UNIVERSITAT DE BARCELONA

The Social Brain in Virtual Reality

Changing Perspective on Self and Others in Immersive Virtual Environments

Solène Neyret

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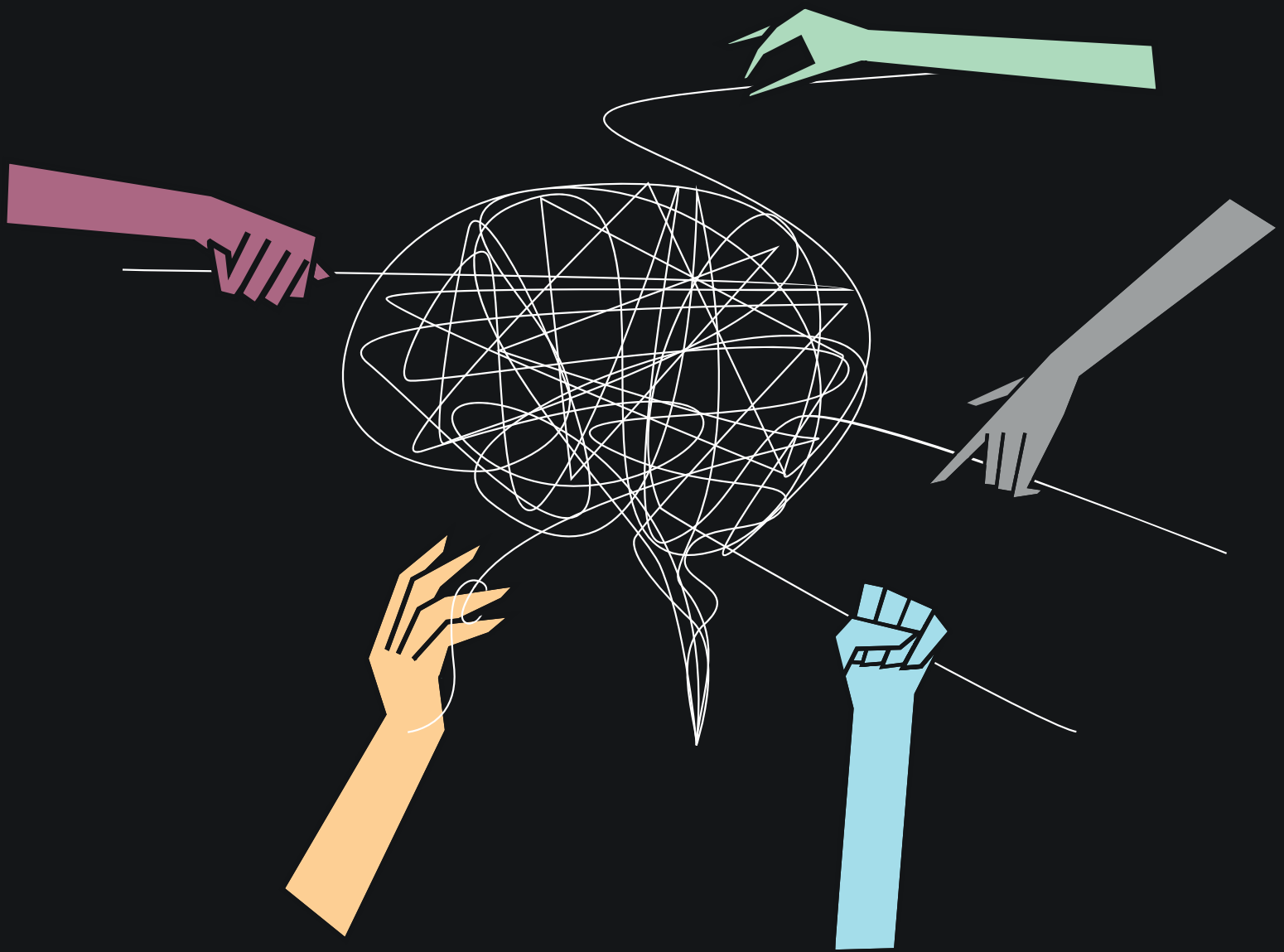

PhD Thesis

Solène Neyret

University of Barcelona

Doctoral Programme in Biomedicine

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The Social Brain in Virtual Reality

Changing Perspective on Self and Others in Immersive Virtual Environments

Author: Solène Neyret

Director: Prof. Mel Slater

Tutor: Prof. Maria V. Sánchez-Vives

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ABSTRACT

One fundamental aspect of the human brain is that it is highly shaped by experience and interaction with the surrounding environment. Signals coming from different sensory streams are integrated to create a coherent representation of the environment and of the "self", as a part of this environment. The boundaries of the self are defined through the constant and dynamic exchanges between an individual and their physical and social environment. Self-perception and self-representation are complex processes that seem to be linked to perception and representation of others. We know that humans experience a sense of self-awareness, but the neural bases of this phenomenon are not clearly understood yet. In this thesis we focus on three different aspects of the "self" as a dynamic process: body representation, social identity, and conceptual representation of a personal problem. We report on three behavioural studies using immersive virtual reality that demonstrate how self-representation is highly influenced by social feedback.

In the first experiment, we re-created a virtual representation of the internal image participants had of their own body shape. We also re-created a virtual body corresponding to their ideal body shape, and another virtual body representing their real body shape. Participants saw the three different virtual bodies from a first-person perspective and from a third-person perspective and they had to evaluate the appearance of those virtual bodies. We observed that female participants evaluated their real body as more attractive when they saw it from a third-person perspective, and that their level of body dissatisfaction was lower after the experimental procedure. We believe that third-person perspective allowed female participants to perceive their real body shape without applying the negative prior beliefs usually associated to the "self", and that this resulted in a more positive evaluation of their body shape.

In the second experiment, we showed how the influence of a group can determine behaviour of an individual. We created a social situation of verbal harassment in virtual reality, and embodied participants in different agents of that scene. In one condition, participants experienced the scene from the perspective of the victim (female avatar). In the other condition, participants saw the situation from the perspective of a member of the group of males performing the harassment (in-group condition). One week later, participants went through a virtual reproduction of the Milgram experiment, and we

measured their behaviour in terms of the number of shocks they would give to the victim (again a female avatar). All participants were sitting with a group of three virtual experimenters (male avatars), who were instructing them to give shocks to the victim until the end of the procedure. Our results show that participants of the in-group condition, behaved according to the instructions received from the virtual experimenters, and were more likely to finish the procedure. We argue that social feedback and group influence is critical in determining individual behaviour.

In the third experiment, we show how subjective evaluation of a personal problem, can be modified by getting a third-person perspective of oneself. Participants were asked to describe a personal problem causing mid-level distress in their daily life and had the opportunity to discuss it, in virtual reality, with an avatar of Dr Sigmund Freud. In the experimental condition, participants were embodied alternatively in their own virtual avatar and in the virtual body of Freud, allowing them to enter in a "self-conversation". In the control condition, participants were embodied in their own virtual body, and received general counselling from the avatar of Freud. Our results show that the self-conversation condition helped participants to get a new perspective on their problem, leading them to get a better understanding of it and new ideas on how to solve it. Participants in the self-conversation condition also reported less negative automatic thoughts after their experience in virtual reality. We believe that the psychological distance given by the third-person perspective, allowed participants to get a more rational understanding of their situation.

Overall, we demonstrate in this thesis, that self-perception, self-representation, self-evaluation and behavioral responses are highly influenced by social feedback. We show that third-person perspective enables to decrease negative bias in self-evaluation. We hope to be able to develop those findings in future clinical applications of immersive virtual reality.

RESUMEN

Uno de los aspectos fundamentales del cerebro humano es que está formado, en gran parte, por la experiencia de uno y su interacción con el entorno que le rodea. Señales provenientes de varios canales sensoriales están integradas para crear una representación coherente del entorno y de uno mismo, como parte de este entorno. Los límites de un individuo se definen a través de los intercambios constantes y dinámicos entre éste y su entorno físico y social. La percepción y la representación de uno mismo son procesos complejos que parecen estar vinculados a la percepción y representación de los demás. Sabemos que los humanos sienten una conciencia de sí mismos pero las bases neuronales de este fenómeno no están claramente definidas aún.

En esta tesis nos focalizamos en tres aspectos diferentes del sentido de uno mismo como proceso dinámico: la representación corporal, la identidad social, y la representación conceptual de un problema personal. Relatamos tres experimentos comportamentales utilizando realidad virtual inmersiva, teniendo como objetivo demostrar el impacto del "feedback" social en la representación de uno mismo.

En el primer experimento, recreamos una representación virtual de la imagen corporal interna de los participantes. También recreamos un cuerpo virtual representando su figura ideal y otro cuerpo virtual representando su figura real. Los participantes vieron los tres cuerpos virtuales desde una perspectiva en "primera persona" y desde una perspectiva en "tercera persona" y tuvieron que evaluar la apariencia de los cuerpos virtuales. Observamos que las mujeres evaluaron su figura real como más atractiva cuando la vieron desde una perspectiva externa (en tercera persona), también su nivel de insatisfacción corporal era menor después del procedimiento experimental. Pensamos que el hecho de percibir su cuerpo real desde una perspectiva externa permitió a las participantes femeninas no aplicar las creencias negativas usualmente asociadas a su percepción de ellas misma, y pensamos que esto resultó en una evaluación más positiva de su forma corporal.

En el segundo experimento, mostramos cómo la influencia de un grupo puede determinar el comportamiento de un individuo. Creamos, en realidad virtual, una situación social de acoso verbal en la que el participante fue personificado ("embodied") en varios agentes de la escena. En una condición, los participantes experimentaron la escena desde el punto

de vista de la víctima (avatar femenino). En la otra condición, los participantes vieron la situación desde la perspectiva de un miembro del grupo de hombres acosando a la mujer (condición "in-group"). Una semana después, los participantes experimentaron una reproducción virtual del experimento de Milgram y medimos su comportamiento en términos del número de choques eléctricos que dieron a la víctima (otra vez un avatar femenino). Todos los participantes estaban sentados con un grupo de tres experimentadores virtuales (avatares masculinos) que les daban la instrucción de enviar choques a la víctima hasta el final del procedimiento. Nuestros resultados enseñan que los participantes de la condición "in-group" se comportaron siguiendo las instrucciones de los experimentadores virtuales, y fueron más propensos a terminar el procedimiento. Argumentamos que el "feedback" social y la influencia de un grupo son definitivos a la hora de determinar el comportamiento de un individuo.

En el tercer experimento, mostramos cómo la evaluación subjetiva de un problema personal puede ser cambiada al tener una perspectiva externa de uno mismo. Pedimos a los participantes que describiesen un problema personal que les causara un nivel medio de angustia en su vida diaria para que tuvieran la oportunidad de hablarlo, en realidad virtual, con un avatar del Dr. Sigmund Freud. En la condición experimental, los participantes fueron personificados ("embodied") en su propio avatar virtual y en el cuerpo virtual de Freud, permitiéndoles entrar en una conversación con ellos mismo ("self-conversation"). En la condición control, los participantes fueron "embodied" en su propio cuerpo virtual y el avatar de Freud les daba consejos generales sobre su problema. Nuestros resultados muestran que la condición de "self-conversation" ayudó a los participantes a tener una nueva perspectiva sobre su problema, y que los llevó a entenderlo mejor y a tener nuevas ideas sobre cómo solucionarlo. Los participantes en la condición de "self-conversation" también reportaron menos pensamientos negativos automáticos después de su experiencia en la realidad virtual. Pensamos que la perspectiva externa les dio una distancia psicológica hacia su problema y les permitió entenderlo de manera más racional.

En esta tesis demostramos que la percepción, la representación y la evaluación de uno mismo están altamente influenciadas por los intercambios sociales ("social feedback"). Mostramos que la perspectiva externa de un individuo sobre sí mismo (en tercera persona) permite disminuir el sesgo negativo en su autoevaluación. Esperamos poder desarrollar estos resultados en futuras aplicaciones clínicas de la realidad virtual.

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- Slater, M., Neyret, S.*, Johnston, T., Iruretagoyena, G., Alvarez de la Campa, M., Alabernia, M., Spanlang, B., Feixas, G. (2018). Embodied Self-Dialogue: An experimental study of a virtual reality counselling paradigm (under revision) - *joint first author

- Neyret, S., Bourdin, P., Barberia, I., Oliva, R., Beacco, A., Valenzuela, J., Navarro, X., Slater, M. (2018). Perspective taking during a verbal harassment scene in virtual reality (in preparation)

- Neyret, S., Bellido, A., Navarro, X., Slater, M. (2018). Which body would you like to have: measuring subjective body appearance in immersive virtual reality (in preparation)

- Hortensius, R., Neyret, S., Slater, M., & Gelder, B. De. (2018). The relation between bystanders' behavioral reactivity to distress and later helping behavior during a violent conflict in virtual reality, 1–20. *PLOS ONE*, https://doi.org/10.1371/journal.pone.0196074

- Skarbez, R., Neyret, S., Brooks, F. P., Slater, M., & Whitton, M. C. (2017). A Psychophysical Experiment Regarding Components of the Plausibility Illusion. *IEEE Transactions on Visualization and Computer Graphics*, *23*(4), 1322–1331. https://doi.org/10.1109/TVCG.2017.2657158

- Friedman, D., Pizarro, R., Or-Berkers, K., Neyret, S., Pan, X., & Slater, M. (2014). A method for generating an illusion of backwards time travel using immersive virtual reality - an exploratory study. *Frontiers in Psychology*, 1–15. https://doi.org/10.3389/fpsyg.2014.00943

LIST OF ABBREVIATIONS

VR: Virtual Reality

VE: Virtual Environment

BO: Body Ownership

BOI: Body ownership illusion

PsI: Plausibility Illusion

PI: Place Illusion

1PP: First Person Perspective

3PP: Third Person Perspective

BI: Body Image

RB: Real Body

IB: Ideal body

BMI: Body Mass Index

BSQ: Body Shape Questionnaire

EDI: Eating disorders Inventory

ED: Eating Disorders

BD: Body Dissatisfaction

DT: Drive for Thinness

DASS: Depression Anxiety Stress Scale

CORE: Clinical Outcomes in Routine Evaluation

STAI: State-trait Anxiety Inventory

ATQ: Automatic thoughts questionnaire

1 INTRODUCTION

"Normal functioning must be understood as a process of integration in which the text of the external world is not so much copied, as composed".
(in *Phenomenology of perception*, M. Merleau Ponty, 1945)

Perception includes an active process that integrates stimuli from different sensory streams to create a set of coherent representations of the environment. Those representations are formed through repeated excitations of the same neural pathways, forming patterns of perception, enabling the organism to adapt to its environment in a fast and effective way. In humans, "self-perception" is a complex mechanism also involving the integration of information from different sensory streams combined with prior beliefs to form a dynamic representation of the self. In being aware of themselves, humans represent themselves as objects, interacting with their surrounding environment. "Self-representation" can be defined as a dynamic process that involves predictions about the outcome of the exchanges between the individual's internal milieu and their surrounding environment (external milieu).

Virtual reality permits the creation of artificial environments that can be perceived as real by the human brain. By creating multisensory stimuli that are synchronized and coherent with the expectations of the participants, it is likely that they would react realistically to virtual environments (Sanchez-Vives & Slater, 2005). Virtual reality is a particularly effective tool for studying self-perception and self-representation since it supports the presentation of a virtual representation of people to themselves, and measurements of how they perceive this. Typically, the representation of the body can be modified inside the virtual environment and affect their body representation. It has been shown that participants immersed in a virtual environment tend to have realistic responses to it. This makes virtual reality a good tool to recreate social situations that cannot be reproduced in reality, and measure behavioural and emotional responses to these social situations. Virtual reality allows the manipulation of several aspects of the "external milieu" surrounding a human individual in experimentally controlled conditions. Here we use it as a tool to investigate the impact of social environment on self-perception and self-representation.

1.1 RESEARCH PROBLEM

The onset of self-representation seems to involve a learning process including perception of conspecifics and interaction with them (Schore, 2001). An intrinsic feature of the brain is its dependence on social context (Han et al., 2012). The definition of self-representation is very complex since the neural basis for the existence of self-awareness have not been clearly identified yet (Singer, 2009). In this thesis we will use behavioural studies in VR to demonstrate how self-representation is highly influenced by social feedback. We will show how behaviour is highly dependent on social context and on the perspective one gets of a social situation. Moreover, we will investigate how this social feedback is somehow internalized and directly affects prior beliefs about oneself. This will lead us to consider how VR can be used as an effective tool for changing ingroup dynamics. We will also consider the use of a VR application as a therapeutic tool for mental disorders related to negative beliefs about the self.

By combining theoretical considerations from the field of affective neuroscience with the experimental use of virtual reality, we will manipulate specific variables in order to investigate the implicit social aspects of self-perception and self-representation.

Here we define self-perception as the act of processing multi-sensory signals related to oneself, including the perception of one's body shape. We use the term "self-representation" to define a more global process including prior beliefs that govern what is perceived about the self. The self-representation determined by prior beliefs is not necessarily correct, but it makes predictions about the sensory signals associated to the self and therefore, affects self-perception. Perceiving the multi-sensory signals related to the self involves an interpretation process that is aimed to maintain the coherence of self-representation but can create a biased perception of the self. We define "social environment" as the group of other humans surrounding an individual. We are interested in the constant and dynamic interaction between one individual and their social environment. This interaction can be recreated in virtual reality with interactive avatars programmed to react to the participant's actions and verbal interventions.

Here we will use virtual reality to investigate three different aspects of self-representation.

Our first specific research question is about body representation:

- We know that humans create an internal visual representation of their body; then, can we display this subjective body representation in the form of a virtual avatar?
- If participants can perceive this internal body representation from different perspectives inside an immersive virtual environment, how will it affect body evaluation?

Our hypothesis concerning these research questions is the following: First person perspective and embodiment in a virtual body will affect the subjective evaluation of the aesthetic attributes of this body. When perceived from a third person perspective, the virtual body will be evaluated more positively.

Our second research question is about the impact of social feedback on one's behaviour:

- We know that belonging to a group is an important motivation of human behaviour; so, to what extent representing oneself as part of a group can define behaviour and moral decision making in a virtual situation involving aggression towards a victim by the group?
- Will embodiment in the victim increase empathy and pro-social behaviour towards the victim?

Our hypothesis is that embodiment in the victim will increase empathy and reduce the probability of engaging in aggressive behaviour.

Our third specific research question is about the verbal aspect of self-representation:

- Self-representation includes verbal and conceptual aspects associated to oneself and expressed through inner speech; therefore, can we transpose this inner speech as an actual dialogue by using body swapping in virtual reality?
- Will self-conversation help in solving a personal problem?

Our hypothesis is that entering in a dialogue with oneself about a personal problem in immersive virtual reality will help in getting a new perspective on this problem.

