Being in Someone Else Body: Users' Opinions About the Body Swap Illusion Experience With the *Machine To Be Another*

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Abstract. Virtual Reality has an enormous potential to induce the sense of body illusion. However, most of the studies examine its efficacy in enhancing research outcomes without focusing on participants' experience, which could imply a lack knowledge about the real impact that technology and its features have. For this, the implication of end-users in the development and testing process is necessary. The present study aims to investigate the usability of a virtual reality embodied system, the Machine to Be Another, to understand the interaction of the participants with the technology and to figure out how it could induce the sense of body illusion. A qualitative study with focus groups was adopted, and four themes emerged: (1) the experience of the sense of embodiment; (2) the trick for the illusion; (3) the participants' impression; and (4) the suspension of disbelief. Each category is described; limits and future directions are also discussed.

Keywords: user experience, technology evaluation, virtual reality, embodied technology, thematic analysis.

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1 Introduction

Human-Computer Interaction (HCI) is a cross-disciplinary area (e.g., engineering, psychology, ergonomics) that deals with the design, implementation, and evaluation of the ways that humans engage with the computing device for a given task (Issa & Isaias, 2015). The primary approach of the HCI is the User-Centered Design (UCD) based on the active involvement of the potential user in the design of the technology to improve the usability of the product or the service itself (Mao et al., 2005). The UCD has the objective to create a product that not only reflects the abilities and the ideas of the designers and developers but also involves the final users in the development process, following a bottom-up approach where the final user is the co-designer of the product (Abras et al., 2004). The critical component of the UCD is the User Experience (UX), defined as a person's perception and responses that result from the use and/or anticipated use of a product, system, or service (Hassenzahl & Tractinsky, 2006). Specifically, the UX includes individual preferences and psychological and behavioral responses that happen before, during, and after the interaction with the product and/or the system (Kolski et al., 2011). Considering the case of Virtual Reality (VR), the environments are often poorly evaluated by users, and the VR content is often created without the voice of the target to whom the content is addressed (Triberti et al., 2018), and without considering the real impact that a specific feature has in the user's experience.

In the last decade, VR was adopted to induce the sense of body swap illusion and several VR embodied systems were developed. Even more, VR is currently considered as an embodied technology, and several authors stated that it is in this powerful capacity that its potential is based (Kilteni et al., 2012, Riva et al., 2019). In this sense, VR is able to fulfill the three factors of the embodiment theoretical model: (1) the sense of ownership, which refers to one's self-attribution of the body; (2) the sense of agency which refers to the sense of having motor control, and the conscious experience of the body; and (3) the sense of self-location which refers to a determinate volume in the space where the person feels to be allocated (Lewis & Lloyd, 2010; Kilteni et al., 2012). However, despite the exponential growth of studies focusing on this model (Peck et al., 2013; Oh et al., 2016; Cebolla et al., 2019; Ventura et al., 2021), there is a lack on the qualitative study on how participants perceived the embody experience in the virtual environment.

One of the VR set-up used to reproduce the body swap illusion is the Machine to Be Another (MTBA), a promising technology that allows the body swap illusion, and it offers the users the immersive experience to see themselves into the body of another person (Bertrand et al., 2018). In this paper, we explore the effects of a VR experience to induce the sense of body swap illusion analyzing the user experience in terms of the strength and the weakness perceived.

2 Materials and method

The project was approved by the Ethics Committee of the University of Valencia (Spain), with the registration number: H1513592028862.

2.1 Participants

The sample was composed of 10 participants (M_{age}=27, SD_{age}=1.31). To be included in the study, participants were invited to participate previously in a body-swapping simulation with the MTBA (Cebolla et al., 2019). After this experience, they were invited to discuss the experience with the technology.

