing and Participant putting on lab coat *Videographer: Important step*

3.1.2. Participant sitting in chair *Videographer: Important step*

3.2. After cleaning the Participant's right index and ring fingers with a wet wipe, attach silver-silver chloride electrodes connected to an SCR data actuation device to these fingers **[1]**.

3.2.1. Talent attaching electrode(s)

3.3. Have the Participant keep the right hand down while not touching anything **[1]** and instruct the Participant to place the left hand on the hand rest with the palm facing up while keeping the hand stable **[2]**.

3.3.1. Participant placing/holding down his right hand *Videographer: Important/difficult step*

3.3.2. Talent giving instructions/Participant placing left hand on hand rest *Videographer:*

3.4. Remind the Participant to relax **[1]** and inform the Participant to look at the left hand when wearing the HMD **[2]**.

3.4.1. Talent gesturing and Participant assuming relaxed position

3.4.2. Talent gesturing and Participant looking at left hand **TEXT: HMD: head-mounted display**

3.5. After giving the instructions, have the Participant put on an HMD with a black screen **[1]** and mirror the screen on the HMD onto the display on the table **[2]**.

3.5.1. Participant putting on HMD *Videographer: Important step*

3.5.2. HMD screen being mirrored onto display/Talent setting up display mirroring

3.6. With the HMD showing a black screen, instruct the Participant to put their left hand on the hand rest with the palm facing up **[1]** and help the Participant arrange the hand so that the fingers are not touching each other or the hand rest **[2]**.

3.6.1. Talent instructing/Participant placing hand NOTE: This and next shot together

3.6.2. Talent arranging Participant fingers

3.7. Next, sit in the chair opposite the Participant with headphones and a paintbrush **[1]** and randomly select one of the videos that matches the gender of the Participant **[2]**.

3.7.1. Talent sitting in chair

3.7.2. Talent selecting video to show

3.8. After announcing that the session is going to begin, start the video **[1]** and brush the Participant's left hand using the same timing and position as demonstrated in the video **[2]** while the Participant looks at the left hand through the HMD **[3]**.

3.8.1. Talent announcing and starting trial

3.8.2. Talent brushing Participant fingers *Videographer: Difficult step*

3.8.3. LAB MEDIA: To be provided by Authors: *Video showing participant's view of hand being brushed through HMD*

3.9. Use the mirrored display to observe when the knife cuts in **[1-TXT]**. Then show a black screen on the HMD for two minutes to allow the SCR to return to normal **[2]**.

3.9.1. Talent checking display/knife and tone appearing, with display visible in frame **TEXT: Researcher will hear tone through headphones** NOTE: Speed up shot

3.9.2. Talent setting screen to black/HMD showing black screen

3.10. At the end of the rest period, repeat the experiment with a different video until two trials have been performed for each of the three conditions in random order **[1]**, asking the Participant whether anything feels wrong physically after every two trials **[2]**.

3.10.1. Talent starting new video

3.10.2. Talent asking Participant/Participant indicating wrist or shaking head or similar representative response

4. Face-to-Face Interviews

4.1. When all of the trials have been completed, ask the Participant if they saw that the hand was moved **[1]**.

4.1.1. WIDE: Talent asking Participant/Participant shaking head No NOTE: 4.1.1 – 4.4.1 in one shot

4.2. If the answer is not "Yes", ask whether the Participant felt anything during the experiment **[1]**.

4.2.1. Talent asking/Participant answering

4.3. Next, ask of the Participant saw the the movement of the two speeds **[1]**. If the answer is not "Yes", ask if the Participant felt anything during the experiment **[2]**.

4.3.1. Talent asking Participant/Participant shaking head No

4.3.2. Talent asking/Participant answering

4.4. Then ask the Participant what they thought of the slower hand movement **[1]**.

4.4.1. Talent asking/Participant answering

Protocol Script Questions

A. Which steps from the protocol are the most important for viewers to see? Please list 4 to 6 individual steps.
2.9.1., 3.1., 3.3., 3.5.

B. What is the single most difficult aspect of this procedure and what do you do to ensure success? Please list 1 or 2 individual steps from the script above.
3.4.1., 3.8.2.

Results

5. Results: Representative Mean SCR Following Knife Threat Under Different Hand Movement Conditions

5.1. As demonstrated in this representative analysis **[1]**, SCR values in response to a knife threat showed no significant differences between the three conditions **[2]**.

5.1.1. LAB MEDIA: Figure 7A
5.1.2. LAB MEDIA: Figure 7A *Video Editor: please add/emphasize n.s. text and bracket*

5.2. However, when the SCR of the first and second duplicates were compared for each condition **[1]**, a significant decrease in the response was observed in the condition with fast movement **[2]**.

5.2.1. LAB MEDIA: Figure 7B
5.2.2. LAB MEDIA: Figure 7B *Video Editor: please add/emphasize p < 0.05 text and bracket*

5.3. These data suggest that, if obvious unpredicted movements are repeated, the illusory sense of ownership will disappear **[1]**. If the movements are slow, however, the sense of ownership will be maintained at the same level **[2]** as that for no movement **[3]**.

5.3.1. LAB MEDIA: Figure 7B *Video Editor: please emphasize fast data bars*
5.3.2. LAB MEDIA: Figure 7B *Video Editor: please emphasize slow data bars*
5.3.3. LAB MEDIA: Figure 7B *Video Editor: please stable data bars*

5.4. In face-to-face interviews, none of the participants reported a sense of agency in the conventional sense **[1]**. Moreover, while Type 1 participants simply denied their sense of agency **[2]**, the attitudes for Types 2-4 overlapped with their observed bodily movements **[3]**.

5.4.1. LAB MEDIA: Table 1
5.4.2. LAB MEDIA: Table 1 *Video Editor: please Type 1 data row*
5.4.3. LAB MEDIA: Table 1 *Video Editor: please Types 2-4 data rows*

5.5. In addition, 13 out of 19 participants described the observed events as their own individual experiences that were formed by the generated sense of agency rather than rejection of the sense of agency **[1]**.

5.5.1. LAB MEDIA: Table 1

Conclusion

6. Conclusion Interview Statements

6.1. **Mai Minoura**: It is important to make the environment comfortable and relaxing for the participants to allow natural results to be obtained. Tracing the brush trajectory accurately is also key to the success of the experiment **[1]**.

6.1.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera (3.3.1., 3.8.2.)

6.2. **Kei Kojima**: As our representative result shows, the contradictory sensations rather represent a person's individual experience, indicating that this protocol enables us to approach the ambivalence of self-consciousness **[1]**.

6.2.1. INTERVIEW: Named talent says the statement above in an interview-style shot, looking slightly off-camera

NOTE to Video Editor: Please add a text overlay or title card crediting the demonstrators with the following text:

Demonstrator (Mock participant/ Researcher): Akira Asano

Demonstrator (participant): Shinnosuke Fujikawa