1.2 OVERVIEW OF THE THESIS

This thesis reports on three experimental studies on human behaviour in virtual reality. In the introduction we will explain the theoretical framework of social bonding that will be used for the interpretation of the results obtained in the three different experiments. Then we describe the first study on body perception and consider how subjective body representation can strongly differ from objective body shape, especially in females. We show how body representation is negatively affected by prior beliefs about the self and how body perception can be modified depending on the embodied perspective from which the body is seen.

In the second experiment, we use virtual reality as a tool to explore how being embodied in different agents during a situation of verbal harassment can directly affect behaviour. We show how social feedback is critical in determining the choices of an individual when involved in a social situation including immoral behaviour.

In the third experiment, we describe how verbal interaction with a virtual representation of the self can help in getting a new perspective on a personal problem. We develop an argumentation on how self-conversation in virtual reality can lead to the development of a clinical application for self-counselling.

Based on the results obtained in those three experiments, we discuss theoretical considerations about the internalization of social feedback and consider how it deeply affects self-perception and self-representation. We argue that self-representation and behaviour are highly affected by interaction with the social environment. We investigate how social feedback is involved not only in perceiving and representing others but in perceiving and representing the self as well.

1.3 BACKGROUND

The integration of signals coming from different sensory streams creates a coherent representation of the surrounding environment and of the self, inside this environment. Virtual reality allows the creation of an experimentally controlled multisensory environment, the interaction between the participants and the virtual environment in which they are immersed produces the illusion of perceptual and behavioural exchanges similar to the ones experienced in reality. A virtual environment can be social, and therefore, makes possible the study of the impact of social feedback on a participant's behaviour. Implicit patterns shaped by experience in the real environment, define how the sensory signals are interpreted inside the virtual environment. This effect can lead to create perceptual illusions both on the self and on the surrounding environment.

In this chapter, we first review the literature on multisensory perception and multisensory illusions used in virtual reality research. We then expose the theoretical framework of affective neuroscience that we use as the general line for the demonstration of the implication of social exchanges in the creation of self-representation. We then move on to the theoretical considerations related to three different aspects of self-representation corresponding to the three experiments reported in this thesis.

1.3.1 Multisensory perception and immersive virtual reality

1.3.1.1 Models of perception and interaction with the environment

The nervous activity associated with perception is not merely a transmission process. It includes the combination and integration of different partial signals coming from different modalities. Perceived reality is shaped by the interpretation of the multisensory signals that are received by the nervous system. Appraisal of the nervous flux needs necessarily an interpretation of this flux (Bowlby, 1958). Humans are in constant interaction with the environment through their sensory-motor system. Perceiving the environment and perceiving one's body in this environment includes a lot information of various kinds, coming from different sources. The combination of all this information is referred to as multisensory integration (Meredith & Stein, 1986), which allows the human brain to create a coherent model of the environment and therefore, a coherent model of one's body in constant interaction with this environment (Ionta, Gassert, & Blanke, 2011). The

formation of mental models allows the creation of generalizations and summaries of past experiences, and these models are then used to interpret new incoming stimuli. This process has a clear adaptive advantage since it permits a faster analysis and anticipation of the events happening in one's surrounding environment (Siegel, 2012a), therefore allowing a fast and accurate reaction to it.

According to the predictive coding model, the brain constructs top down expectations about sensory samples from the world and uses internal hierarchical models to predict sensory inputs (Carhart-Harris & Friston, 2010; K. Friston, 2010). This model suggests that neuronal activity and synaptic connections are shaped to minimize the prediction error about the incoming sensory signals. Successful perception, cognition and action are associated with successful suppression of prediction error (Seth, Suzuki, & Critchley, 2012). Through active inference, the prediction error is minimized by acting on the world, while through perceptual inference, the prediction error is minimized by changing (updating) the internal model, making the internal model more similar to the world (K. Friston, 2010; Wiese & Metzinger, 2017). Prior beliefs about the world (external milieu) are generated by the internal states. States of the external milieu are associated with internal states, and prior beliefs predict the outcome of the interaction with the external milieu through action or perception. Predictions are probabilistic and based on sensory evidence (Moutoussis, Fearon, El-Deredy, Dolan, & Friston, 2014). We will use the term "prior beliefs" throughout the thesis to define the internal representation humans create of their surrounding environment and of themselves.

1.3.1.2 Multisensory integration and body ownership illusions

Perceived stimuli are processed according to pre-learned patterns and predictions. If there is any incongruence in what is perceived, the brain will create a "coherent" explanation based on the previous experience it has of the surrounding environment. This aspect of human perception is salient in illusions that involve stimuli coming from different sensory streams. One famous example of such an illusion is the ventriloquist effect. The auditory information is perceived as combined with the visual information and the brain interprets the sound as coming from the mouth of the puppet even if it is coming from the mouth of the ventriloquist. There is a misidentification of the source due to the characteristics of multisensory integration and to the dominance of the visual stimulus over the auditory

one (Alais & Burr, 2004). Bimodal integration leads to a drift in the spatial localization of the auditory stimulus source.

Multisensory integration also overrules body representation. Stimuli coming from proprioception, tactile and visual inputs are combined to create a coherent representation of one's body. Illusions involving body perception show that, in optimal conditions, the visual information is dominant over other senses and that body representation is very plastic. The most famous example of body illusion is the rubber hand illusion (Botvinick & Cohen, 1998). In this experiment, the participant is sitting at a table with one of their hands hidden from sight, and instead of their real hand, they see a rubber hand. The experimenter applies a tactile stimulus both on the real hand and on the rubber hand. The participant's visual attention must be focused on the rubber hand and the tactile stimulus applied to the real hand must be perfectly synchronized with the visual stimulus applied on the rubber hand. After a very short period of time of this visuo-tactile stimulation (between twenty seconds and two minutes depending on the individuals), the brain integrates the visual perception of the rubber hand together with the tactile perception coming from the real hand. The brain creates a "coherent" interpretation of the multisensory event: the bimodal integration process triggers a "body ownership illusion" (BOI) towards the rubber hand, and includes it into the body representation of the participant.

Then, if the rubber hand is threatened, the participant will react by withdrawing his real hand, as if a part of his real body was threatened. This experiment has been widely used in the literature to demonstrate the multisensory aspect of body perception and the high plasticity of body representation (Armel & Ramachandran, 2003; Costantini & Haggard, 2007; Ehrsson, 2005; Kammers, de Vignemont, Verhagen, & Dijkerman, 2009; Tsakiris & Haggard, 2005). Faced with conflicting information coming from different sensory streams, the brain solves the ambiguity by creating the body ownership illusion. Body ownership can also be elicited over a full body and trigger a drift in localization of one's body (Petkova et al., 2011; Petkova & Ehrsson, 2008). In virtual reality we use this brain characteristic of "solving" perceptual ambiguities by creating an illusion, to trigger a full body ownership illusion over a virtual body. In the following section we review the fundamental concepts used to describe experiences in virtual reality.

1.3.2 **Fundamental concepts of Virtual Reality**

1.3.2.1 Embodiment

It has been demonstrated that body ownership over a virtual body can be elicited inside virtual reality and that the key factors to elicit this effect are: visuo-tactile and visual sensori-motor contingencies, first person perspective, spatial collocation, and the morphological appearance of the virtual body (Kilteni, Normand, Sanchez-Vives, & Slater, 2012; Kokkinara & Slater, 2014; Maselli & Slater, 2013). If the movements of a virtual body are synchronized with the movements of the participant, a sense of agency over this virtual body will be experienced by the participant. Using the latest technology allowing head and body tracking (see description of the equipment in Methods 2.1.1), we create a synchronization between the motor output of our participants and the visual input they receive from the movements mapped onto their virtual body. We use the term "body ownership" to refer to the sensation of owning a virtual body. We use the term agency to describe the sensation of having a virtual body which moves accordingly to one's intentions (Kilteni, Groten, & Slater, 2012). When participants are embodied in a virtual body, properties of their virtual body are processed as if they were the properties of their real biological body. As described earlier about the rubber hand illusion, when embodied in a virtual body, one will have a realistic emotional response to a threat applied to the virtual body (González-Franco, Peck, Rodríguez-Fornells, & Slater, 2014). We know from previous studies that first person perspective is crucial to create embodiment and that seeing the virtual body reflected in a virtual mirror in front of the participant is an important factor in inducing embodiment (González-Franco, Pérez-Marcos, Spanlang, & Slater, 2010). When embodied in a virtual body, participants accept the avatar as the partial representation of their "self", at least during the course of the experiment. As a result of this identification with a virtual avatar, we can measure some aspects of body representation and self-perception inside a virtual environment (Slater & Sanchez-Vives, 2014; Slater, Spanlang, Sanchez-Vives, & Blanke, 2010).

1.3.2.2 Presence, Place Illusion and Plausibility illusion

Presence is defined as the subjective experience of "being there" inside the virtual environment. It has been described as the combination of different factors: the illusion of being in the place depicted by the virtual environment (Place Illusion, PI), and the extent

to which the situation and events taking place inside the virtual reality seem to be "really happening" (Plausibility Illusion, Psi). There is a temporal aspect to presence and it lasts only while the participant is immersed inside the virtual environment (Sanchez-Vives & Slater, 2005; Slater, 2003, 2009). Presence in VR corresponds to the subjective-phenomenal experience of "now being there" in reality (Metzinger, 2003). It involves a dynamic exchange between the individual and the surrounding environment, as the one described earlier (Section 1.3.1.1). To create the illusion of presence, it is necessary that the brain makes a coherent interpretation of the incoming multi-sensory stimuli and establishes a behavioural functional equivalence between the predictions it usually does in real environments and the virtual stimuli it gets inside VR (Seth et al., 2012). The virtual reality system must, therefore, afford natural sensori-motor contingencies in order to generate this sense of presence in the participants.

The concepts of presence and embodiment are used to describe the subjective sense of a temporal reality of the world and of the "self" when immersed inside a virtual environment. There is an active appropriation of the technical device and the sensorimotor perception resulting from it, this active perception triggers cognitive and functional immersion (Auvray & Fuchs, 2007). Prediction and prior beliefs about the outcome of one's actions in real environments must be respected to create "Plausibility Illusion" inside virtual environments. The physical laws usually experienced in the real world must be applied to the visual components of a virtual environment to give a "plausible" feedback to the participants, corresponding to their expectations and prior beliefs about the environment. In a study conducted recently (Skarbez, Neyret, Brooks, Slater, & Whitton, 2017), we showed how plausibility and agency created immersion in a virtual environment. We isolated the different factors that could affect the sense of Plausibility inside the virtual scenario. Participants could modify different components of the virtual environment in order to reach the optimal sensation of plausibility. The elements that could be modified were the following: appearance of the environment, physical behaviour of objects inside the environment, posture of the participant's virtual body, behaviour of the other virtual avatars in the environment. Our results showed that participants tended to give priority to improving the behaviour of their virtual body before improving any other component of the virtual environment. This shows that an accurate and coherent self-representation is primordial to the creation of plausibility illusion.

According to the model of predictive coding described earlier (Section 1.3.1.1), Presence can be defined as a suppression of prediction error by top down predictions of informative interoceptive signals. Informative interoceptive predictions are successfully matched to multi-sensory inputs and prediction error is suppressed, creating a coherent representation of the surrounding environment and triggering the illusion that the virtual environment is real. This is why the behaviour of the virtual body and of the objects inside a virtual environment, must match the participant's predictions, This will trigger the illusion that there is a "real" dynamic interaction happening between their internal milieu and the external milieu of the virtual reality (Seth et al., 2012).

By changing the multi-sensory input coming from the surrounding environment, we can also change self-perception, the self being an active perceiving "agent" in the virtual environment. In this thesis, we will show how being embodied in different virtual bodies and adopting different perspectives on oneself or others inside VR, show the existence of prior beliefs affecting self-perception and perception of the social environment. We will use the term "co-presence" to refer to the subjective experience of being inside the virtual environment with other virtual avatars. The level of co-presence will be related to the degree to which participants modified their own behaviour according to the behaviour of the other avatars in the virtual environment. This concept will be particularly important in the second experiment given that we will re-create a social situation of in-group pressure through virtual social influence. We will see how the in-group effect directly affects behavioural responses of the participants.

1.3.2.3 Realistic responses of participants to virtual situations

As we have seen earlier, human interaction with the environment is done through behaviour and perception (K. J. Friston, Daunizeau, Kilner, & Kiebel, 2010). There is a continuous dialogue between interoceptive signals and exteroceptive signals creating a learning process predicting the outcome of behaviour depending on the signals that are perceived (Suzuki, Garfinkel, Critchley, & Seth, 2013). The central nervous system reacts and modifies its activity depending on the environmental conditions that are perceived by the organism, permitting biological adaptation to the surrounding environment (A. Schore, 2001). Bodily states are associated with perceived states of the environment and predictions about the outcome of an action are formed to adapt the behaviour depending

on the perceived situation (Seth, 2013; Seth & Friston, 2016). There is a learning process shaping how internal affective states are associated to the states of the surrounding environment. The aim of the interaction of an organism with its environment is generally oriented to survival, in humans many factors influence both the perception of the surrounding environment and the behavioural responses to it. Behavioural responses to a constantly changing environment are based on the prior beliefs that were learnt in previous interactions of an individual with the environment.

Responses to environmental cues are very complex and include many different co-existing mechanisms that can sometimes enter in contradiction within one individual system, and create a multisensory conflict that the brain needs to solve to maintain a coherent representation of the environment and of the body inside the environment (Blanke & Metzinger, 2009). We have described before how this type of multisensory conflict can be "solved" by creating a perceptual illusion, for instance body ownership illusion (Section 1.3.1.2). The experience of presence inside virtual reality involves at least two co-existing cognitive processes entering in contradiction. Top down predictions related to the "consciousness" of being inside the laboratory are co-existing with the bottom up predictions related to the multisensory signals coming from the virtual body and the virtual environment. The brain "solves" this conflict by creating body ownership and place illusion. Therefore, the physiological, emotional and behavioural responses of participants immersed in virtual environment are similar to those they would have in a real situation (Sanchez-Vives & Slater, 2005). It has been shown that when faced with a violent conflict between two avatars in an immersive virtual environment, participants adopt a behaviour similar to that they would adopt in a real situation (Hortensius et al., 2018; Slater et al., 2013). Based on these results, it is possible to create an in-group effect by manipulating the social feedback received from avatars present in the same virtual environment as the participants. We will show how participants can feel an "in-group affiliation" with virtual people and how this effect influences their behaviour towards another virtual person belonging to a different group (See experiment II).

As described earlier (Section 1.3.1.2), the prior beliefs corresponding to one's body representation are responsible for the illusion of body ownership happening towards a virtual body. If stimuli coming from two different sensory modalities are synchronized, the brain makes the prediction that these stimuli must be associated to the same source. In the first experiment, we use visuo-tactile integration to create body ownership illusion

towards the virtual body in the 1PP condition. In the second and third experiment, we use visuo-motor correlation to trigger the illusion of body ownership towards the virtual body. The movements of the participant's upper body are tracked and mapped to the virtual body, creating a sense of integration between motor activity and visual feedback received inside the virtual environment.

In the three studies presented here, we explore how the responses observed in a virtual situation can provide evidence about the different mechanisms involved in self-representation and how it is shaped by social interaction. In this second part of the introduction we explain how the intrinsic social aspect of human development is involved in the following aspects of self-representation: body perception and body representation, behavioural responses associated to social reward, inner speech and self-regulation. We first consider how attachment behaviours create a self-representation that is highly dependent on social feedback. We then show how this self-representation creates predictions and shapes both self-perception and perception of one's surrounding environment.

1.3.3 **The construction of self-representation through interaction with physical and social environment**

Interaction between an organism and the environment in which it evolves is a constant process of exchange. The more the organism interacts with the environment, the more the adaptation process is effective. One of the fundamental aspects of the human brain, is that it is mainly shaped by experience and therefore, it is highly affected by the inputs received from the environment in which the human individual evolves. Maintaining the equilibrium of the individual's internal milieu while being in a constant interaction with the environment is a key element for survival and adaptation (Churchland, 2002). The preservation of homeostasis through exchanges with the external environment is determined by the social resonance processes occurring between limbic systems (A. Schore, 2001; A. N. Schore, 1997).

The external milieu in which humans are evolving and acting is a social one. Interaction with other individuals is critical in the evolution of behavioural patterns (Han et al., 2012). The human brain is a relational organ that bridges the gap between the internal milieu of

the organism and its social environment. Exchanges with the environment develop specific neural mechanisms that help the individuals to adapt to specific changes of their social environment (Porges, 2004). The nervous system responds to environmental signals, physiological changes, personal experiences, and adapts to social contexts during development. The brain, as a self-organizing system, needs its surrounding environment to make sense, signals received are processed and integrated to make a coherent model of the environment and construct the most efficient predictions about it (Friston, 2010). As we explained before (Section 1.3.1.1), the brain creates prior beliefs about the environment and the outcome of actions on this environment, those prior beliefs are updated through active interaction with the environment (Friston et al., 2013). Bayesian inference about the state of the world associated to internal states (prior beliefs) also applies to the self and to the social environment (Moutoussis et al., 2014). A representation predicts outcomes that matter under some prior beliefs. Here we will focus on the prior beliefs about the self. We use the term "self-representation" to describe the set of prior beliefs related to the self.

Humans are born highly immature and unprepared for their surrounding environment. This makes them both very adaptable to a large variety of possible environments, and highly dependent on their caregivers (Bowlby, 1958). The human brain has very high learning capacities, but it needs to be born very immature to leave space for neurons to develop, therefore the bonding between the caregiver and the baby is evolutionarily adaptive. The mother treats the baby as if it were "part of herself", and caregivers are neurochemically wired to the offspring (Casebeer & Churchland, 2003; Churchland & Winkielman, 2012). This aspect of brain development makes humans a highly social species and makes the constitution of self-representation highly dependent on other humans (Singer, 2009). Social realities serve as priors for perception of others and perception of oneself. The cultural environment defines the prior beliefs humans use to construct a self-representation (Han et al., 2012; Singer, 2009).

Meltzoff and Moore (Meltzoff & Moore, 1979) showed that humans create a representation of themselves at an early age. Observation and interaction with other humans create elements that are incorporated to the representation of the self. Infants seem to learn about themselves through seeing others. They gain experience by isolating and extracting goals and behaviours they observe in their surrounding social environment, and this shapes the way they represent their own actions. The neural system responsible

for the construction of self-representation seems to be related to perception of others (Siegel, 2001, 2012b). According to Siegel, self-organization relies on the regulation of brain regions that depend on patterns of communication. Infants use the states of their attachment figures in order to organize the functioning of their own states (Siegel, 2012a). Infants create a mental representation of their caregivers that is associated with multi-sensory signals (faces, voice, smell, taste, touch) and with the sense of the interaction they can have with them and with the environment. Stable patterns of activation enable the individual to create a coherent internal model of the surrounding physical and social environment.