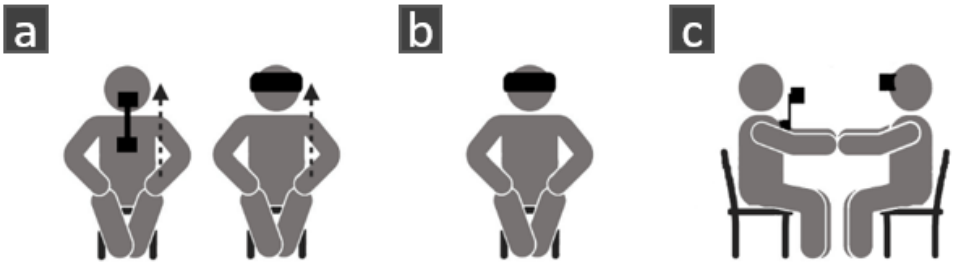
2.2 Measures

Two focus groups were conducted to generate ideas, opinions, and a constructive debate about the topic (Nili et al., 2017). A researcher moderated the debate to avoid misunderstanding and keep the conversation in line with the research goal. Semi-structured guidelines with open questions were developed to lead the focus group (e.g., *How was your experience with the MTBA?; Did you feel uncomfortable during the experience?; What would you like to change from the setting?*). The complete topics guideline is available upon request from the authors in its original language.

2.3 Apparatus and Procedure

The Machine to Be Another (MTBA-VR) is an embodiment system designed to address the relationship between identity and empathy. It is a low-budget body-swapping system where the user sees another person's perspective (performer) that mimics participants' movements. (Bertrand et al., 2018). First, participants were invited in a study aimed to increase their compassionate skills using the MTBA-VR (Cebolla et al., 2019). The VR experience is divided into three phases (Figure 1): The first phase aims to generate a body swap illusion through an embodied induction, which allows the participant to take over the body of another person (the performer) (Figure 1A). The participant and the performer were sitting aligned; the participant was wearing the head-mounted display (VR Oculus Rift), which allowed the participant to see the torso, legs, and arms of the performer's body. The performer was wearing a camera controlled by the participant's head movements. A pre-recorded instruction to perform specific movements was played to participants (e.g., *Put your right hand on your right knee, and then slowly move it up to your lap, as if you were caressing it*). All the movements selected followed two principles: (1) a combination of visual and haptic senses in order to increase the embodied illusion; and (2) the synchronization between the participant's and performer's movements. In addition, during the induction, several tactile cues were given to the participant synchronously with what s/he sees through the VR system. This phase lasted 5 min. The second phase consisted of the compassion meditation itself (Figure 1B), where the participant was still wearing the

Oculus Rift but turned it off. A self-compassion meditation was played to the participant for 15 min. After, the third phase began (Figure 1C). The performer sat facing the participant, and the Oculus Rift was turned on to allow the participant to see him/herself from a third-person perspective. The participants were invited to hug themselves while listening to self-compassionate messages. The performer followed the participant's movements like a mirror. This phase lasted from 5 to 7 min depending on how long the participants hold the hands of the performer at the end of the compassionate audio (Figure 1C).



Note: Phases of MTBA-VR (a) Phase 1: Embodied illusion induction; (b) Phase 2: Self-compassion training; and (c) Phase 3: Body Swap experience- Self-compassion facing oneself

Figure 1. The procedure of the study with the Machine to be Another.

Once participants finished the intervention, later they were invited to participate in the focus group to assess the overall experience and discuss the body-swapping experience. After consenting, the participants sat in a circle facing each other to encourage the discussion; they were audio-recorded to transcribe the content later. The focus groups were held one week after the simulation with the MTBA-VR to ensure that the participants could vividly recall the experience with the technology.

2.4 Data analysis

The audiotapes of all interviews were transcribed verbatim and analyzed via inductive thematic analysis (Braun & Clarke, 2006). At the first step, the analysis was conducted independently by two researchers (SV and RH) to categorize the content into different themes. In the second step, the researchers put together the results to reach the final agreement. To ensure the rigor and reliability of the study results, a third researcher (AC) checked the analysis and refined the results.

3 Results

Information collected was organized in different themes: (1) the sense of embodiment including the ownership, the self-location, and the agency; (2) the visual/motor synchronicity effect; (3) the participants' impression of the experience; and (4) the suspension of disbelief about the sense of body illusion. Each theme is discussed below.

3.1 Sense of embodiment

The result showed that the MTBA-VR could be an efficacious instrument to induce the sense of body illusion.

Ownerships. All participants reported that they experienced the illusion of having another body during the MTBA-VR simulation, but this illusion only lasted a short time. In particular, participants revealed that they had the body illusion at the beginning of the simulation. After a while, they recognized a performer was in the same room. Some statements related to this theme are:

> *At a specific time, I realized that what I was seeing was not my body* (participant).
>
> *After a while, I asked myself: who is? Is there another person?* (participant).
>
> *It was like a trick to see a body different from mine but at the same time…mine* (participant).

