

## POSTER PRESENTATION

### Consciousness of the Self and the Body and Presence Studies

Maria V. Sanchez-Vives<sup>1</sup> and Mel Slater<sup>2</sup>

<sup>1</sup>Instituto de Neurociencias de Alicante, Universidad Miguel Hernández-CSIC,  
San Juan de Alicante, Spain

<sup>2</sup>ICREA-Virtual Reality Centre of Barcelona  
Universitat Politecnica de Catalunya  
Barcelona, Spain.

#### Abstract

*In this paper we discuss the use of virtual environments in the understanding of the role of body image on consciousness of the self. If we consider presence as a restricted form of consciousness in the realm of virtual environments, assessing presence while modifying a virtual body may allow an insight in the impact that body perception has on consciousness of the self. The possibility of using VE for the diagnosis and treatment of body dysmorphias is also considered.*

**Keywords---** Consciousness, Body image, Body perception, Dysmorphias, Rubber hand illusion.

#### 1. Introduction

We all experience ourselves as being a specific and unique individual, our Selves: someone who wakes up, experiences the world, and this “self” can sometimes vanish, for example during periods of sleep or other forms of unconsciousness. The nature of this sense of the self or consciousness can be defined in many different ways, from an emergent property of the brain [1] to a phenomenal self-model [2]. Far from being a question only discussed in philosophical or scientific forums, the consideration of “Who am I?” is entrenched in our daily existence and in the foundation of human forms of expression such as art or religion. But still, what are the critical mechanisms by which this sense of the self arises?

Even when the brain creates the illusion of an intangible, ethereal self, somehow independent from the body to which it is “attached”, the ownership of a body is probably a critical element for the development of the sense of the self.

From birth, the sense of self is inseparable from the body. As proposed by I. Rosenfeld “our conscious perceptual experiences are experiences of the world having an impact on our bodies,... and our bodies having an impact on the world”

[3]. While babies in their cribs look at their hands moving and touching the surrounding objects, their cerebral cortex processes visual, tactile, proprioceptive and motor activity as coherent and synchronous. The result of this coherent binding results in an internal representation of the body and the external world, both considered to be to main layers of the self [4]. Furthermore, as a result of that processing, the boundaries between body and environment are established and stabilised. The brain neuronal network will then predict neuronal activities (sensory modalities, firing rates, timing) as a result of an incoming stimulus acting on a particular location in the body, or following the realisation of a movement. As a result, we perceive our body as a unit which is separated from the surrounding space, and subjective perception remains stable for the rest of our lives unless disruptive neurological conditions appear.

The questions that we want to discuss here are: If the internal representation of the body is so bound to the concept of the self, to what extent is our “self” contingent on our body? Do changes in the body have an impact on the “self”? What can we learn about the “self” by studying body perception and its plasticity? How can the use of virtual environments and the concept of presence can be important for the study of body perception and consciousness?

#### 2. Malleability of the Body Image

##### 2.1 The Rubber hand illusion

A simple experiment such as that referred to as producing the rubber hand illusion [5] has evidenced that the apparently stable internal representation of our body is indeed easily challenged. In that experiment, a dummy rubber arm is placed in front of the subject in a feasible position, while the real arm is hidden from the subject’s view. In that situation, both real and rubber-arm receive synchronous tactile stimulation. This coherent visual and

tactile information leads the subject to feel that the position of their arm must be that of the rubber arm, generating the proprioceptive illusion of displacement and that of ownership of the rubber arm. Variations on this basic scheme were carried out by Armel and Ramachandran [6], who wrote: "Our experiments suggest that the so-called body image, despite all its appearance of durability and permanence, is a transitory internal construct – a temporary shell – that can be profoundly altered by the stimulus contingencies and correlations that one encounters."

## 2.2 The Virtual Arm Illusion

From these experiments we can reach the conclusion that congruencies between different sensory streams can generate illusions that can alter even the sense of ownership of our own body. It has also been shown that this illusion can be induced by replacing the rubber arm by a virtual arm, using a 2D projection [7], and also 3D stereo projection coming out of from the subjects's shoulder [8]. The 2D flat projection yielded weaker results than those in the original Botvinick experiment, but those in the 3D version had the same degree of strength. This study therefore confirmed that a virtual body part can be somehow internalised as one's own if the right stimuli are provided. That being the case, the use of virtual environments opens a wide door for the studies of body ownership and self consciousness.

