

Invoking the Rubber Hand Illusion in Virtual Environments

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In the “rubber hand illusion”, Botvinick and Cohen (Nature; 391: 756, 1998) showed that synchronous stimulation of a rubber hand and the subject’s hidden real hand could result in a projection of ownership towards the rubber hand. In previous studies, we have demonstrated that the “rubber hand illusion” can be also induced with a virtual 3D-projected arm (Sanchez-Vives and Slater, 5th FENS Forum, 2006). In an attempt to determine the critical factors that influence the occurrence of the evoked illusion, here we compared the virtual illusion evoked using two different paradigms. In both conditions, the participants saw a computer generated stereo image of a virtual right arm as projecting horizontally out from their right shoulder. Their real right arm rested on a mounted shoulder high wooden shelf, hidden from their view. After 5 minutes stimulation, the virtual arm rotated slowly to the right and returned to the original position (supination-pronation movement). One-channel EMG recording on the forearm was recorded.

In the first condition, the experimenter taped and stroked the subject’s real hand with a ball. The subject saw a virtual sphere that taped and stroked the virtual hand in synchrony and in the same place on the hand as the real hand was touched. In the second condition, two alternating air puffs stimulated two different locations of the hidden real hand at random intervals and randomly between the two locations. The visual input observed by the subject was a virtual spray can that provided air puffs synchronously and on the corresponding two positions of the virtual hand.

Subjective, behavioural and physiological measures showed that the illusion worked in both conditions although the degree of the experienced illusion varied between them. After the experiment, subjects were interviewed to collect their impressions about the experience and then they filled out a 14-item questionnaire for quantifying the presence of the evoked illusion. In both conditions, the mean score of the illusion-related questions was significantly higher than the scores of the control questions (following Botvinick and Cohen, Nature; 391: 756, 1998).

Other behavioural measurements such as 1) the displacement of proprioception and 2) the movement of the real arm following the movement of the virtual arm were also obtained and in both cases they were more significant in the ball-paradigm.

A possible reason for such differences between both conditions is that when tapping and stroking with the ball, more extensive areas of the hand are randomly stimulated. It is possible that this stimulus is more realistic and induces less adaptation due to the randomness of the location. Another possible reason is that the air puffs cause a sensation of coldness to the subject that intensifies the perception of their own real hand, as reported by some participants. Summarising, the significance of the illusion-related questions was demonstrated in two different conditions of the virtual hand illusion. However, although the results of EMG data are encouraging and corroborate the results obtained in previous studies, further investigation in this direction is needed. Additional physiological measures will be included in future research.

This work was carried out as part of the PRESENCIA project, an EU funded Integrated Project under the IST programme (Project Number 27731).