Environmental factors play a crucial role in establishment of synaptic connections after birth. Genetic potential is expressed within the setting of social experiences; it influences how neurons connect to one another. As we saw in Section 1.3.1, the interpretation of the afferent nervous flux referring to the internal state of the organism or to the state of the environment needs an interpretation process. This interpretation process is performed depending on the norms defined by previous experiences or by already stored information that seems appropriate for appraisal of the new incoming stimuli. The appraisal and judgement processes seem to occur at different levels of the central nervous system and the interpretation processes can be conscious or unconscious. They play a vital role in behaviour regulation, feeling of internal states and communication with others. Instead of developing an independent regulating circuit, the infants develop a communication pattern that enables them to regulate their internal states through interaction with others (Panksepp, 2010). A consequence of this behavioural pattern is the high dependence of the offspring on other humans for making sense of the environment.

1.3.3.1 The social self within the boundaries of a body

As stated in Section 1.2, the first aspect of self-representation we will investigate in this thesis is body representation. Here we review the theoretical framework on which the first experiment is grounded.

A human being can be described as a self-organizing adaptive system whose activity is aimed at maintaining equilibrium within its boundaries. Defining the boundaries of a human being necessarily requires the consideration of the body (Tsakiris, 2016). The body is one element of the individual that we can perceive in a spatially limited space. The

difficulty comes when we start to consider the body as perceived by the individual himself. We know that body representation is not accurately tuned to the real spatial boundaries of the body (Longo & Haggard, 2010).

Proprioception and visual information are combined to create an internal representation of one's body (S. Gallagher, 1986). This representation is involved in motor control and in the construction of a body image (Arnheim, Bermudez, Marcel, & Eilan, 1997). It is also known, that the visual information that one receives when observing the body of conspecifics can be integrated to their own body representation (Calvo-Merino, Glaser, Grèzes, Passingham, & Haggard, 2005). Body representation includes some visual references coming from the perception of others. Humans are unable to perceive their own body from a third person perspective. They can construct an internal visualization of the body, based on the visual information perceived in other bodies, through visual imagery (J Decety, 1996; Naito et al., 2002). The visual perception of other bodies somehow overlaps with the representation of one's body. We will show in the first experiment that prior beliefs about the self, affect body perception.

In the literature we can find various definitions of body representation and how it is related to a conceptual sense of self. Minimal self and the sense of agency define the sense of "mineness" and ipseity, ipseity being a pre-reflective proprioceptive, ecological sense of self that contributes to the basic differentiation between self and non-self (Gallagher, 2007). Self-representation is developed as a meaningful structure at the level of our bodily movements through space, in the basic interaction between an organism and its environment (Neisser, 2008).

One critical element appearing in all the different definitions is the conscious aspect of being a self through the subjective experience of having a body (Metzinger, 2014). One common differentiation found in the literature is the distinction between "body image" and "body schema" (S. Gallagher, 2000; S. Gallagher, 2005; S. Gallagher, 1986; Kammers, Longo, Tsakiris, Chris Dijkerman, & Haggard, 2009). The body image is defined as a quite constant, conscious representation of one's body including conceptual beliefs about the self, whereas the body schema is defined as an unconscious and very plastic representation. F. De Vignemont proposed that the main distinctions between body schema and body image are in the temporality of the representation (long term vs short term), its availability to the consciousness and its functional role (action vs perception) (de Vignemont, 2010). In the first experiment we will use the term "body image" in the

sense of the conscious, long term, pre-existing representation involved in body perception of oneself. We will observe how body image is closely related to prior beliefs about the self.

1.3.3.2 The social self within a group of conspecifics

Prior beliefs about oneself and predictions about the environment (physical or social) affect behaviour. Maintaining the equilibrium of the internal milieu by using prior beliefs shaped by experience, allow an optimal interaction with one's surrounding environment. The external milieu in which humans are evolving is also composed by other individuals and interaction with those individuals shapes the way humans understand how to manage their internal equilibrium through the exchange with the external milieu. Self-representation predicts and optimises the outcomes of social interactions (Moutoussis et al., 2014). Virtual reality makes it possible to build and control a multisensory and social environment that creates the illusion of a realistic and dynamic exchange between the participant and the virtual avatars inside the virtual environment (Hortensius et al., 2018; Slater et al., 2013). Here we review the conceptual background on which the design of the second experiment is based.

In the second experiment reported in this thesis we show how participants' behaviour in a social situation displayed in virtual reality can be modified by manipulating embodiment and perspective. We measured the behavioural responses of our participants using a virtual reproduction of the obedience experiment done by Stanley Milgram in 1963 (Milgram, 1963). It has already been shown that participants respond realistically to a reproduction of the Milgram experiment in Virtual Reality (Slater et al., 2006). In the study reported here, we measured how the empathic response towards the victim, can be affected by the social pressure received inside the virtual environment.

We define empathy as the capacity to feel an appropriate emotion in response to that expressed by a conspecific. Empathy therefore involves a clear distinction between self and other. An individual feeling empathy must have the capacity to identify the source of the emotion as separated from the self. When feeling empathy, one understands implicitly or explicitly the other's emotion and can regulate their own internal emotional response to this external emotional manifestation (Jean Decety & Jackson, 2004; Jean Decety & Sommerville, 2003; Jean Decety & Svetlova, 2012). As defined by Decety, empathy

requires the projection of self attributes to the other. Empathy requires the capacity to adopt the perspective of the other, there is a shared representation of the self and of the other, allowing the inclusion of other's characteristics within the self (without a complete merging between self and others feeling). Empathic feeling, requires the mental flexibility to intentionally adopt the perspective of the other associated to an efficient self-awareness process. Emotional contagion is an internal emotional manifestation in which an individual feels the same affective state he is perceiving in an external agent, in this case the distance between oneself and the other is not maintained (de Vignemont & Singer, 2006). In the second experiment we measured the impact of being embodied in the victim of a verbal harassment scene on later empathic behaviour. The feelings triggered by the verbal aggression are directly experienced in a first-person perspective, therefore triggering an emotional experience of "being the victim". Our hypothesis was that this 1PP experience would then emphasize the inclusion of the victim's feeling within the self in another similar situation of aggression.

Humans are highly specialized in inferring the emotional states of their conspecifics. Social perception defines social inference, which determines social behaviour. But as the individual evolves and gets experience of his surrounding environment the social behaviour determines social perception. Activity in the amygdala is related to both social inference and to the neural processing of one's own emotions. There is a lot of evidence showing that the individual emotional system is related to the inference made on others emotions (R Adolphs, Damasio, Tranel, Cooper, & Damasio, 2000; Ralph Adolphs, Tranel, & Damasio, 2003). With using virtual reality to create embodiment of a participant into a virtual avatar we use this characteristic of the human brain and emphasize this overlap between self-representation and the representation of others' emotional states. In the reproduction of the Milgram scenario used in the second experiment, we observed how participants behaved in relation to the pain experienced by a virtual avatar sitting in front of them.

It has been shown that when a rat experienced electroshocks, he will be more likely to help another rat that is suffering from electroshocks (Church, 1959). This puts in question the understanding of pain in others when the corresponding physical sensation has never been experienced by oneself. It seems that in this case inference and reasoning define how an individual understands the pain that another individual is suffering (Danziger, Faillenot, & Peyron, 2009). It has been argued that there is, in humans as well, a shared

network for the representation of self-pain and pain of others (Jean Decety & Sommerville, 2003). The inter-individual differences and social factors seem to affect these processes of empathy, for instance, similarity between self and other increase empathic behaviours. Emotions are shared most likely with other individuals with whom one can identify (Jean Decety & Jackson, 2004). Empathic behaviours seem to depend as well on the opinion one has towards the other, social criteria therefore influence directly empathic behaviour (Jean Decety, Echols, & Correll, 2010). It has been shown that empathic behaviour is modulated by the group membership (Hein, Silani, Preuschoff, Batson, & Singer, 2010).

The in-group membership and social valuation is first developed through the attachment to the caregivers (Frith & Frith, 2012). By orienting the attention of the infants to certain cues of the environment, the caregivers make them able to interpret their internal states and understand how to interact with their physical and social environment, in order to maintain their internal equilibrium (Bowlby, 1958; Porges, 2004). The immaturity of humans in their early years of life makes the social aspect prevalent in the onset of human interaction with the environment (Churchland & Winkielman, 2012; Panksepp, 2010). This has clear benefits on the adaptation level, humans can evolve in very different kind of environments thanks to this brain "immaturity" and high adaptability they are born with. The reward system, emotional reactions and patterns of social interaction that will affect behaviour of an individual during all his life, are highly shaped in those very plastic early years of life. The bond created with a group of other humans is directly linked to the reward system and corresponds to the safety seeking program (Panksepp, 2010; Porges, 2004). There seems to be a valuation system applied to other humans depending on the group to which they belong, this valuation process directly affects prosocial behaviour and ingroup bonding towards conspecifics (Jean Decety et al., 2010; Hein et al., 2010).

1.3.3.3 The inner self as a product of social interaction

It has been argued in the literature that the valuation process applied to others is somehow internalized through inner speech within one individual (Alderson-day & Fernyhough, 2015; Häfner, 2004; Morin, 2005). Inner speech can be defined as the subjective experience of language in the absence of overt and audible articulation (Alderson-day &

Fernyhough, 2015). It can be considered as a very adaptive process in terms of developing meta-cognition, self-awareness, self-understanding, self-regulation, social understanding, executive rehearsal in working memory, action planning, decision making and problem solving (Alderson-day & Fernyhough, 2015; Cragg & Nation, 2010; D'Argembeau, Renaud, & Van Der Linden, 2011; Williams, Bowler, & Jarrold, 2012). By internalizing the perspective of others, executive rehearsal and action planning can include information coming from other sources of conceptual knowledge, concepts that were learned through interaction with conspecifics, not only through the mere interaction of one individual with their environment. Internalization of other's perspective and conceptual knowledge allows one individual to expand their cognitive capacities.

In the third experiment, we show the effects of having a conversation with oneself inside a virtual scenario. It has been demonstrated that body swapping between one's body and a virtual representation of Sigmund Freud triggered cognitive changes related to the attributes associated to the figure of Sigmund Freud (Osimo, Pizarro, Spanlang, & Slater, 2015). In this study, participants presented a personal problem and had a conversation with an avatar of Freud standing in front of them. It was shown that the benefits of this conversation were greater when the virtual body of Freud was moving accordingly to the participant's movement, showing the importance of embodiment in getting the cognitive attributes of a famous figure internalized in one's own "way of thinking". Here we will show how inner speech can somehow be externalized by using this same body swapping technique inside virtual reality. We will demonstrate how applying a second person perspective to a representation of the self seems to modify predictions and automatic thoughts related to self-representation. We will show how self-conversation, being alternately embodied in one's own avatar and in an avatar of Freud, has clear benefits compared to conversation with the same avatar of Freud without body swapping. Here we briefly review the literature on inner speech, and we explain how prior beliefs are related to what is defined as "schema" in cognitive behavioural therapy.

The external criteria coming from caregivers and from culture are internalized in the conceptual representation one has of the surrounding environment of oneself (Han et al., 2012; Raque-Bogdan, Ericson, Jackson, Martin, & Bryan, 2011). Through inner speech, the human brain internalizes the perspectives of others (Alderson-day & Fernyhough, 2015; Morin, 2005, 2010). This is a very adaptive process since it allows one individual to understand an external situation from different perspectives, at least conceptually.

Inner speech appears to have a role in emotional expression and regulation (Atencio & Montero, 2009). It also seems to be involved in planning for communicative interaction (San Martín, Montero, Isabel Navarro, & Biglia, 2014). Although we do not understand yet the neural bases of such a process, it seems like a very adaptive mechanism enabling one individual to take decisions using different sources of information. Inner speech seems to emerge from the regulatory function of social speech: verbal content that was previously used to regulate the exchanges with other humans seems to have gradually become directed back at the self, and became a self-regulatory system.

According to Morin, conversations with our selves permit the acquisition of self-information and is involved in the formation of self-awareness and self-concept. The internalization of other's perspective, in the form of inner speech is therefore involved in the formation of self-representation. Since inner speech is involved in problem solving strategies and executive rehearsal, it also involves self-evaluation (Morin, 2012).

Self-evaluation is an adaptive process implicated in executive rehearsal, it optimizes the planning of executive functions and the rehearsal of social interactions. Inner speech seems to be linked to neural circuits attributing positive or negative value to the self (Brühl, Rufer, Kaffenberger, Baur, & Herwig, 2014). We have seen before that social evaluation is critical in behavioural choices (Section 1.3.3.2). Behavioural and emotional responses highly depend on the value given to a conspecific and the value attributed to the self, in comparison to this other individual. There is a deeply grounded process of self-evaluation and social comparison affecting behaviour and self-representation (Häfner, 2004; Häfner & Schubert, 2009).

As explained at the beginning of this Chapter (Section 1.3.3), the interaction with caregivers shape the way an individual perceives and interprets the signals coming from the surrounding social and physical environment (Churchland, 2002; Churchland & Winkielman, 2012). The underlying cognitive structures shaped by early life experience, that include this primary social interaction with caregivers, are defined as "schema" by Beck (Aaron T.Beck, 1967; A. Beck, Rush, Shaw, & Emery, 1979; J. S. Beck & Beck, 2011). "Schema" determine how an individual interprets the stimuli perceived from the environment in a meaningful way. Schema are defined as patterns of interpretation of the incoming signals from the surrounding environment. They determine predictions about the outcome of interactions between an individual and their physical and social environment. We can make a parallel definition between schema and prior beliefs: the

information coming from the environment is processed depending on the predictions based on the prior beliefs generated by internal states (as described in Section 1.3.1.1), the interpretation of the external stimuli depends on the schema formed by the prior beliefs. As described by Beck, maladaptive predictions can lead to process the environmental stimuli in a distorted way, this process is defined as cognitive distortions (A. Beck et al., 1979; A. T. Beck & Haigh, 2014; J. S. Beck & Beck, 2011).

Cognitive distortions correspond to wrong predictions individuals make when interpreting their surrounding environment. They can occur at different levels, in the form of automatic thoughts or dysfunctional attitudes, both driven by the underlying schema or "maladaptive prior beliefs" (Wong, 2008). These constructs are hierarchically related and play a role in most forms of psychopathology as well as in normal functioning (A. T. Beck & Haigh, 2014). Automatic thoughts can be repetitive and intrusive predictions related to maladaptive prior beliefs about the self, and they can lead to psychopathology (Tanaka et al., 2006). Negative automatic thoughts about the self, reflect specific conceptual "content" which depend on the "schema" (set of prior beliefs) that give a wrong interpretation to the stimuli received. Automatic thoughts can create a negative bias on self-perception. A Bayesian model of psychopathology has been proposed, defining maladaptive beliefs as prediction error and lack of update in the hierarchical model of inference about the self and about the environment (Fletcher & Frith, 2009).

Emotional states associated to maladaptive prior beliefs can lead to cognitive distortions and negative automatic thoughts. Automatic thoughts express conceptual content and are at least partially expressed through language. The Self is conceptually represented through language, in the interaction with others but also in inner speech (as explained before). In the third experiment we created an externalization of the verbal interaction with oneself through self-conversation using the body swapping method. We demonstrate that the self-conversation helps participants in adopting a new perspective on their personal problem.

1.4 OBJECTIVES

The general objective motivating the experimental studies carried out in the framework of this thesis is to investigate the impact of social feedback on self-representation. We aim to show that perceiving others affects the structure of self-perception and that social interactions directly affect self-representation and exchanges with one's surrounding environment.

1.4.1 General Objectives

- Investigate self-representation and show that it is a dynamic process dependent on social interactions

- Show how changing from first to third person perspective in virtual reality can have a direct impact on self-perception, self-evaluation and self-representation

- Show how social feedback in an immersive virtual environment can directly affect behaviour and decision making

1.4.2 Specific objectives

- Create an avatar corresponding to the mental representation of one's body shape in virtual reality and compare it to one's real body shape and one's ideal body shape (Experiment I)

- Evaluate the impact of first person perspective and third person perspective on body perception and subjective evaluation of body characteristics (Experiment I)

- Create a controlled social feedback with virtual avatars and see how it influences behavioural responses of human participants inside virtual environments (Experiment II)

- Show how experiencing a social situation of verbal harassment from the perspective of the victim can lead to increase the probability of adopting pro-social behaviour, when confronted to a structurally similar situation later in time (Experiment II).

- Demonstrate the benefits of self-conversation compared to general counselling inside virtual reality (Experiment III)

- Show how third person perspective on oneself explaining a personal problem allows to get a better understanding of this problem (Experiment III)

- Describe how changing perspective on the self in virtual reality could be used as a therapeutic tool to re-define some aspects of self-representation associated to automatic thoughts and cognitive distortions (Experiment III)

2 METHODS

2.1 OVERALL METHODOLOGY

In this section we present the technical description of the equipment that was used in the three experiments. Specific methods and procedures for each experiment are then described in separated sections within this chapter.

2.1.1 Virtual reality system

All the virtual environments from the three experiments were programmed and generated using the software Unity Technologies, www.unity3d.com. The virtual environment was displayed at a 75 Hz frame rate. Specific setup of the virtual environment and avatars used will be described in specific methods for each experiment.

2.1.2 Equipment

2.1.2.1 Head-Mounted Display for experiment I

In the first experiment (*The impact of first person perspective on Body Perception*), we used the nVision SX111 head-mounted-display (HMD) made by NVIS (Figure 1). It displays a 3D scene in stereo with a horizontal field of view of 102 degrees and vertical field of view of 64 degrees by sending left-eye and right-eye images to left and right screens. Its weight is 1.3Kg. An Intersense Tracker mounted on the top of it, tracks the head movements of the participant with 6 degrees of freedom, and updates the images displayed accordingly, allowing participants to experience visuo-motor correlation between their head movements and the displayed virtual environment. From the point of view of the participant, it is equivalent to using their head gaze normally to look around a scene.

Figure 1: nVis Head-Mounted Display

2.1.2.2 Head Mounted display for experiment II and III

The equipment used in experiment II (*Changing perspective in a verbal harassment scene*) and experiment III (*Changing perspective on a personal problem through self-conversation*) is a Vive head-mounted-display (HMD) made by HTC (Figure 2). It displays a 3D scene in stereo with a field of view of 110 degrees. The device uses two screens, one per eye, each of them having a display resolution of 1080x1200. Its weight is 555g. Adjustable straps as well as foam inserts and nose pads provide participants with support and comfort while immersed in virtual reality.

Figure 2: The HTC Head-Mounted Display and the two associated light houses

The device uses more than 70 sensors including a MEMS gyroscope, accelerometer and laser position sensors. It operates in a 4.6 by 4.6 meters tracking space if used with both "Lighthouse" base stations that track the user's head and hands movement with sub-millimetre precision. The Lighthouse system uses simple photosensors on any object that needs to be captured; to avoid occlusion problems this is combined with two lighthouse stations that sweep structured light lasers within a space. Using this tracking data, we

reconstruct hand and arm movements of the participants and apply it to their virtual body. Participants can therefore experience visuo-motor synchronisation between their real movements and the movements of their virtual body.