Self-location. During the MTBA-VR simulation, participants had the illusion to be in a different place than they were located. This illusion confused some participants because the virtual scenario dislocated their actual location.

> *Before the simulation, I was seated in a side of the room, and then I was virtually dislocated on another side, so I felt as I was there… but inside myself, I knew that it was a joke* (participant).

> *I watched in front of me (referred to the Oculus point of view), and it was a different place from what I watched before the study, and that confused me a lot* (participant).

Agency. Results showed that participants felt as they moved the avatar's body, but they found it hard to accept that they were the owner of the movements.

> *I am moving, but it is not my body. It is like that another person is doing the same movements as me.*

> *At a specific moment, I played with my fingers, and I started to move them to see if the body was mine...*

> *I was a little annoyed because I figured out that my movements were not the same as the virtual body movements*

3.2 Synchronicity

The synchronicity between visual, motor and tactile cues is essential to generate the sense of body illusion (Kondo et al., 2018). In this study, performer synchronized their movements with participants' movements, following instructions through an audio record. Results showed that sometimes the synchronicity was not perceived. Participants saw (through the Oculus) different movements from those they were doing. Below are some representative quotes that explain how participants live this synchronicity.

> *The movements were some millisecond delay. During the experiment, I thought about what kind of movements the avatar would do to plan my movements. I felt like I was following the avatar movement* (participant).

> *After a while, I moved at the same time with the avatar. This happened because I kept attention only to the avatar and not to my real movements, so I reached the goal to be the avatar, and I forgot about what was happening around me* (participant).

> *At the beginning of the experiment, I realized that I was the one who is looking for the synchronicity of the hands' movements because I started to move my hand, and it did not work. However, when I figured out that the hand started to move, I detected that the rhythm between the virtual hand and my real hand was different* (participant).

> *The movements that I was doing with my hands were faster than the avatar hand, so I decided to get slower my movements* (participant).

From the quotes, it is possible to argue that the MTBA-VR has the limit to reach the synchronicity between visual and tactile input. This could happen because the performer has to follow the user's movements. So, if the participant's movements were faster or s/he improvised some movements that were not on the protocol script, it was difficult for the performer to follow the movements synchronously, and in some cases, this breaks the body illusion.

3.3 Participants' impression

The current theme emerged from the discussion with participants about how they felt the experience of embodying another body with the MTBA. It was the first-time using VR and virtually embodied an avatar for all participants. The novelty of the experience caused a substantial impact on participants with interesting reactions. Below are some representative quotes.

> *The experience was something weird; it is difficult to explain. I was myself, but at the same time, I was another person* (participant).

> *I was so curious to understand how that illusion could happen. Sometimes, during the experiment, I was anxious cause I did not have complete control over what was happening* (participant).

> *I felt a little uncomfortable during the experiment because I knew that it was not my body, and I wanted to see my real body…if was possible, I would take off the Oculus because I wanted to know what was going on" (it was possible but the participant did not do not to affect the study)* (participant).

3.4 Suspension of disbelief

Connected to the previous theme, from the focus group emerged the suspension of disbelief as a reaction related to the experience. The suspension of disbelief refers to the interruption of the belief that the virtual environment is not real. During the embodied experience with

the MTBA, participants experienced a limited suspension of disbelief. They felt to embody the performance body at some points of the experience, but different discrepancies broke this suspension. Below some representative quotes related to this topic.

> *In the beginning, I was inside the experience. After some time, I recognized that the clothes I saw were not the ones I wore in the morning (...). From that on, it was more an effort to put myself inside the experience* (participant).

> *I figured out that it was not my body because I never wore a watch to the left wrist, and the shoes were different. Furthermore, my movements and avatar movements were not synchronized* (participant).

> *I was aware that it was not my body (...) I mean, I was inside the experience, but I knew that was not my body. Moreover, I did not wear bracelets that day* (participant).

As it is possible to deduce from the quotes, the suspension of disbelief occurred due to performer characteristics and the hardware itself. If the performer (the person who wear the MTBA) wear accessories such as bracelets, watch, rings, this affects the illusion of embodying the performance body. The accessories acted as cues that users recognized as different between her/his body and the virtual one. Even though the MTBA generated the suspension of disbelief, this occurred if the synchronicity were perceived. As mentioned in the previous theme, sometimes the movements between performer and user were not perceived as synchronized, which affected the sense of illusion. Beyond the reasons that could cause the suspension of disbelief, an important factor should stand on how much participants can be dragged from experience: the more the participants are obstinate to the illusion, the more the suspension of disbelief could occur and be sustained.

