

Editorial comments:

1. Formatting: Please split 2.1.3 into two steps.

→ done

2. Grammar:

-1.2.5.3 – “it completely open”

-1.4.2.3 – “a Likert scales”

-“Table 4: means”

→ fixed

3. Visualization: Please provide a photographic image of the setup for the virtual-face illusion. This can be included as a supplemental file.

→ We already had a picture showing the setup!

4. Additional detail is required:

-1.1.2 – What does DOF stand for?

→ degrees of freedom, defined now

-2.3.4.3 – How long should participants touch their cheek for? How is the cheek touch synchronized with the action on the screen?

→ There was no strict instruction regarding the duration. As soon as the system detected the touch, the stimulation was provided in the synchronized condition.

5. Results: Please format the results section such that the relevant data (Table 1, 2, 3, 4, etc.) is cited with the appropriate result/conclusion. It is unclear how the data ties to the results discussed. Please reformat the important results to be shown in the video as graphs to provide more visual interest if possible.

→ We have rewritten the entire results section and replaced all tables by figures of the most important effects.

6. Discussion: Please discuss any modifications/troubleshooting that can be performed.

→ We did not fully understand this question, but we in any case describe how the reported technique can be applied to investigate theoretically interesting questions by more easily manipulating the appearance of the virtual effector.

Reviewers' comments:

Reviewer #1:

Manuscript Summary:

The current manuscript describes techniques to induce ownership illusions on an external virtual hand and face and describes two experiments where these procedures are used.

I appreciate the way in which the methodology is being reported and I think it could be useful for both experts and non-experts of VR. However, in its current form the manuscript needs to be extended in both introduction and discussion parts, by including more references about works that already used similar approach. Thus, I have some suggestions which are outlined below.

→ We have extended the introduction and the discussion and have cited other papers. However, please note that the purpose of a JOVE article is to provide insight into the setup of a particular kind of experiment but not to present novel approaches or data. In fact, the two studies that we report here are old news, as they both have been reported before. As have been many other studies. Hence, we do not feel obliged to provide a full-fledged overview of the literature.

Title

The title "Creating virtual-hand and virtual-face illusions to investigate the self" is very general. I would suggest to better specify term "the self", i.e. self-conscious? Self-perception? self-representation? Body awareness?

→ We know refer to self-representation.

Introduction

Line 67 - 79. Here Authors described the rubber hand illusion as induced by only visuo-tactile stimulation. However, studies from Kalckert and Herson (2012, 2014) show that synchronous visuo-motor stimulation also play an important role in eliciting the illusion over the external rubber hand. Considering that this aspect is also important for the present manuscript, I would suggest to briefly extend this part.

→ Again, the purpose of this article is not to present anything you but to go into more detail regarding the technique. Nevertheless, we now mention and describe the two papers.

Line 81 - 88. This part needs to be extended by highlighting the advantage, brought by virtual reality, in substituting the real body of the subject with a virtual one that can be observed in a first-person perspective. Indeed, previous evidences suggest that, even when no multisensory visuo-tactile or visuo-motor stimulation are applied, the 1PP is a sufficient condition in eliciting Ownership (and Agency) on the virtual body. (See Slater et al, 2010; Maselli and Slater 2013; Tieri et al. 2015; Pavone et al. 2016). Please, extend this part considering these previous evidences.

→ we now cite all these studies and have added some more benefits of the general technique.

Line 91 - 93. The enfacement illusion could be added here (Sforza et al. 2010; Bufalari et al. 2015).

→ we have added this information and references to the papers.

Discussion

This part have to be extended by including the role of 1PP. Moreover, I would suggest to better describe the "new possibilities for experimental manipulations" by adding and highlighting interesting manipulations, such as detaching pieces of body (Tieri et al. 2015), elongating it (Kiltner et al. 2012), changing the colour of the skin (Martini et al. 2013, Peck et al. 2013) and the size of body (Banakou et al. 2013). These aspects represent another important advantage of VR to investigate the Body Ownership, and therefore should be mentioned in this part of the manuscript.

→ we have added this information and references to the papers.

Line 632 - 635. It could be useful to add here a possible solution for the real-time control of the avatar's facial expression, for example by using real-time Motion Capture.

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Reviewer #2:

Manuscript Summary:

Authors described a method to manipulate self-perception using virtual reality. They described some fundamental steps to induce bodily illusions. Given the expansion of VR technology this paper may be useful for the broad readership. Nevertheless the reviewer has minor comments that would like to be addressed.

Minor Concerns:

- Authors miss an important paper on a similar topic and should clarify the novelty of their manuscript B. Spanlang, J.-M. Normand, D. Borland, K. Kiltner, E. Giannopoulos, A. Pomés, M. González-Franco, D. Perez-Marcos, J. Arroyo-Palacios, X. N. Muncunill, and M. Slater, "How to Build an Embodiment Lab: Achieving Body Representation Illusions in Virtual Reality," *Front. Robot. AI*, vol. 1, no. November, pp. 1-22, 2014.

→ as mentioned above, the aim of this article in JOVE is not to provide any new data but to describe the method in more detail. Accordingly, we see no reason to clarify the novelty of our manuscript, and we clearly say that it actually is not novel with respect to the data, which all have been published before. We nevertheless cite the paper by Spanlang et al.

- Self-perception manipulation is easily achieved using immersive video games. To improve the impact of this manuscript and allow broad readership to understand the possible impact of this technology I suggest to

mention a recent work by two philosophers:

M. Madary and T. K. Metzinger, "Recommendations for Good Scientific Practice and the Consumers of VR-Technology," *Front. Robot. AI*, vol. 3, no. February, pp. 1-23, Feb. 2016.

→ Again, we do not pretend that we are the first or the only group using this technique, and we have mentioned several others. We also do not want to advocate its use, we just justify why it may be reasonable to use its advantages. The main purpose is simply to describe the method in more detail. The mentioned paper goes way beyond our present rather modest purpose.

Regarding games in general, we are not convinced that they provide sufficient experimental control over dimensions that are of theoretical interest. Theoretically, one may of course think of designing a game from scratch, so that all considerations regarding experimental control are built in. But given the enormous development costs for a game, this is hardly a feasible suggestion for experimental researchers.

- Please specify if the .zip files are in the software package or are supplemental materials of the manuscript

→ yes they are, we assume that this will be highlighted in the published article.

- I would appreciate if references regarding control questions about bodily illusions and sense of agency are mentioned.

→ We are not quite sure we fully understand this question. If it refers to control in the sense of agency, we are referring to the original Botvinick questionnaire wherever possible. If it refers to control in the sense of experimental versus control, we are unable to think of a tendency that such control questions could have measured. The different questions all refer to various aspects that have been assumed to be related to selfhood in a wider sense. Given that there is unlikely to be an underlying dimension, something like good or bad, that could have been measured by using control questions that are neutral in some sense, we didn't use any control questions of that sort.