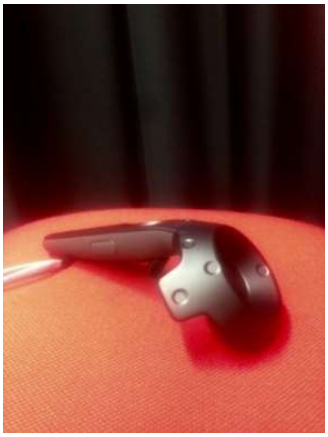


Figure 3: Hand controller of the HTC VIVE, in experiment II and III participants were holding one controller in each hand in order to track their upper body movements and map them to their virtual body in real time

2.1.2.3 Optitrack motion capture system

The Optitrack motion capture system was used in experiment I and experiment II. It is designed to support real-time whole body tracking of a participant (http://www.optitrack.com). It includes a Velcro suit with 28 retroreflective markers (Figure 4), which are tracked by 12 infrared cameras. It also includes small sets of 3 markers used to track the hand position of the participants.

Figure 4: A participant wearing the Optitrack body suit and the HTV VIVE Head Mounted display

2.1.2.4 Sound equipment

In experiment II and experiment III, wireless headphones were used in order to allow participants to listen to the instructions and to the dialogue of the avatars inside the virtual environments. In both experiments, participants were wearing stereo headphones Sound Blaster Tactic3D Rage USB V2.0 with 50mm full spectrum drivers and SBX Pro Studio technologies.

2.1.2.5 Tactile feedback

The tactile feedback (used in experiment I) was provided using an Arduino board (Figure 5) that controlled four small vibrator devices (Figure 5). Four vibrators were placed on the participant, one on each leg in the middle point between the knee and the foot, and one on each hand. The Arduino board operates via Zigbee. These vibrators were used to give visuo-tactile feedback to the participants when the virtual objects entered in contact with their virtual arm or virtual legs (see experimental procedure in Section 2.2.2.1.2).

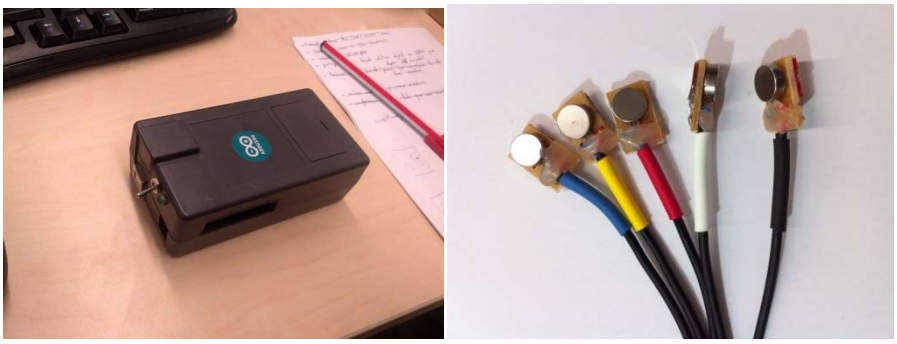


Figure 5: Arduino board (left) and vibrators (right)

2.1.3 **Ethics committee**

An ethics case for each of the three experiments was presented to the Ethical committee of the University of Barcelona (Comissió Bioètica de la Universitat de Barcelona), each ethics case was officially approved.

2.1.4 **Participants**

All our participants were contacted through the internal database of the EventLab. In order to be added to this internal data base, participants had to fill in a form including the normative of data protection relative the University of Barcelona (see form “future

studies" in Appendix A). A recruitment email was sent to the mailing list generated from this database, announcing the specificity for each experiment and the requirements for participating (see recruitment email in Appendix A). Eligible participants arranged a convenient time with the experimenter to come to the laboratory. Once they arrived at the laboratory, they were given a paper sheet including all the information about the experiment and had to sign it in order to be able to participate (see Appendix A). They also had to sign a consent form (see Appendix A) accepting the risks that can be related to the use of virtual reality. All this documentation was kept following the rules of high level protection stated by the data protection office from the University of Barcelona. All participants remained naïve to the research question during all the course of the experimental procedures and were informed that they would be able to ask questions about the aim of the investigation once the procedure would be over.

2.1.5 **Follow up**

One month after the end of the experimental procedure all our participants were contacted by email (having given their consent for this in the consent form). The follow up email was measuring possible negative effects of the virtual reality experience participants have had during the experiment they were part of. We received feedback from the participants for all the three studies reported here and none of them reported any negative effect about the experience they had (see follow up email in Appendix A)

2.1.6 **Questation**

We used an internal online platform called "Questation" in experiment II and experiment III. Questation is a web-based application developed in-house as a means for hosting and delivering the questionnaires to our participants. It collects and export responses in Microsoft Excel spreadsheets. The application has been developed in PHP and Javascript with a MySQL database. It is hosted locally and is accessible only within the laboratory, with data for each researcher protected with a username and password. Questation allows creation and sharing of questionnaires among researchers, in addition to having certain standard templates such as a demographics questionnaire (see Figure 1). In addition, it includes features such as randomising the order of the questions displayed and switching the interface language to Spanish or Catalan.

Figure 6: Appearance of the demographics questionnaire on the Questation platform

2.1.7 **Data analysis**

All statistical analyses were conducted using the software STATA MP 15.1 (https://www.stata.com). Qualitative data analysis for experiment II and III, were conducted using the software Nvivo 12 pro (https://www.qsrinternational.com/nvivo). We imported the answers from the qualitative questionnaires and the transcripts of interviews inside the software. We then ran a word frequency analysis and defined categories based on the results obtained. In order to create the word clouds, we selected words that were repeated at least two times (across conditions but not by the same participant) within the corresponding questionnaire. Word clouds were generated according to the frequency reported in the corresponding tables in the Results Chapter (see Sections: 3.2.6 and 3.3.5). We created categories of answers according to the methodology of the Nodes allowed by the Nvivo software. Graphs representing the Nodes identified in the interview transcripts of experiment III were generated with the "graph function" of Nvivo (see Figure 52 and Figure 53).

2.2 SPECIFIC METHODS EXPERIMENT I: THE IMPACT OF FIRST PERSON PERSPECTIVE ON BODY PERCEPTION

As described in the introduction (Section 1.3.3.1), body representation is highly inaccurate in humans. In this first experiment we wanted to re-create avatars showing the inaccuracy of the internal model people might have of their own body. We also wanted to test whether the evaluation of a virtual body representing the self would vary depending on the perspective from which it was perceived. In order to show how inaccurate body representation can be, we developed a method enabling us to measure participants' representations of their own body (body image) and to re-create an avatar corresponding to these measures. In addition to that, we asked participants to give us an estimation of their ideal body shape and we re-created another avatar corresponding to their ideal body. In order to create a possible comparison between those bodies generated from subjective representation, we also measured the real body shape of the participant and generated a third avatar corresponding to their real body appearance. The avatar based on the real body measures obtained through the optitrack device (see Figure 4) was called the Real Body (RB), the second avatar based on the estimations participants gave of their subjective body representation, was called Body Image (BI) and the third avatar based on the estimations participants gave of their ideal body shape, was called Ideal Body (IB). In the second session, participants were seeing those avatars without knowing which one corresponded to which. We asked the participants to evaluate the appearance of the three virtual bodies. There were two conditions for this subjective evaluation: one in first person perspective (in which the participants were embodied in the virtual body), the other in third person perspective. We expected that prior beliefs about the self would negatively affect the way participants perceive and evaluate their avatars in first person perspective.

2.2.1 **Participants**

We recruited 11 males and 12 females from the Psychology campus of the University of Barcelona. Participants were between 18 and 38 years old, the mean age was 24.79 (±5.64). We had to exclude one male and three females because their scores were above the threshold on the clinical questionnaires. Participants had to fill in BSQ-34 and EDI-2 before the first session of the experiment and after having completed the second session.

All participants had normal or corrected-to-normal vision and were screened for contra-indications for VR (e.g., epilepsy, recent alcohol intake, psychoactive drugs treatment). The total compensation was ten euros. The study was approved by the Comissió Bioètica of Universitat de Barcelona. Participants were asked to come twice to the Virtual Reality laboratory. They received the general information about the experimental procedure and signed the informed consent. They were told that the aim of the experiment would be explained after the end of the second experimental session and remained naïve about the goal of the experiment until the end of the procedure. No side effects of the virtual reality were reported.

2.2.2 **Experimental Procedure:**

The experiment was split in two sessions separated by one week of time.

2.2.2.1 Session 1

Participants arrived at the laboratory and read the information corresponding to the first phase of the experiment (see "information sheet" in Appendix B). After signing the corresponding consent form (see Appendix A) they first filled in a demographic questionnaire (see Appendix A), and then filled in two clinical questionnaires in order to exclude participants with pathological tendency to eating disorders (EDI-2 and BSQ, a detailed description of those two questionnaire appears in Section 2.2.3).

2.2.2.1.1 Object estimation task

After filling in the questionnaires and before putting on the HMD (Nvis Head mounted display described in Section 2.1.2.1), the participants were asked to inspect a chair from the laboratory. We instructed them not to pay attention to anything else but its proportions from a certain distance (we didn't want them to remember the chair proportions in relation to their body). Once in the virtual environment, the participant had to estimate the width of the seat of the chair and the height of its back using what we will refer as the "virtual cylinder technique". A virtual cylinder appeared in between the participant's hands inside the virtual environment. It was generated based on the hands position tracked inside the virtual environment by a set of three retro-reflective markers from the Optitrack body tracking system (described in Section 2.1.2.3). Participants had to modulate the cylinder

length by bringing their hands together or moving them away (like if they were holding the cylinder between their hands). Once the participant thought that the cylinder length corresponded to the measure they were asked to estimate, they indicated it verbally to the experimenter. If the distance estimated was correct the cylinder was turning green, if the distance estimated was wrong the cylinder was turning red (5cm error considered).

2.2.2.1.2 Virtual Reality scenario

The virtual scene consisted in the reproduction of the real virtual reality laboratory (shown in Figure 7). We decided to use this scenario in order to give a spatial reference to the participants and make the size estimation task easier to perform.

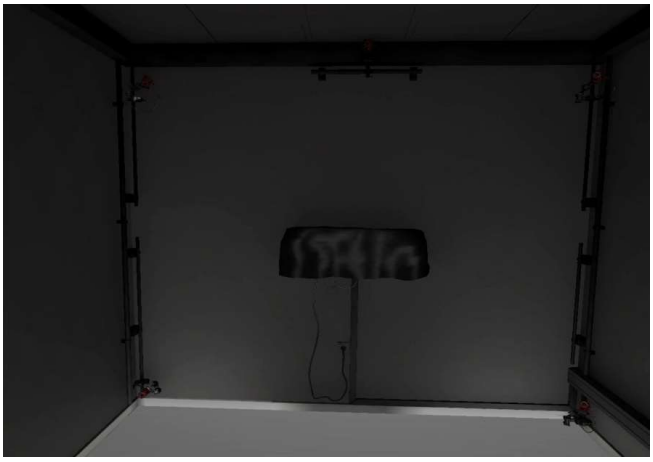


Figure 7: Model of the VR laboratory used in experiment I

2.2.2.1.3 Training phase

Before starting the actual experiment, we ran pilots and found out that participants had difficulties with estimating the body part we referred to. Therefore, we included a training task in which the participants were asked to estimate the size of a gender matched avatar standing in front of them in the virtual environment. For each part of the body that had to be estimated, participants were able to navigate inside the virtual environment in order to inspect the avatar closely, and had as much time as they wanted. Once participants considered they had memorized the size of the body part they were asked to estimate, they would indicate it to the experimenter and the avatar in front of them disappeared. When the estimated size was wrong, the gender matched avatar was shown again and participants were doing the estimation task again. A schematic picture of the body measure was shown on the virtual wall in front of them (see Figure 8: On the left, the

cylinder used in the body shape estimation tasks. On the right, the body structure constructed by the participant and the schematic picture on the wall (the part that needed to be estimated was highlighted in red on the schematic picture, here “chest width”)). The training phase was over when the participants managed to estimate accurately all the body parts of the gender matched avatar.

The set of body parts estimated depended on the gender of the participant. Indeed, we noticed during the pilot phase of the study that males and females do not focus on the same parts of their body to create a mental representation of their body shape. The size of the biceps was more critical in males and women gave more attention to the width of their waist. The final set of measures required by gender was the following:

- Male measures: hips width, hips depth, abdominal width, chest width, chest depth, thigh width, biceps width, neck width, distance between shoulders
- Female measures: hips width, hips depth, waist width, waist depth, chest width, chest depth, thigh width, neck width, distance between shoulders

2.2.2.1.4 Body shape estimation

After this training phase, the same task of “Body shape estimation” was performed using the same virtual cylinder technique. This time participants had to estimate their own body shape. During that phase there was no feedback about the accuracy of the measures given. The set of body measures were the same as the ones provided during the training phase. Participants were able to see all the tubes collocated in space and were able to visualize the whole “body structure” they were constructing. This method was inspired from the paper by Myers and Biocca (Myers & Biocca, 1992) in which three projected bands of light represent the size of the chest, waist and hips of the participant.

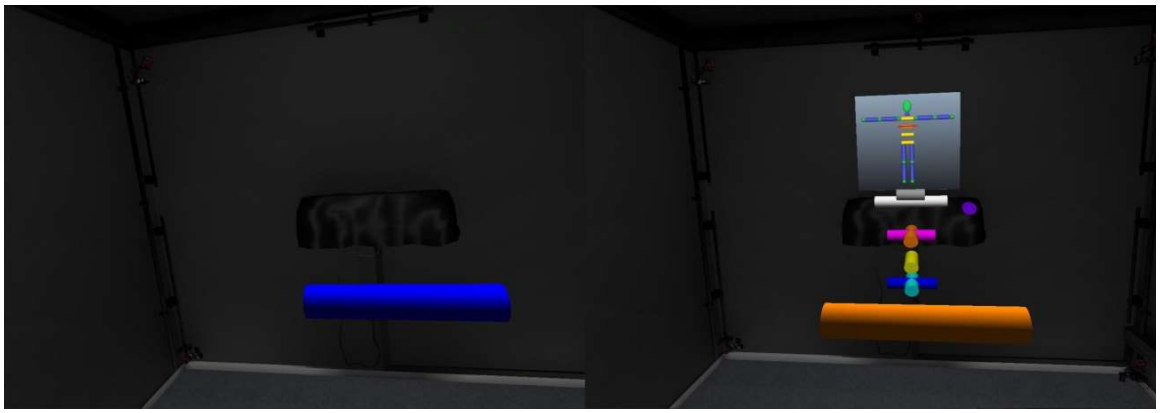


Figure 8: On the left, the cylinder used in the body shape estimation tasks. On the right, the body structure constructed by the participant and the schematic picture on the wall (the part that needed to be estimated was highlighted in red on the schematic picture, here "chest width")

Participants could correct the size of each cylinder as many times as they wanted until the body structure they constructed appeared correct to them. As they were some measures of depth, they were also able to navigate in the virtual environment seeing the body structure in 3D. After estimating their real body measures, the participants were asked to construct their ideal body structure using the same method, we instructed them to imagine "the body they would like to have ideally" (height was not modifiable). The data gathered after this second part was used to generate two avatars per participant: one representing their Body Image (BI) and the other representing Ideal Body (IB). At the end of this first session, participants were asked to put on the Optitrack suit (see Section 2.1.2.3, Figure 4) and we placed 32 markers on their body. The positional data extracted from those markers was used to generate an avatar representing their Real Body (RB). The RB avatars were generated using the 3D animation software Autodesk Maya 2012 (https://www.autodesk.com/products/maya).

2.2.2.2 Session 2

During the second session (one week later), participants were able to see the virtual representation of their three Avatars (inside the virtual environment) from two different perspectives: first person perspective (1PP), as shown in Figure 9, and third person perspective (3PP), as shown in Figure 10.

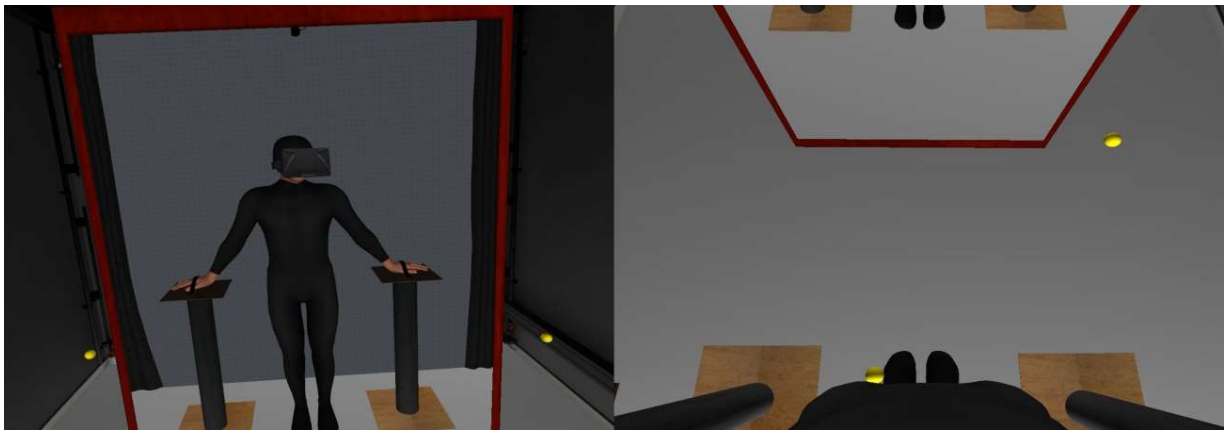


Figure 9: Front view of the avatar reflected in the mirror (1PP) and yellow balls moving towards the legs to create visuo-tactile feedback (left). View of the virtual body when the participant looks down (right)

In total, participants saw six virtual bodies that they had to evaluate. The avatars were presented randomly alternating between first person perspective and third person perspective. In the 1PP condition, we wanted to induce body ownership over the virtual body. We used visuo-motor correlation and synchronized head movements between the participant and the avatar. There was a virtual mirror in front of the participants in which they could see themselves moving their head. Participant's hands were placed on two modules covered with a rough brown material. Their real body posture corresponded to the posture of the virtual body (co-located body) and the two modules were reproduced in the virtual environment (haptic feedback). Participants could see their virtual hands and legs by moving their head down. We gave a special attention in reproducing exactly the appearance of the rough brown texture covering the two modules to enhance the illusion of body ownership towards the virtual hands through visuo-tactile feedback. In addition, four small yellow balls were going back and forth in the virtual environment touching the participants' hands and legs in a continuous movement (see Figure 9). The vibrators, described in Section 2.1.2.5, were activated synchronously when the balls were touching participant's virtual body.