4 Overall discussion and conclusion

The research goal of this study was to explore the usability of the MTBA to generate the body-swap illusion. For this, a qualitative study with focus groups was adopted, and 10 participants who had a previous experience with the MTBA participated in the study. The results showed that the MTBA could be a potential tool to generate the body illusion and to reach the three components of the sense of embodiment: ownership, self-location, and agency (Kilteni et al., 2012); however, the illusion decayed rapidly. According to participants, this happened because the sense of body illusion confused them, and they did not recognize if what they were seeing was their own body. This sensation led participants to test their body "avatar", performing movements or touching parts of the body out of the study protocol, generating a higher discrepancy between the inputs from vision, touch, and motor control. Participants confirmed that they had the sensation to move the avatar's body

as it was their own at the beginning of the experiment, but when they started to change movements, the agency decays. This brings to another important theme: Synchronicity. To date, there are controversial results about the role of synchronicity as a moderator variable of the body-swap illusion. Some authors discovered that the synchro movements between participants and avatar are essential to reach the illusion (Kondo et al., 2018; O'Kane & Ehrsson, 2021). On the other hand, others studies (Seinfeld et al., 2018; Lush et al., 2021) figured out that a-synchronicity, that is when the participants' body do not move simultaneously with the avatar's movements, could not inhibit the body-swap illusion if participants are wholly immersed in the experience. Following this debate and analyzing the quotes of the participants, we argue that the consequence of the suspension of disbelief may not stand into the movements between avatar and participants, but into the rationality of the participants. In fact, when participants recognize that the environment where they are immersed is an innovative and impacting experience, the illusion declines. Moreover, the body-swap illusion experience was not appreciated at all, and it caused anxiety to some participants. This could happen because when they discovered that they did not control the virtual body, they felt tense, and some of them wanted to finish the experiment as soon as possible. Some others felt curiosity over the experience, and they were more open to being dragged by the illusion. Following this point, it is interesting to investigate if personality and personal traits could influence the sense of body illusion. For example, previous studies (e.g., Alsina-Jurnet & Gutiérrez-Maldonado, 2010; Wallach et al., 2010; Kober & Neuper, 2013) discovered that personality and personal traits are closely related to the sense of presence in VR. Absorption showed significant positive correlations with presence, and it is the best predictor for the feeling of presence in VR; mental image and the internal locus of control are also significantly correlated with the sense of presence. It is interesting the quote of Schubert et al. (2001): "Stimuli from a VR are only the raw material for the mind that constructs a mental picture of a surrounding world, instead of a mental picture of pixels on the display in front of the eyes". From this perspective, presence is more an active and creative process of the mind rather than a passive processing of the sensory information. This suggests that presence can be influenced by individual factors, either situation-specific states or more endurable dispositions (i.e., traits) (Alsina-Jurnet & Gutiérrez-Maldonado, 2010). Another study (Kober & Neuper, 2013) figured out that the factor *Openness* is also related with presence. The current positive correlation indicates that more someone is open to new experiences, stronger is his or her feeling of presence. The authors Dewez and colleagues (2019) also found that *the external locus of control* – the belief that things happening thanks to the influence of other people or chances - is a significant predictor of the sense of embodiment. However, as the study on the sense of embodiment through VR is a growing research area, the consideration of how participants experience the illusion still need more attention.

The current study on the user experience of the MTBA is an interesting example of the importance of considering the participants' voices for the design of the technological mechanism, and it opens new directions to investigate the paradigm of the body-swap

illusion. The contribution that emerged from the present study is the human factor as a moderator of the technological application. In short, studies that adopt innovative technologies such as VR should consider how participants feel when they use them. Not all users react in the same way, and not all reactions have the same impact on technology.

In conclusion, it is important to investigate the users' perceptions and acceptance toward the technology because it could influence the decision-making of the researchers, sellers, developers, or the professionals involve in the field of the human-technology interaction. In fact, more the technologies are developed considering the expectation of the end-users, more people accept the technologies. The only simple improvement or addition of new features, or better quality does not guaranty an improvement in the user's experience and, for this reason, more studies focusing on the user experience with immersive technologies are needed.

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