## 3. Presence and virtual environments in the study of body perception

Suppose within a head-tracked head mounted display delivered virtual reality, where the participants cannot see their own physical body, that they looked down and saw their virtual body, with movements that matched their proprioception of their real body movements, how much would they incorporate this virtual body as their own? Even more: suppose that virtual body was somehow significantly different from their own – for example, a woman sees her body as that of a man, or vice versa, or being green, or having three legs, or a hole through their trunk, or being transparent? How would the participant's sense of self be altered under such conditions?

Today, anomalies in body perception are mostly studied in patients, in a large number of pathological conditions that may cause distortions in the perception of the body: different agnosias, neglect syndrom, body dysmorphias, alterations in the perception of body orientation, etc. However, in order to determine to what extent the sense of the self has been modified by an altered body perception, it is not ideal to analyze patients that have had a more or less severe brain damage.

The possibility of internalizing (or considering as one's own) a virtual body supports carrying out different experiments on body perception and on the impact that

modified bodies have on the consciousness of the self. If we consider presence as a restricted form of consciousness within the realm of the virtual environment, eliciting presence while a virtual body is altered will contribute to the understanding of the impact of the body on the consciousness of the self. We illustrate this with a particular experiment. Our hypothesis is: The sense of the self will be affected by the characteristics of the virtual body. The resulting prediction is that, given an environment in which the virtual representation of the participant's body is diminished, then the corresponding degree of presence would also be diminished. Consider the situations ranging from no virtual body, a partial virtual body, a transparent body, through various stages to a full and accurate representation of the body. We would expect that the degree of presence would change in correlation with the completeness of body representation. However, this has two dimensions – the first is with respect to visual appearance. The second, and probably even more critical is the requirement to match the sense of proprioception, such that movements in the person's real body correspond to movements of the virtual body, generally the match between proprioception and sensory data. Thus, the responses (physiological, emotional, cognitive) to the VE would decrease in a partial body representation with respect to those in a full body representation, and with respect to diminished body tracking, and so would the subjective reported presence. Following this hypothesis, the decreased presence would be reflecting changes in the consciousness of the self. Changes in the consciousness of the self should also be tested through interviews and questionnaires. If the hypothesis would be rejected, the findings would still be relevant for the understanding of the body image impact on the consciousness.

Experiments of this kind could be run not only in healthy subjects, but also in those suffering from body dysmorphic disorders. This is a psychiatric disease in which the patients tend to perceive physical anomalies that cause significant distress and interferes with the social life of the patient [9]. In order to understand this disorder, it seems important to explore whether these patients would perceive the same dysmorphias in a virtual body. In these pathological conditions, the use of VE centered on their own body representation could be relevant for both diagnosis and probably treatment of the problem.

Previous experiments in VE have also revealed that presence increases when participants physically engage their bodies during navigation or interaction in a VE than when they navigate by means of a mouse or joystick [10]. This increase in presence could be attributed to a better spatial representation triggered by sensory motor correlations and a good correlation between allocentric and egocentric cues [11], but also to a better internalisation of the virtual body by integration of sensory-motor information.

#### 4. Our own body and how we are perceived by the others

Here we have considered the possibilities that presence and virtual environments provide for the study of body perception, and its potential of being used as a therapeutical tool in the treatment of body distortions.

There is an additional aspect that is worth mentioning here which is the role of *others* on the perception of ourselves. Recognition by others is an important element for us to know that we exist. Our presence in a social scene but not being acknowledged by others would drive us to doubt our own existence. To illustrate this with a well known fictional character: To what extent does the self of "The invisible man" remain intact while he cannot be seen by the others?

Not only that, but how we perceive ourselves is deeply influenced by how others perceive us: if looked at with admiration we feel satisfied and better looking than if looked with disapproval.

Social virtual environments allow the exploration of the impact of the others on our own perception. Does our sense of presence decrease in an environment in which we are not acknowledged by the virtual characters?

While in a car last week we heard a song on the radio: "Is it still myself when nobody sees me?" Some of these questions may find an answer in presence studies in virtual environments.

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