In the third person perspective case, we did not want to create any kind of embodiment towards the virtual body: head movements of the avatar were independent from participant's head movements, the avatar had a different posture and was performing a pre-recorded animation so there was no motor correspondence between the participant's movements and the avatar's movements. The camera was located outside the body and participants had no visual feedback of their body when they looked down, there was not

any kind of tactile feedback. We wanted the participants to perceive the virtual body as if it was the body of someone else.

Figure 10: Avatar seen in third person perspective, from the point of view of the participant

The subjective evaluation of the avatars was based on a verbal questionnaire in which participants had to judge several aspects of the appearance of each avatar while they were seeing it, inside VR. The order of the questions was randomized for each "evaluation", but the BO questions were always first, as we did not want the participant to confuse them with those relative to the physical appearance of the avatar. This way, the two blocks of questions were more clearly differentiated. The participants rated their answers on a seven-point Likert scale where 1 meant "not at all" and 7 meant "very much". All avatars were dressed in a black body suit (similar to the Optitrack body suit the participants were wearing) and a virtual model of the Oculus rift (similar to the nVis HMD in appearance), and were consistent with the participant's gender. At the end of the second session, the three avatars corresponding to the BI, IB and RB of each participant were presented simultaneously in 3PP. Participants were asked to guess "which of those was their real body", and to choose "which of those bodies they would like to have".

Afterwards, we provided each participant with a personalized feedback, telling them which avatar corresponded to their real body, ideal body, body image. We wanted the participants to perceive their real body shape from a new perspective. Right after this, participants fulfilled again the EDI-2 questionnaire in order to measure if this experience would have an immediate effect on self-evaluation (results are reported in Section 3.1).

2.2.3 Clinical questionnaires

Participants filled in two psychological tests evaluating Body satisfaction and Eating Disorders symptomatology (BSQ-34 and EDI-2); high scores to one of these questionnaires, showing a pathological tendency to Eating Disorders, was an exclusion criterion. We isolated the results of two subscales of the EDI-2 that were the most relevant for the purpose of our study: Drive for thinness (DT) and Body dissatisfaction (BD). The results of both questionnaires are reported in Section 3.1.3.

2.2.3.1 EDI-2: Eating disorders inventory

The EDI-2 is a self-report questionnaire composed of 91 items rated from 0 to 5 (0: Never, 5: Always). It has been developed in order to evaluate the symptoms associated to eating disorders. It includes 11 subscales: Drive for Thinness, Bulimia, Body Dissatisfaction, Ineffectiveness, Perfectionism, Interpersonal Distrust, Interoceptive Awareness, Maturity fears, Ascetism, Impulse Regulation, Social Insecurity (Garner, Olmstead, & Polivy, 1983). It has been adapted to Spanish and has shown good internal validity (García-García, Vázquez-Velázquez, López-Alvarenga, & Arcila-Martínez, 2003). Here we used the Spanish version.

2.2.3.2 BSQ-34: Body Shape Questionnaire

The BSQ-34 is a self-report questionnaire of 34 items measuring how the individual has been feeling about their body appearance over the past four weeks. It was developed and validated in clinical and non-clinical populations (P. J. Cooper, Cooper, Cooper, & Fairburn, 1987). All the items are rated on a Likert scale ranging from 1 to 6 (1: Never, 6: Always). In this experiment we used the adapted Spanish version (Raich et al., 1996).

2.3 Specific methods experiment II: Changing perspective in a verbal harassment scene

As we explained in the introduction (Section 1.3.3.2), belonging to a group can affect one's behaviour towards an individual from another group. In this second experiment we wanted to test to what extent behaviour and decision making would be affected by in-

group affiliation to virtual avatars in a violent social scenario. The participants were first exposed to a verbal harassment scene: a group of male avatars entered in verbal conflict with a female avatar on a virtual terrace. Participants first saw the scene from inside the group of males and then saw a replay of the scene from another perspective. In one condition, participants saw the replay of the harassment scene embodied in the female who was the victim of the verbal harassment (woman condition). In the other condition, participants experienced the replay of the harassment scene from the perspective of another member of the group of males (in-group condition). Only the participants in the "out-group condition" experienced the scene of the verbal harassment from the perspective of the victim, as we wanted to measure if this experience would affect their prosocial behaviour when confronted to a similar scene one week later. In the second session, we reproduced the Milgram obedience experiment (Milgram, 1963) in virtual reality. A control group was added to get a baseline of average behaviour in the Milgram scenario (this group was not exposed to the verbal harassment scene in the first session).

2.3.1 **Participants**

We recruited 62 males from inside and outside the Psychology campus of the University of Barcelona. Participants were between 18 and 35 years old, with a mean age of 24.58 (± 4.42). We had to exclude two of them because they could not attend the second session. The 60 participants were assigned to three different groups of 20 corresponding to the three different conditions. The assignation of the participants to the different conditions was randomized. In total we had 20 participants in the control group, 20 in the in-group condition, and 20 in the out-group condition (later referred as "Woman" condition). All participants had normal or corrected-to-normal vision and were screened for contra-indications for VR (e.g., epilepsy, recent alcohol intake, psychoactive drugs treatment). The total compensation was 25 euros. The study was approved by the Comissió Bioètica of Universitat de Barcelona. Participants remained naïve about the aim of the experiment until the end of the procedure. No side effects of the virtual reality were reported.

2.3.2 **Experimental procedure**

2.3.2.1 Session 1

The first session lasted 80 minutes. In the first iteration of the scene with the other avatars, participants were instructed to interact and intervene freely. Participants could see their life-sized virtual body when looking down towards themselves, and also in a reflection on a window of the virtual terrace (Figure 11). Participants were wearing the HTC vive and the full body Optitrack Motion Capture suit (Section 2.1.2.2 and 2.1.2.3). Their movements were tracked and recorded using the Optitrack Motion Capture system. Their head and upper body movements were mapped to the movements of their virtual body through real-time motion capture (participants' movements and verbal interventions were recorded and replayed in the second iteration of this scene). Participants were hearing the dialogue of the avatars and their own verbal intervention when replayed through wireless headphones (see Section 2.1.2.4)

The verbal harassment scene went as follows: a group of male avatars were sitting around a table in an open-air terrace (Figure 11) and the participant was seated amongst them. One of the males asked for the participant's name in order to establish an interactive social bond with him. After the participant introduced himself to the group, the avatars entered in a daily life conversation and then started to complain about women. At some point of the conversation, one of the male avatars invited the female avatar sitting on the other side of the terrace to join them. The female avatar refused but the male avatar kept insisting, becoming verbally aggressive. At the end of the scene, one of the male avatars stood up and walked aggressively towards the woman saying that he will "bring her" to the group (see full script of the dialogue in Appendix C). After the first iteration of the scene, participants were asked to answer verbally to the presence and body ownership questionnaire (using a scale displayed on a monitor: Figure 12) relatively to the experience they just had (phase 1).

Figure 11: The terrace Scenario, during the first iteration of the verbal harassment scene, the participant was embodied in the red shirt character with raised hands. In the second iteration, he was embodied in the woman (woman condition) or in the grey shirt male avatar (in-group condition).

Then the scene started again, and participants saw it from a different perspective (phase 2), whether from the perspective of the woman sitting on the other side of the terrace (woman condition) or from the perspective of another male avatar sitting with the group (in-group condition). During this second exposure to the scene, all the skeleton poses of the avatar recorded during the first phase were replayed, participants could therefore see and hear their previous avatar doing what they did during the first phase (but from a different perspective).

The participants in the control group did not see the verbal harassment scene, they entered the same Virtual Environment, but no avatars were present in the scene. They were exposed for 150 seconds (baseline) to the virtual terrace. For the participants in the in-group and woman conditions, there was also this baseline of mere exposure to the virtual environment for 150 seconds and then the scene started.

After each exposure to the verbal harassment scene participants had to answer verbally to the embodiment questionnaire (see Appendix C). Participants heard verbal instructions from the experimenter and saw a visual scale (-3 totally disagree, 3 totally agree) on a monitor (Figure 12). After the second phase, participants had to answer the presence questionnaire (see Appendix C) including questions about how they felt inside the Virtual Environment. Results are reported in Section 3.2.5 and 3.2.6.

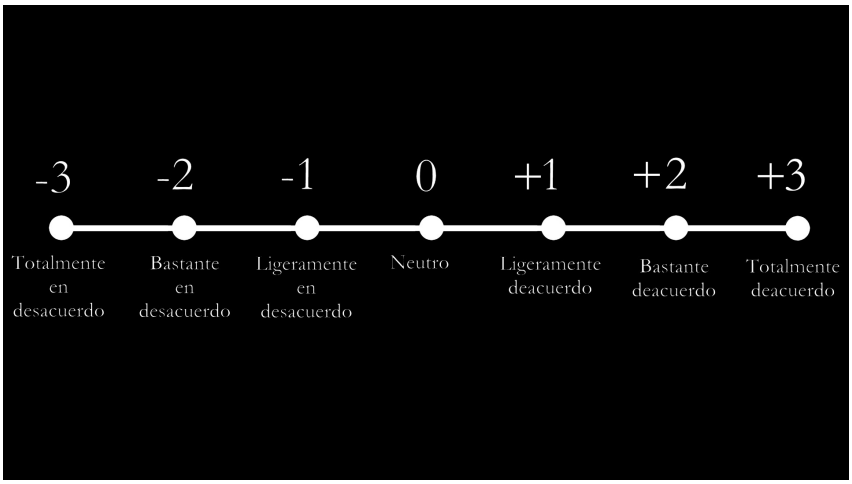


Figure 12: Scale used for rating the body ownership, presence, co-presence levels after the first and second phase of the terrace scenario (verbal harassment scene)

2.3.2.2 Session 2

One week after the first session, all participants experienced another scenario of aggression from a group of males against an isolated female avatar. As stated before, this second scenario was a virtual adaptation of the Milgram obedience experiment (Milgram, 1963). All the participants (independently of the condition to which they were assigned in the first session) were told they will be the teacher of a virtual "learner" who had been instructed to remember some word associations. When entering the virtual environment, participants were sitting at a table with three virtual experimenters (the same avatars as in the first session, wearing a white coat). A female avatar was sitting on the other side of the room (Figure 13). The virtual experimenters were treating the participants as "part of their team". This way we wanted to enhance the sense of belonging to the experimenter's group for all our participants. Two of the virtual experimenters instructed the participants to send electroshocks to the virtual learner (female avatar) when she would make a mistake in recalling the word associations (see script in Appendix C).

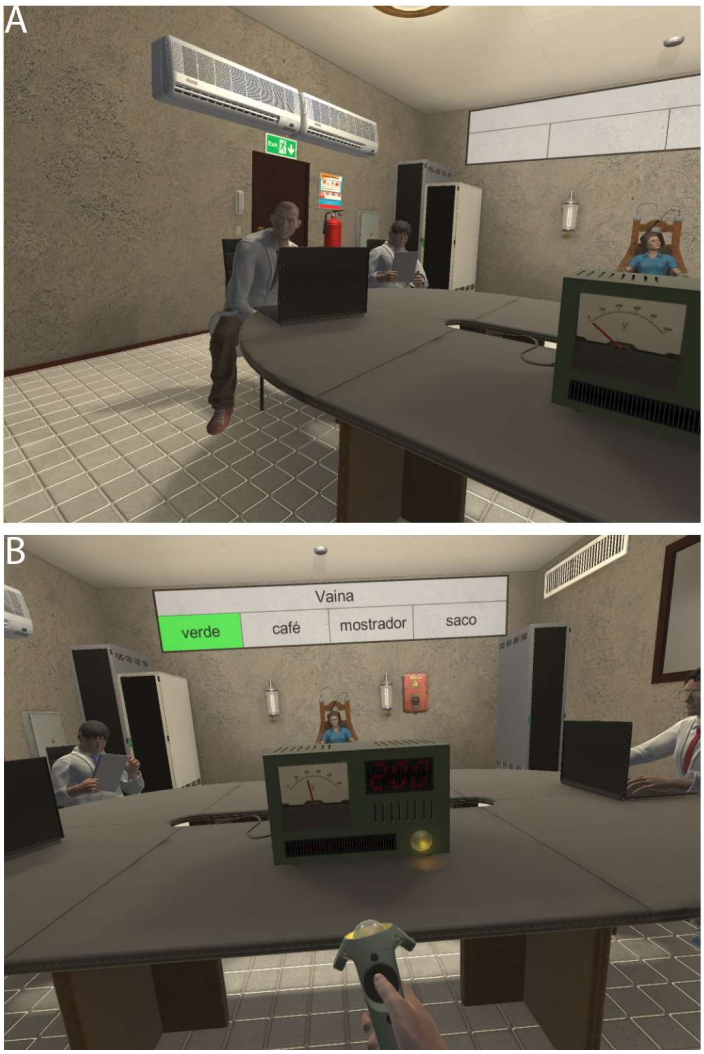


Figure 13 - The Milgram Obedience Scenario - (A) Two virtual experimenter sitting on both sides of the table gave the participant instructions for the experiment. The "Learner" (woman) was sitting on the other side of the room. (B) The participant was instructed to increase the shock level by pushing the button on the virtual controller. The electrical level was shown on the machine and the shocks were represented as a blue electrical lightening above the head of the learner.

All the participants were given the same instructions and their behaviour was measured in terms of the number of shocks they gave to the female victim. As the number of incorrect responses increased, so did the voltage of the shocks. The virtual experimenters were insisting on the fact that it was very important to finish the procedure. If the participant was hesitant to give a shock, the two virtual experimenters encouraged him to continue. There was a safety signal allowing the participant to stop the procedure before reaching the maximum level of electroshocks, by calling out loud the name of the experimenter who was running the study. After a certain point (around shock number 9), the virtual learner started to complain about the pain caused by the shocks and vociferously asked to be let out of the experiment. There was a total of 20 incorrect

answers and if the participant administered a shock for each of them, the voltage reached a lethal level (following the design of the original Stanley Milgram experiment). After the end of the experiment (after fulfilling all the post-experiment questionnaires), participants were immersed one more time in the virtual environment and were seeing the female avatar saying that she was safe. This was aimed to lighten the feeling of guiltiness participants could undergo after such an experience.

An interactive command was designed specifically for this experiment, it allowed the experimenter to control the interventions from the avatars and therefore adapt to the behaviour of each participant in real time, making the virtual experimenters answer to his comments or questions about the procedure and making the female avatar answer to the questions and react to the electroshocks in real time. The experimenter had an external independent program running in another computer enabling to trigger different pre-programmed answers or interventions of the avatars, the communication with the VR program was done using UDP messages through the local network. When coming out of the virtual reality participants fulfilled the presence questionnaire on a monitor (see Appendix C). After that, they answered a semi-structured interview that was recorded.

2.4 SPECIFIC METHODS EXPERIMENT III: CHANGING PERSPECTIVE ON A PERSONAL PROBLEM THROUGH SELF-CONVERSATION

As we saw in the introduction (Section 1.3.3.3), inner speech is highly based on verbal interaction with others. With this third experiment, we show that creating a virtual situation in which inner speech can be expressed “outside” oneself, reduce negative automatic thoughts related to the self. Two groups of participants went through a procedure of three different sessions (detailed bellow) in which they had to define a personal problem.

2.4.1 **Participants**

2.4.1.1 Inclusion criteria

All participants had to discuss a personal problem causing them mild level distress. These problems could include personal dilemmas, family conflicts, procrastination, distressing feelings and similar difficulties. The problem had to be approachable in one session, therefore it had to:

- Be defined in psychological terms (neither economic, physical, etc.; e.g. "I want to move to my own place, but I don't want to worry my parents") [avoid problems such as: "I'd like to have enough money to move to my own place"].
- Be specific (not too broad or vague; e.g. "I find it really difficult to start a conversation with any of my classmates, they must think that I'm weird") [avoid problems such as: "I feel bad about my social relationships"].
- Be deemed relevant by the person to be changed (the person is unsatisfied with the current situation; e.g. "I'll have to do several presentations this year but I have a lot of trouble talking to a wide audience") [avoid problems such as: "I have difficulties talking to large groups, thank God I don't really need to do it in my daily work"].
- Depend on the person to be solved (not totally determined by external factors; e.g. "I'd like to be more flexible when my friends change plans in the last minute") [avoid problems such as: "I'd like my friends to never reconsider plans when they've already been scheduled"].
- Cause distress (disturbs person's everyday life, mild to moderate; e.g. "I feel annoyed when I lose focus while attending class, I'd like to not lose track") [avoid problems such as: "I often lose focus when I'm in class, so I read the slides again at home"].
- Have likely realistic solutions (avoiding problems for which the person expects magic or radical changes; e.g. "I don't like to be that shy, I wish I was a bit more sociable, so I could make some new friends") [avoid problems such as: "I know I'm shy but I want to become the most outgoing person in the world and have lots of friends"].

2.4.1.2 Exclusion criteria

We discarded participants with severe problems or with non-suitable problems. Potential participants were excluded if they were currently under psychological treatment, had been lately diagnosed with any mental disorder including post-traumatic stress disorder, suffered of drugs or alcohol abuse, had psychotic symptoms or current suicidal ideation, had mental retardation, presented substantial visual or hearing deficit, presented cognitive or organic brain dysfunction, suffered seizure disorders or epilepsy, did not have enough level of competence to communicate in Spanish or Catalan.

2.4.1.3 Sample

We recruited 69 participants, males and females from inside and outside the Psychology campus of the University of Barcelona. We had to exclude 11 of them because of psychological issues detected during the screening session or logistical problems in attending the second or the third session. The final sample comprised a total of 58 participants, 29 in the experimental condition (15 females and 14 males) and 29 in the control condition (15 females and 14 males). The assignation of the participants to the different conditions was randomized. All participants had normal or corrected-to-normal vision and were screened for contra-indications for VR (e.g., epilepsy, recent alcohol intake, psychoactive drugs treatment). The total compensation was 30 euros. The study was approved by the Comissió Bioètica of Universitat de Barcelona. All participants remained naïve about the aim of the experiment until the end of the procedure. No side effects of the virtual reality were reported.

2.4.2 **Experimental procedure**

Participants were asked to describe a personal problem causing mid-level distress in their daily life. In the first session they defined the problem in one sentence with the help of a psychologist. In the second session they had the opportunity to discuss their problem with an avatar of Dr Sigmund Freud. The third session included a mid-term evaluation of the process. Participants rated to what extent the VR session helped them in solving their problem. Participants were randomly assigned to two different groups (gender balanced). In the experimental group participants entered in a dialogue with themselves embodied as Freud during the VR session, they switched back and forth between their own virtual

body (scanned avatar: see Section 2.4.2.1) and the virtual body of Sigmund Freud, establishing a "self-conversation" about their personal problem. In the control condition, the VR session was a conversation between the participant and the avatar of Freud (giving general counselling about the problem). The control condition did not involve any change in perspective or "self-conversation". The purpose of this control condition was to address the importance of the perspective taking and "self-conversation" in helping the participants with solving their personal problem. In both conditions, the participant's head and upper body were tracked by the HTC VIVE tracking system (see Section 2.1.2.2) and the movements mapped to their virtual representation in real time using Inverse Kinematics methods. Participants attended three different sessions separated by one week of time between each session. One week after the initial meeting, participants came back to the laboratory for the VR session. One week after this VR session, participants came back again to the laboratory for the follow up session measuring the long-term effect of the VR intervention. A detailed description follows here.

