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Title Inducing the virtual hand illusion through brain-computer interface.

Text Although the internal representation of the self-body image appears to be stable, different body illusions (e. g. rubber hand, Pinocchio) and neurological alterations (e. g. phantom limbs, out-of-the-body experiences) are able to substantially change this. Earlier we demonstrated that coherent somatosensory and visual information of touch over a real and a 3D projected virtual hand respectively leads to the internalisation of the virtual hand as part of the self-body image (Sanchez-Vives and Slater, 5th FENS Forum, 2006), what we called the 'virtual hand illusion'(VHI). This internalisation involved feelings of ownership and agency as well as a proprioceptive drift toward the fake limb. We also found that not only the perceptual system is deceived by the VHI, but also the motor system can be recruited (Pérez-Marcos et al., Body Representation, Rovereto, 2007). Here our experiment explored whether the voluntary control of a virtual hand by means of a brain-computer interface (BCI) would be enough to invoke a similar illusion of ownership. Participants (8 males; mean age 24(7.6) years) saw a stereo image of a virtual arm projecting horizontally out from their left shoulder. Due to head tracking, were the subject to sway his body, then the arm would move accordingly. Participants were novices both with respect to BCI training and virtual/rubber hand illusion. Each subject completed once a motor imagery-based BCI task, consisting of the imagination of left hand or feet movement to produce distinct brain signals that resulted in opening/closing of the virtual hand. The results of the questionnaires showed both significant feelings of ownership and agency ($p < 0.05$), but no proprioceptive displacement occurred. Thus, the generation of motor commands along with a coherent visual feedback could be enough to generate an illusion of ownership over a virtual body part, even in absence of additional multisensory correlations. Supported by EU 6th project PRESENCIA, Contract 27731.

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