2.4.2.1 Session 1: Initial meeting and body scanning

In the first meeting participants received the information about the experimental procedure (see Appendix D) and signed the attached consent form (see Appendix A). They were informed that they had to think about a personal problem causing mid-level stress in their daily life. After that, they were asked to enter the laboratory and to stand in between two supports in order to be scanned.

The body scanning technique, developed and used in Osimo et al. (2015), was applied for this experiment. This system creates virtual bodies based on a 3D scan of the participant's whole body using an IPAD AIR with an Occipital Structure Sensor. SSL encryption is used while uploading data from the iPad to the cloud and encrypt all model-related data with industry-standard algorithms before storing it to S3 with unique key for each model.

This method allows to re-create a scanned avatar with high-quality resemblance to the person's real body (Figure 14). The scanned avatar is registered with a virtual skeleton for body animation. Participants could see their virtual representation (scanned avatar) when looking down at their virtual body, and in a virtual mirror displayed in the virtual environment on their left side (Figure 16). Participants recognized themselves based on

different features of their virtual body (including clothes, hair, face, etc.). In addition, their voice was mapped to facial expressions for lip syncing.

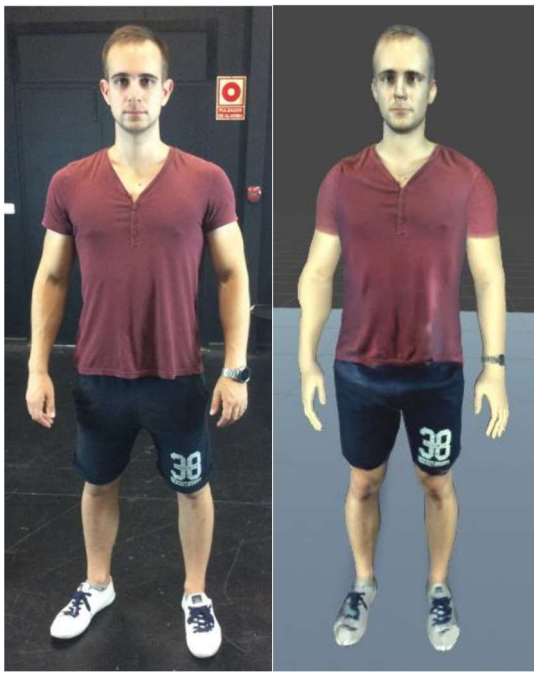


Figure 14: On the right a photo of the participant, on the left, the virtual avatar of the participant obtained with the technique of the body scanning (scanned avatar).

Once the scanning process was finished, participants were screened for psychosis with a psychologist giving them the CIDI psychosis module (see full description in Section 2.4.3.1). After that, they were asked to fill in the following questionnaires on a computer monitor: DASS-21 (baseline), CORE, STAI-State, ATQ-8 (see full description of the questionnaires in Section 2.4.3). After filling in the questionnaires, participants sat with the psychologist who helped them define their problem in one sentence in which they were the actor. The problem definition was done through a verbal semi-structured interview. The sentence had to follow the following structure: "When… I feel …. I think….. I act/ react/ do …. and I would like to …." (see Appendix D).

2.4.2.2 Session 2: Virtual Reality scene

One week after the initial meeting, participants came back to the laboratory, they received the information relative to the second session and signed the attached consent form. Prior to entering the VR scenario participants filled in the following questionnaires on the computer monitor: CORE, STAI-State, Changes questionnaire (based on Elliott, Slatick,

& Urman 2001). Just before entering the VR, participants were asked to copy the sentence they wrote in the first session with the psychologist in order to have it in mind during the VR session. After that, participants were asked to sit on a chair situated in between the two HTC light houses, inside the tracking area. They were told that they will enter a virtual room, that they will be sitting in front of Sigmund Freud and that they will have the opportunity to discuss their problem with him. The experimenter reminded them the structure of the sentence they should use to define their problem inside the virtual room and made sure they had the sentence in mind. The experimenter showed them the controller and told them to press the central button each time they finished speaking. For the participant in the self-conversation condition, the experimenter added that when pushing the button, they would enter the body of Sigmund Freud. Once in the other body they were instructed to listen carefully to the person sitting in front and then answer to them trying to help them find a solution to the problem: giving advices or asking some questions. The HMD was placed on the participant's head, the controllers in their hands and the headphones on their ears. Participants first received embodiment instructions through the headphones and then started the dialogue with the avatar of Freud. Participants were sitting on a chair at a wooden table inside a virtual consulting room. The avatar of Sigmund Freud was sitting in front of them (Figure 15).

Figure 15: The virtual consulting room, with the scanned avatar of the participant sitting in front of the avatar of Sigmund Freud. On the left side, a virtual mirror in which participants can see the reflection of their virtual body.

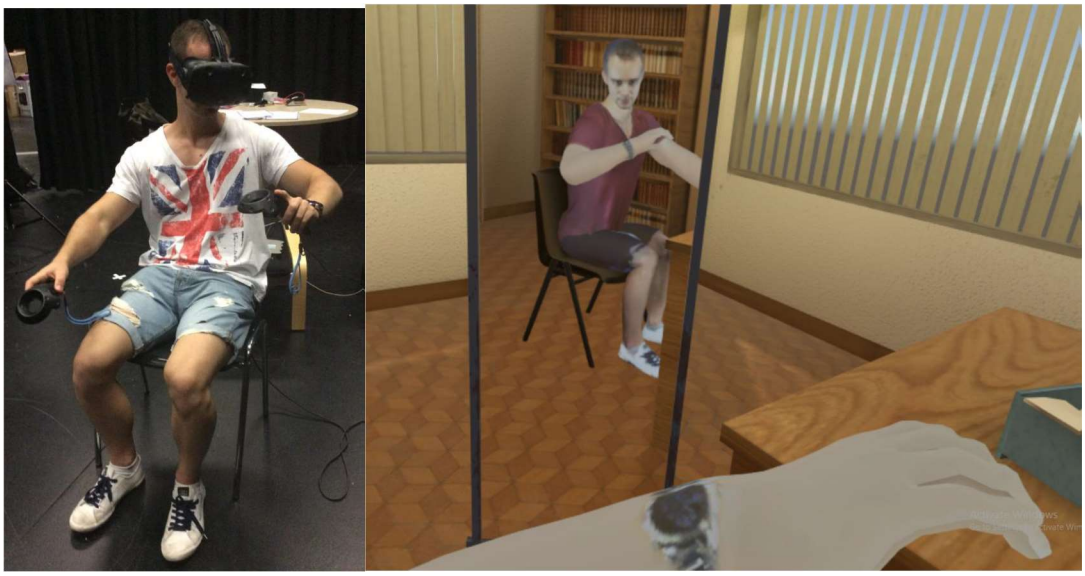


Figure 16: A participant with the tracking system on the left and its virtual body in the virtual reality scenario on the right.

Right after the end of the VR session, the HMD and the controllers were removed by the experimenter and participants were asked to fill in again some questionnaires on the computer monitor (in order to measure the short-term effect of the VR session): STAI-State, Changes questionnaire, ATQ-8, body ownership and presence questionnaires (see Appendix D), problem evaluation form (see Appendix D).

2.4.2.3 Session 3: Follow up session

One week after the VR session participants came back to the laboratory, they received the information relative to the third session and signed the attached consent form. After signing, participants were invited to enter the laboratory and to fill in the following questionnaire on the computer monitor: ATQ-8, STAI-State, CORE (long term effect), DASS-21 (long term effect), changes questionnaire (long term), problem evaluation form (long term). After filling the questionnaires, participants were asked to sit in front of the experimenters and went through a semi-structured interview about the general feeling they got from the experimental procedure they had been through during the past 3 weeks and about the evolution of their problem if they had noticed one. The audio of this interview was recorded, and the content was analysed using qualitative categorisation (see results in Section 3.3.6).

2.4.3 **Clinical questionnaires**

2.4.3.1 CIDI

We used the Psychosis module of the World Health Organization's Composite International Diagnostic Interview (CIDI), in order to check for any psychotic symptoms. The CIDI is a comprehensive and fully standardized diagnostic interview designed for assessing mental disorders according to the definitions of the Diagnostic Criteria for Research of ICD-10 and DSM-III-R. (L. Cooper, Peters, & Andrews, 1998). In this case we used the Spanish adaptation of the psychosis module (Navarro-Mateu et al., 2013).

2.4.3.2 DASS-21: **Depression Anxiety Stress Scale**

The DASS-21 is a 21 items self-report questionnaire. It includes seven items measuring anxiety, seven items measuring stress, and seven items measuring depression using a 4-point Likert-scale (3: applied to me very much, or most of the time; 0: did not apply to me at all), the sentences describe emotional states experienced during the last week (Lovibond & Lovibond, 1995). We used the he Spanish version which was found to have good psychometric properties (Bados, Solanas, & Andres, 2005).

2.4.3.3 CORE-SFB: Clinical Outcomes in Routine Evaluation-Short Form

The short form of the clinical outcomes in routine evaluation (CORE-SFB) is an 18 items self-report questionnaire that assesses four areas of the participant's life: subjective well-being, symptoms or problems, life functioning, and risk. The original 34-item CORE-OM was developed to measure progress and outcome of psychotherapies, and was found to be a valid and reliable tool (Barkham et al., 2001). It was adapted by Feixas et al. (2012) in Spanish, and the CORE-SFB was derived from this adaptation. The Spanish version of the CORE-OM was found to have satisfactory psychometric properties (Trujillo et al., 2016).

2.4.3.4 STAI-state: State-trait anxiety inventory

The state-trait anxiety inventory consists of two separate scales that measure general, latent anxiety (trait scale) on the one hand, and anxiety felt at a particular moment (state

scale) on the other hand. Both scales are composed of 20 items, rated on a 4-point Likert-type scale (1 = not at all; 4 = very much so). The original version (Spielberger, Gorsuch, & Lushene, 1970) was adapted into Spanish by Bermúdez (1978a, 1978b) and commercialized by TEA editions (Spielberger, Gorsuch, & Lushene, 1982). It was found to have sustained satisfactory psychometric properties and to be sensitive to changes in environmental stimuli that cause stress (Guillén-Riquelme & Buela-Casal, 2011). In this study, we used only the state scale.

2.4.3.5 ATQ-8: Automatic thoughts questionnaire

The original version of the Automatic Thoughts Questionnaire (ATQ-30) (Hollon & Kendall, 1980) is constituted of a 30-item, each answer is rated on a 5-point Likert scale on which 5 corresponds to "all the time" and 1 corresponds to "not at all". The ATQ measures the frequency of negative automatic thoughts experienced during the past week. It has been found to have excellent internal and temporal consistency, as well as convergent and discriminant validity (Chioqueta & Stiles, 2004; Hollon & Kendall, 1980; Kazdin, 1990). This questionnaire is widely used and has been validated in different populations (Chioqueta & Stiles, 2004; Pan, Ye, & Ng, 2015). Netemeyer et al., (2002) derived shortened forms of the scale with a single underlying factor that maintains the construct content of the original four factors: the ATQ-8 was found to display strong psychometric properties with good internal consistency (coefficient alpha estimates ranged from .85 to .92 across samples) and reliability. The version used in this third experiment was the Spanish language version of the ATQ-8, validated by Ruiz, Suárez-Falcón, & Riaño-Hernández (2017) with 1587 Columbian participants that were divided into samples of undergraduates, general population, and clinical population. The authors used the Spanish validated version of the ATQ-30 (Cano García & Rodríguez Franco, 2002) and extracted the 8 corresponding items of the ATQ-8 (Netemeyer et al., 2002) It was found to have a good internal consistency (overall coefficient alpha estimate of .89), and construct validity as well as good convergent validity.

2.4.3.6 Problem definition form

In order to define the personal problem participants would be talking about, we created a standard "problem definition form". As explained in Section 2.4.2.1, after a short

interview with a clinical psychologist about the problem, participants had to write a sentence defining the problem using the following the structure: "When (*I am in this situation*) …..I think……and feel….. and I react…..and I would like to…" ("Cuando (*estoy en esta situacion*) ….pienso….y me siento…. reacciono….y me gustaría …"). A model of the problem definition form is reported in Appendix D.

3 RESULTS

In this chapter we report the results obtained for each of the three experiments. Each specific section starts with a description of the age characteristics of the participants and then shows the graphic representation of the results obtained for each specific measure and questionnaire, a table detailing the questionnaires precedes every graph in order to indicate which exact measures are represented.

3.1 EXPERIMENT I: THE IMPACT OF FIRST PERSON PERSPECTIVE ON BODY PERCEPTION

In this first experiment, we wanted to test whether seeing the representation of one's body from a third person perspective would affect the way that body was perceived and evaluated. Three avatars were generated for each participant, all the avatars were presented one time in 1PP and one time in 3PP. The order of presentation was randomized. Participants did not know which avatar corresponded to their Body Image, Real Body or Ideal Body at the moment when it was presented to them. That way, the evaluation they were giving about the appearance of the virtual body was only affected by the perspective they had of it. In order to create a possible comparison between those bodies generated from subjective representation, we also measured the real body shape of the participant and generated a third avatar corresponding to their real body appearance. The avatar based on the real body measures was called the Real Body (RB), the second avatar based on the estimations participants gave of their subjective body representation, was called Body Image (BI) and the third avatar based on the estimations participants gave of their ideal body shape, was called Ideal Body (IB). In the second session, participants had to evaluate the appearance of those virtual bodies without knowing which one corresponded to what. There were two conditions for this evaluation: one in 1PP and the other in 3PP. The evaluation was done through a verbal questionnaire while the participants were immersed in VR. We expected that prior beliefs about the self would negatively affect the evaluation of the virtual bodies perceived in first person perspective.

3.1.1 **Participants**

Table 1: Age characteristics of the participants.

	Age (mean ± SD)	Age (Min)	Age (Max)
Total (n=19)	24.79 ± 5.64	18	38
Females (n=9)	23.89 ± 6.79	18	38
Males (n=10)	25.6 ± 4.59	19	32

There was no significant difference in the age of the participants, one participant was a bit older than the average (38 years old) but this did not affect the results obtained.

Table 2: BMI (body mass index) characteristics of the participants. The scale is as follows, 16.0 to 18.5: underweight, 18.5 to 25: healthy weight, 25 to 30: overweight, 30 to 35: Moderately obese

	BMI (mean ± SD)	BMI (Min)	BMI (Max)
Total (n=19)	23.6 ± 3.42	17.75	33.33
Females (n=9)	22.84 ± 3.31	17.75	27.25
Males (n=10)	24.28 ± 3.54	20.30	33.33

The BMI for both genders were distributed in the range of healthy weight, there was one female underweight and one male overweight. The BMI is calculated as follows: Weight/ (Height*Height).

3.1.2 **Body ownership**

In the first person perspective condition, participants were embodied in the virtual body, there was a visuo-tactile stimulation on their legs and hands (see Figure 9 in Section 2.2.2.2). We measured the level of body ownership participants were experiencing, each time the virtual bodies were presented in 1PP (see Figure 17). We measured the level of body ownership when the virtual bodies were presented in 3PP as well, to make sure that

the 1PP was triggering the effect we wanted. Results show that the level of body ownership was almost not existent in 3PP and very high in 1PP. The questionnaire was the following:

Body ownership questionnaire 1PP: **Likert scale, 1: not at all, 7: very much**	**Variable Name**
¿Hasta qué punto sientes que el cuerpo que ves en el espejo es tuyo (sin tener en cuenta el nivel de semejanza física entre este cuerpo y el tuyo)? *To what extent do you feel the body you see in the mirror is yours (not considering physical resemblance)?*	Mirror
¿Cuándo miras hacia abajo, hasta qué punto sientes que el cuerpo que ves es tuyo? *When you look down how much do you feel that the body you see is yours?*	LookDown

Body ownership questionnaire 3PP: **Likert scale, 1: not at all, 7: very much**	**Variable Name**
¿Hasta qué punto sientes que el cuerpo en frente de ti es tuyo (sin tener en cuenta el nivel de semejanza física entre este cuerpo y el tuyo)? *To what extent do you feel the body you see in front of you is yours (not considering physical resemblance)?*	BO 3PP

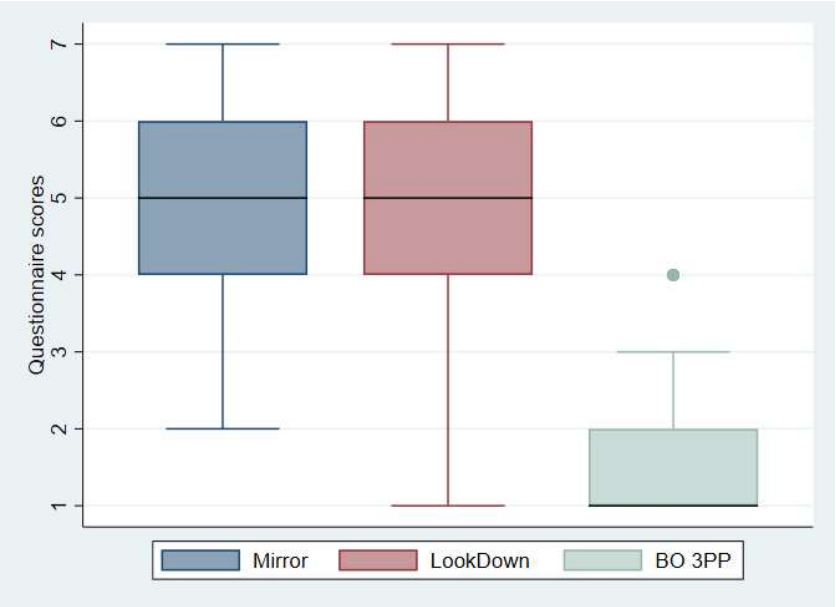


Figure 17: - Box plot presenting the level of body ownership depending on the perspective. The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots. Mirror and LookDown correspond to the level of body ownership for all the avatars when presented in 1PP. BO 3PP corresponds to the level of body ownership for all the avatars when presented in 3PP.

The illusion of body ownership was very high (median=5) in the first-person perspective condition (Mirror and LookDown) and very low (median=1) in the third-person perspective (BO 3PP). Here we can verify that the visuo-tactile integration elicited on the hands and legs of our participants by the synchronisation of the virtual balls entering in contact with their virtual body and the vibration felt on their real body, created a strong body ownership illusion on all the avatars presented in 1PP, independently of the avatar's appearance. On the contrary, there was no body ownership illusion over the avatars when presented in 3PP.

3.1.3 **Clinical questionnaires**

3.1.3.1 BSQ-34

Table 3: Scores obtained in the body shape questionnaire (BSQ), the scale is as follows, <81: no concern with shape, 81-110: low concern with shape, 111-140: moderate concern with shape, >140: concern with shape.

	BSQ_pre (mean ± SE)	BSQ_post (mean ± SE)
Females (n=9)	80.55 ± 4.26	80.55 ± 5.74
Males (n=10)	53.6 ± 4.84	58.7 ± 4.53

The Body shape questionnaire (see description in Section 2.2.3.2), was filled after the first session (BSQ_PRE) and after the second session (BSQ_POST). We observed that the female participants had more concern with their body shape than the male participants. Since we measured the same group of individuals at two different times, a paired t-test was adapted to test for significance in the difference observed. There was no significant difference between the BSQ score before and after the experimental procedure for females ($p = 0.50$), and neither for males ($p = 0.96$).

3.1.3.2 EDI-2

This questionnaire was used for the screening in order to make sure that the sample was formed only of healthy participants. Additionally, we wanted to compare the results before and after the experimental procedure to see if there was any effect on any of the subscales. Here we report the results obtained for the subscales: Body dissatisfaction (BD) and Drive for thinness (DT). All the results are presented separately for males and females since there are critical differences between the two groups. "Pre" refers to the scores obtained before the experiment, "Post" refers to the scores obtained after seeing the six avatars in 1PP and 3PP, right after the second session of the experimental procedure.

Table 4: Scores of the Drive for thinness (DT) subscale of the EDI-2 questionnaire. The scale is as follows, 0: percentile 32, 2: percentile 59, 4: percentile 78, 17: percentile 99

	DT_pre (mean ± SE)	DT_post (mean ± SE)
Females (n=9)	3.44 ± 0.83	2.55 ± 0.75
Males (n=10)	0.4 ± 0.22	0.6 ± 0.43

We observe a decrease in the scores of the "Drive for thinness" scale, in our female participants. The effect is not observed in male participants. The DT scores measured before the experimental procedure is much higher for females than for males. We ran a paired t-test to see if the difference of the DT scores before and after the VR session was significant, but it was not in females ($p= 0.32$) and neither in males ($p= 0.55$).

Table 5: Scores of the Body dissatisfaction (BD) subscale of the EDI-2 questionnaire. The scale is the following, 0: percentile 26, 3: percentile 56, 6: percentile 75, 24: percentile 99

	BD_pre (mean ± SE)	BD_post (mean ± SE)
Females (n=9)	7.11 ± 1.83	3.89 ± 1.49
Males (n=10)	1.2 ± 0.76	2.3 ± 1.00

We ran a paired t-test and the difference in body dissatisfaction before and after the experiment was significant for females ($p = 0.04$) but not for males ($p = 0.19$). It seems that the experimental procedure of seeing the different avatars representing their body, resulted in a tendency to reduce body dissatisfaction in females. We believe the feedback given to the participants about the real shape of their body led them to get a better self-evaluation and less body dissatisfaction.

3.1.4 **Averaged avatars**

Here we present pictures corresponding to the avatars that were generated based on the estimations participants gave of their own body (BI) and ideal body (IB). We present four averaged avatars corresponding to the females' body image and ideal body, and to the males' body image and ideal body.

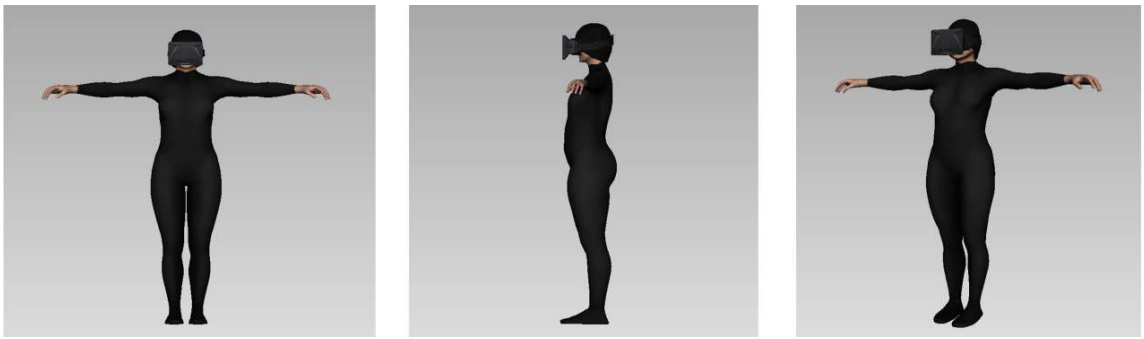


Figure 18: Average shape of the **body image** avatars showing the mean (over)estimation **females** gave of their own body shape.

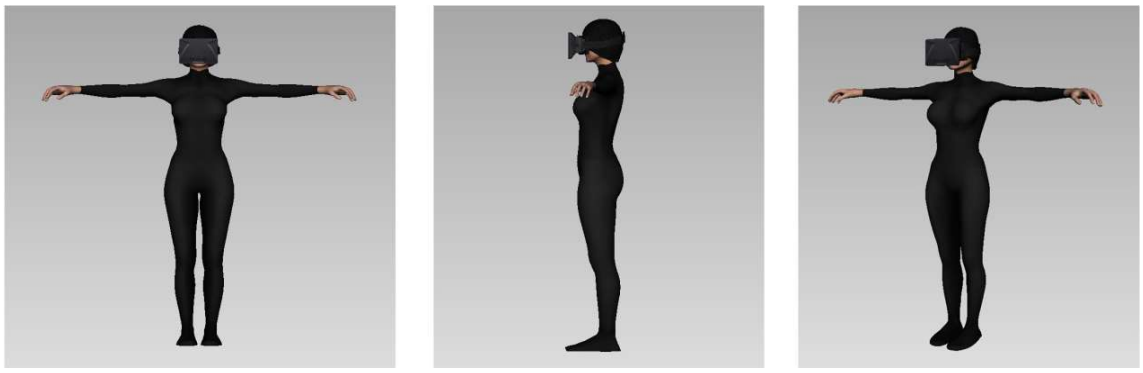


Figure 19: Averaged shape of the **ideal body** avatars generated with the mean estimation **females** gave of their ideal body measures.

We can observe that the ideal body image is significantly thinner than the Body Image avatar for females. The critical body measures are the “waist width” and “hips width”, significantly smaller in the ideal female averaged body. It is interesting to note that the ideal body shape we obtained corresponds to the “hour glass” shape reported in Simmons, Istook, & Devarajan (2004), we discuss these results in Section 4.1.

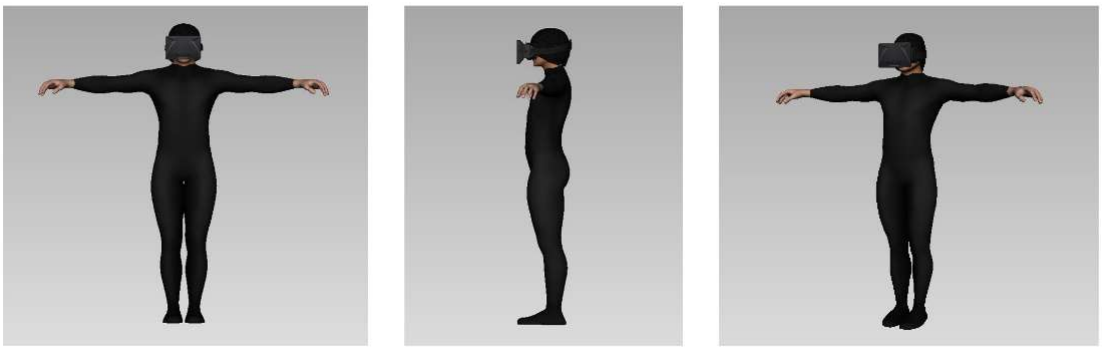


Figure 20: Average shape of the **body image** avatars showing the mean estimation **males** gave of their own body shape.

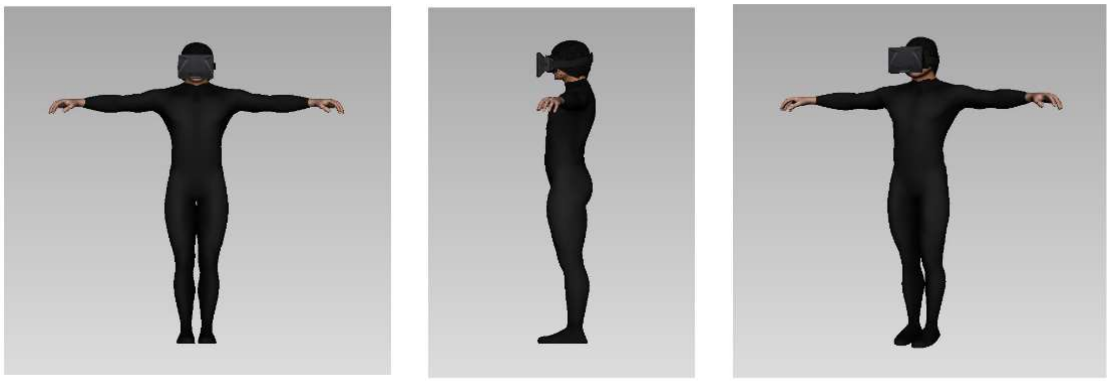


Figure 21: Average shape of the **ideal body** avatars showing the mean estimation **males** gave of their ideal body shape.

3.1.5 **Subjective evaluation of the avatars**

In the second part of the experiment the three avatars generated (Real, Ideal and Body Image) where presented to the participants in 1PP or 3PP in a random order. Each avatar was perceived in both perspectives and we measured the subjective evaluation for each avatar in each condition.

Evaluation of the Avatars **Likert scale from 1 to 7, 1: not at all, 7: very much**	**Name of variable**
¿Cuán gordo crees que es este cuerpo? *How fat do you think this body is?*	Fat
¿Cuán delgado crees que es este cuerpo? *How thin do you think this body is?*	Thin
¿Cuánto te gustaría que tu cuerpo se pareciera a este? *How much would you like your body to resemble this one?*	LikeToResemble
¿Cuán atractivo te parece este cuerpo? *How attractive does this body look to you?*	Attractive

3.1.5.1 Results for female participants

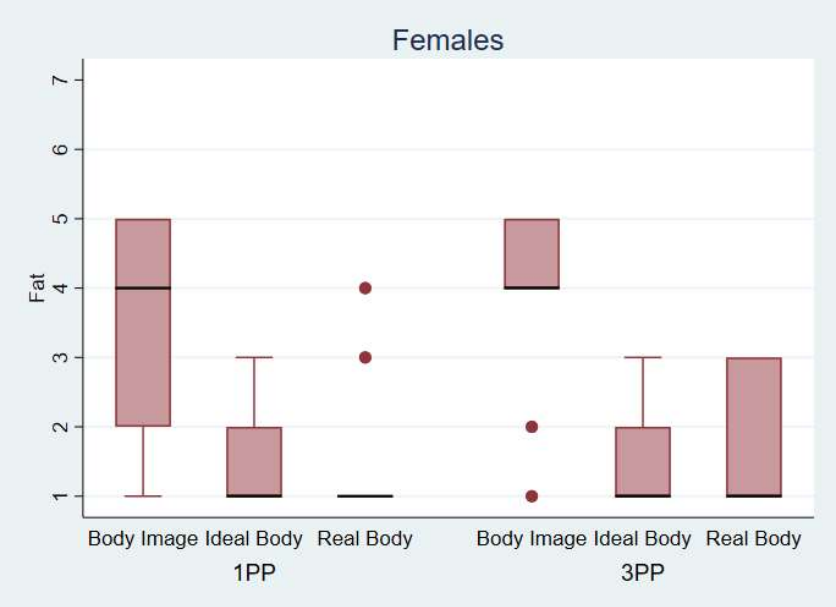


Figure 22: Box plot presenting the scores obtained during the body evaluation phase. Answers to the question: *How fat do you think this body is*? The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots.

In Figure 22, we can observe that our female participants evaluated the avatar corresponding to their Body Image as fatter (median=4) than the avatars corresponding to their Real Body and their Ideal Body. The body image avatars were indeed "objectively" fatter than the real body avatars because female participants tended to overestimate the size of their own body (see Figure 18).

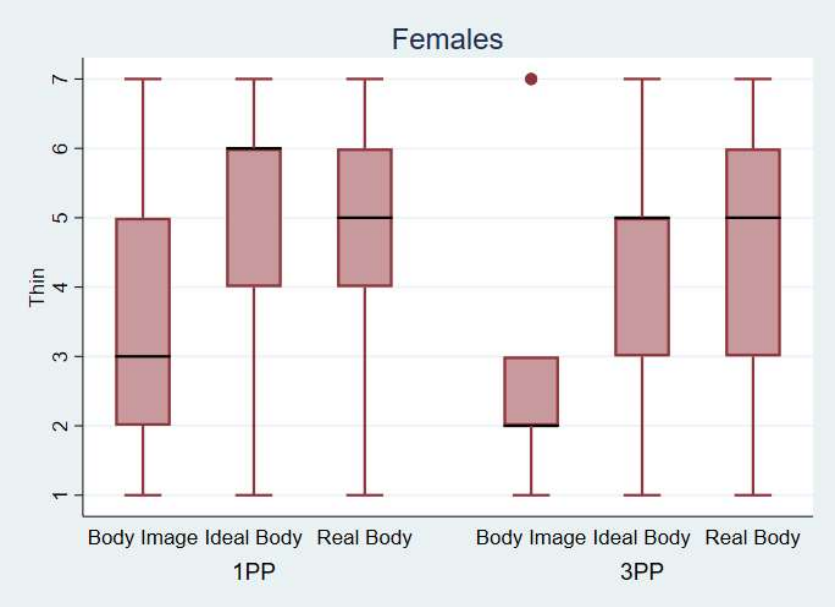


Figure 23: Box plot presenting the scores obtained during the body evaluation phase. Answers to the question: *How thin do you think this body is*? The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots.

Logistic regression with fixed effects over Perspective and Body and random effects over the individuals shows that there was no interaction effect ($p = 0.4$) but strong main effects, with both Ideal Body and Real Body being evaluated as significantly thinner than the Body Image ($p = 0.0005$). For the question about the thinness of the avatar we observe the same effect as in the previous question, the Body Image avatar is perceived as significantly fatter than the other two avatars, from both 3PP and 1PP.

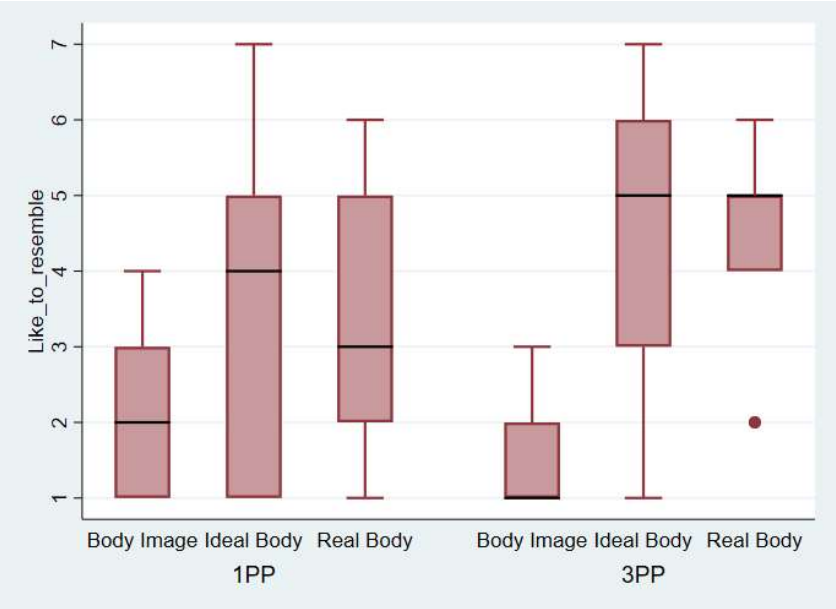


Figure 24: Box plot presenting the scores obtained during the body evaluation phase. Answers to the question: *How much would you like your body to resemble this one?*–The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots.

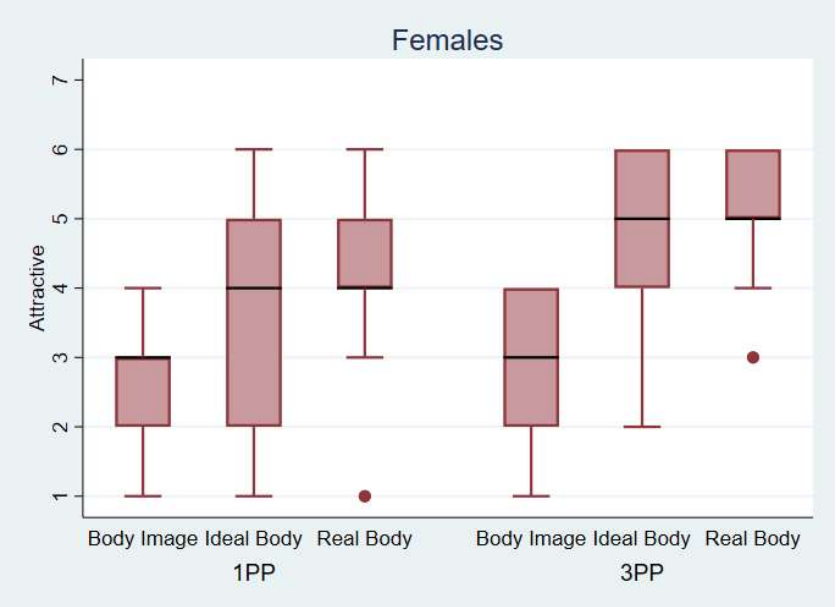


Figure 25: Box plot presenting the scores obtained during the evaluation phase. Answers to the question: *How attractive does this body look to you?* - The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots.

Figure 24 shows that the female participants wanted their body to resemble the avatar re-created form their real body measures, when perceiving it from a third person perspective (median=5). Figure 25 shows that the Ideal body and Real body were evaluated as

significantly more attractive when perceived in third person perspective Logistic regression shows that the Real Body and Ideal Body were rated as significantly more attractive than the Body Image ($p = 0.002$) and that there was a main effect of Perspective ($p = 0.052$). These results show that seeing their real body shape in 3PP led female participants to evaluate it more positively (see discussion in Section 4.1).

In the next section we show the results obtained for the same questionnaire on subjective evaluation of the avatars but in males.

3.1.5.2 Results for male participants

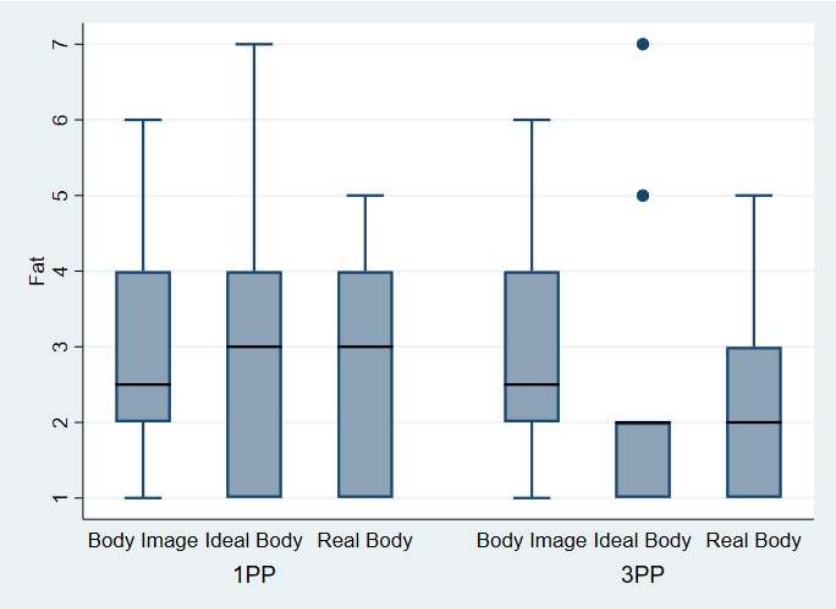


Figure 26: Box plot presenting the scores obtained during the body evaluation phase. Answers to the question: *How fat do you think this body is*? The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots.

In males the effect of evaluating the Body Image as fatter than the other virtual bodies was not observed. All the medians have similar values (between 2 and 3) for all the avatars in both conditions (1PP and 3PP).

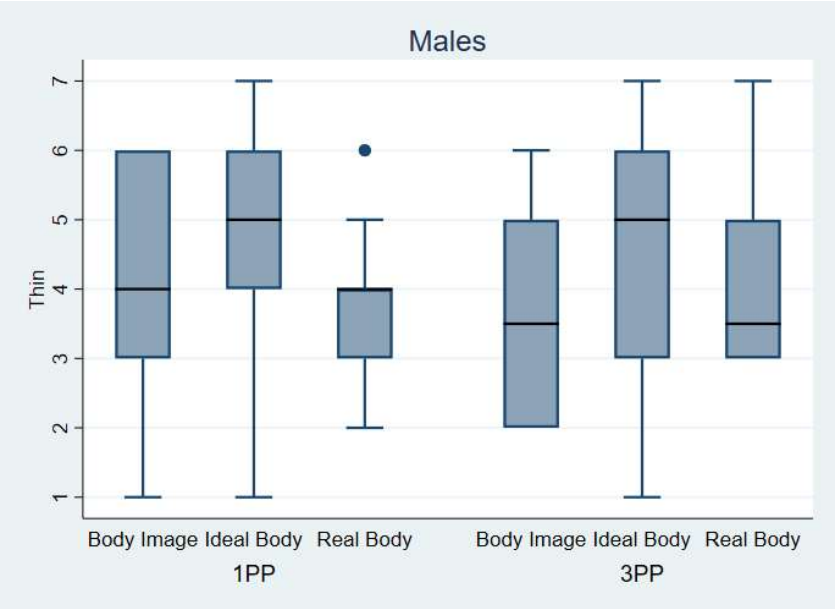


Figure 27: Box plot presenting the scores obtained during the body evaluation phase. Answers to the question: *How thin do you think this body is*? The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots.

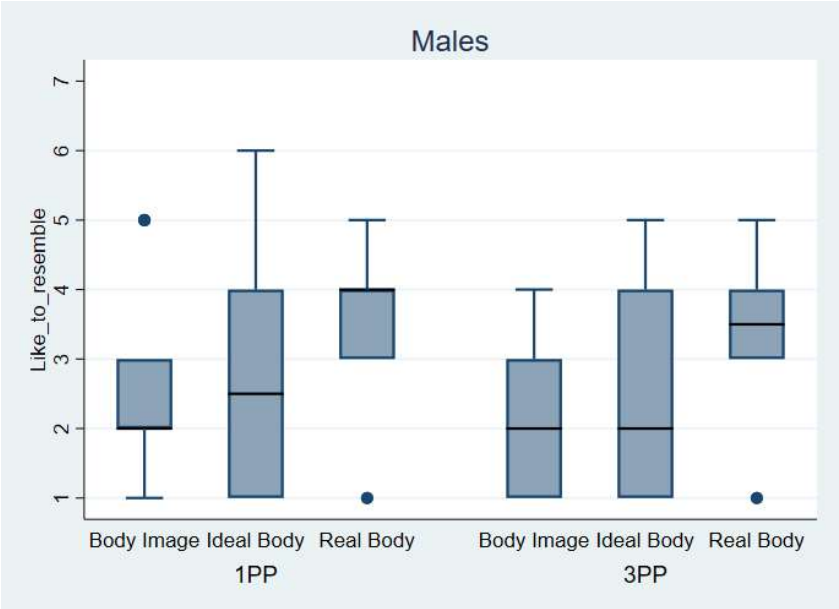


Figure 28: Box plot presenting the scores obtained during the body evaluation phase. Answers to the question: *How much would you like your body to resemble this one?*–The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots.

One effect observed in female participants was also observed in males: to the question "*How much would you like your body to resemble this one*", the Real Body was the one that was preferred (median between 3 and 4). But there was no effect of perspective.

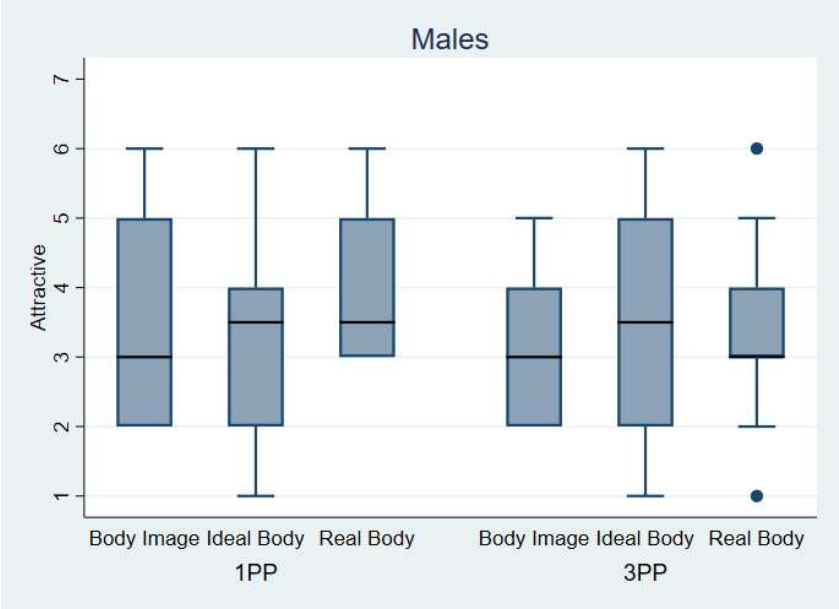


Figure 29: Box plot presenting the scores obtained during the body evaluation phase. Answers to the question: *How attractive does this body look to you?*- The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots.

In males the evaluation of the attractiveness was similar for all the virtual bodies in both 1PP and 3PP conditions. All the medians are comprised between 3 and 4 (see Figure 29).

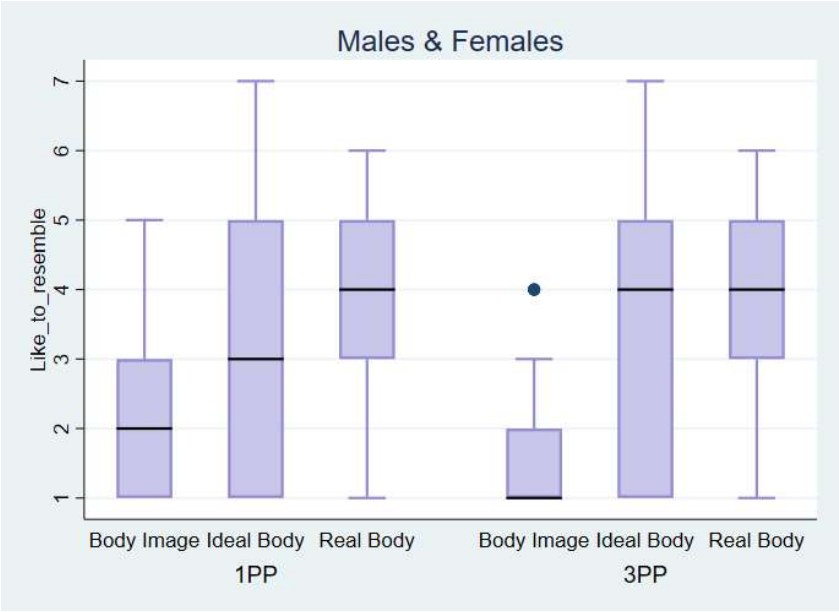


Figure 30: Box plot presenting the scores obtained during the evaluation phase. Answers to the question: *How much would you like your body to resemble this one*. The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR). Outliers are shown individually as separated dots.

We combined the results of all participants, males and females for the question "*How much would you like your body to resemble this one".* It is interesting to note that participants wanted their body to resemble the avatar that was reconstructed from their real body measures. When the Real Body avatar was seen in a third person perspective, that effect was higher, but only in females. This means that our hypothesis was partially true, we can give a new perspective on people's real body making them want to have the body they already have when seeing it in 3PP. This effect can be explained by the bias produced by negative comparison of the self with others. We know that this negative bias on self-evaluation is increased in patients with eating disorders. Seeing their real body shape in 3PP could actually be therapeutic for those patients, if we obtain with them the same effect as the one reported here. We think that the effect observed on this small sample of females with no eating disorders predicts that in ED patients the effect would be even stronger.

3.1.6 **Body identification**

In the last phase of this experiment, participants could view the three avatars in 3PP, one next to the other, and choose which avatar best represented their real body, and which body shape they would like to have.

Table 6: Final evaluation with the three avatars in front of the participant, frequency of choice for Females

Females	Which body do you think is your real body?	Which body do you think is your ideal body?	Which body would you like to have?
Body Image	3	1	**0**
Ideal Body	1	5	4
Real Body	5	3	5

It is interesting to note that no female participant chose their Body Image as the Body they would like to have.

Table 7: Final evaluation with the three avatars in front of the participant, frequency of choice for Males

Males	Which body do you think is your real body?	Which body do you think is your ideal body?	Which body would you like to have?
Body Image	2	4	4
Ideal Body	0	3	1
Real Body	**7**	2	4

We observe that the majority of our male participants recognized the right avatar corresponding to their real body.

Table 8: Final evaluation with the three avatars in front of the participant, frequency of choice for Males and Females

Total	Which body do you think is your real body?	Which body do you think is your ideal body?	Which body would you like to have?
Body Image	5	5	4
Ideal Body	1	8	5
Real Body	12	5	9

Overall, participants had a tendency to choose their real body as the one they would like to have. During the post experiment feedback, we observed some participants being really surprised and satisfied to see that the body shape they preferred was actually their real body shape.

3.2 EXPERIMENT II: CHANGING PERSPECTIVE IN A VERBAL HARASSMENT SCENE

The second experiment was aimed at assessing the impact of in-group affiliation, and embodiment in an individual from the out-group, on behavioural responses. Participants were first exposed to a verbal harassment scene in virtual reality: a group of males (in-group) triggered a situation of verbal conflict with an isolated female (outgroup). Participants saw the same scene twice. First, they were sitting with the group of males and embodied in an avatar representing themselves. There were two conditions for the second exposure to the harassment scene, one from the perspective of the victim (woman) and one from the perspective of another member of the group of males encouraging the harassment (in-group condition). A third group (control condition) did not see the harassment scene at all. The second session, one week later, was a virtual reproduction of the Milgram scenario. We used it as a tool to measure the impact of the first session on prosocial behaviour of our participants. We expected that embodiment in the victim during the first session (harassment scene) would increase prosocial behaviour during the Milgram scenario. The behaviour of the control group was used as a baseline indicating

how people in general would behave in the Milgram scenario we reproduced in VR (this group was not exposed to the verbal harassment scene in the first session). We measured the responses of the participants to the virtual situation during the harassment scene (composed of two phases) and during the Milgram scenario. Co-presence is particularly important in this experiment since the influence of the other avatars and the way the participant felt towards them is a major aspect of this study. We measured participant's behaviour in terms of the number of shocks they would give to the woman during the Milgram scenario.

3.2.1 **Participants**

Table 9: Age characteristics of the participants

Condition	Age (mean ± SD)	Age (Min)	Age (Max)
In-group (n=20)	24.75 ± 4.92	19	35
Woman (n=20)	24.1 ± 5.02	18	32
Control (n=20)	24.9 ± 3.31	20	32
Total (n=60)	24.58 ± 4.42	18	35

The age distribution of the participants was similar in all three conditions, excluding any possible age effect for the results obtained.

3.2.2 **Body Ownership**

We measured Body ownership illusion in the first virtual scenario, when the participants were sitting on the terrace with the other avatars. After the first exposure to the verbal harassment scene (phase1), participants were asked the body ownership questions verbally and had to answer in the same way. After the second exposure to the verbal harassment scene (phase2), participants were asked the questions again, the experimenter insisted on the fact that those questions were referring to the body they just had experienced in this second exposure (participants in experimental condition were embodied in the woman during this second scene).

Body ownership questionnaire, each of these questions were scored on a -3 to 3 Likert scale, -3: completely disagree, 3: completely agree	**Name of the variable**
He sentido que el cuerpo virtual que veía cuando miraba hacia abajo era mi propio cuerpo *I had the feeling that the virtual body I saw when I looked down was my body*	LookDown
He sentido que el cuerpo virtual que veía cuando miraba hacia el espejo era mi propio cuerpo *I had the feeling that the virtual body I saw when I looked towards the mirror was my body*	Mirror

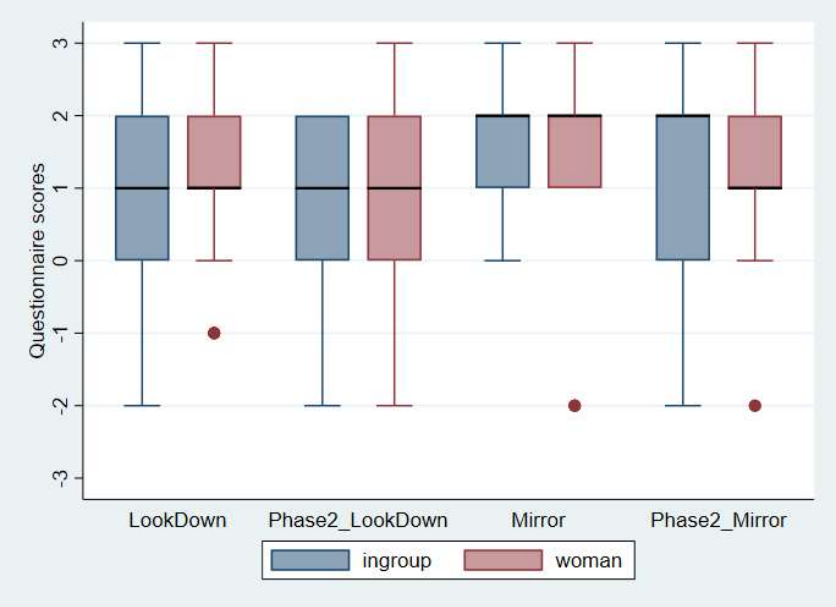


Figure 31 - Box plot presenting the level of body ownership by condition after each phase. LookDown and Mirror correspond to the level of body ownership after the first exposure, Phase2_LookDown and Phase2_Mirror correspond to the level of body ownership after the second exposure to the verbal harassment scene. The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots.

Figure 31 shows the box plots of the two questionnaire scores by phase and condition. Overall, the body ownership scores were high (all the interquartile ranges are above the 0 score, and all the medians are comprised between 1 and 2). It is important to note that the level of body ownership did not differ whether the participants were embodied in the male or female body during the second phase, and the level of body ownership did not vary between the two phases.

3.2.3 **Presence**

As explained in the introduction (Section 1.3.2.2), Presence is the sensation of "being there" inside the virtual environment. The two components of presence are "place illusion" (PI) and "plausibility illusion" (PsI). Here we report the levels for PI and PsI after each phase of the terrace scenario, asking the following questions:

Presence questionnaire **-3: completely disagree, 3: completely agree**	**Name of Variable**
He tenido la sensación de estar sentado en la terraza *I had the sensation of sitting on the terrace*	PI
He tenido la sensación de que la conversación en la terraza estaba ocurriendo realmente *I had the sensation that the conversation on the terrace was really happening*	PsI

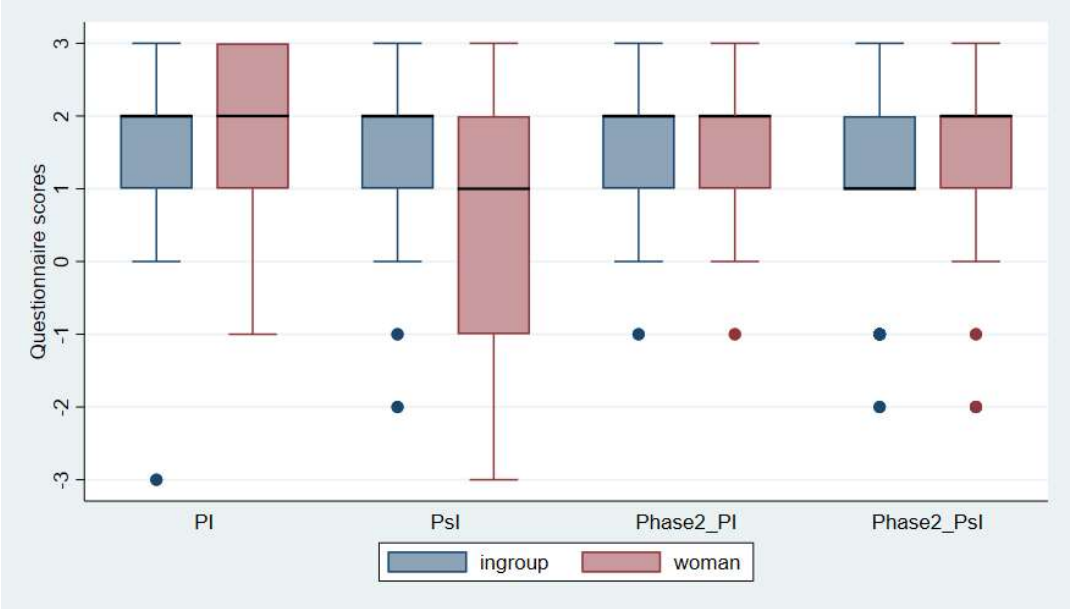


Figure 32 - Box plot presenting the level of presence (PI and PsI) by condition after each exposure. The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots. PI and PsI correspond to the measures obtained after the first exposure to the verbal harassment scene, Phase2_PI and Phase2_PsI correspond to the measures obtained after the second exposure.

The level of place illusion and plausibility illusion were very high both in the first phase and in the second phase independently of the condition. All the medians are equal to 1 or 2 (the maximum score being 3). High levels of PI and PsI indicate that the

participants were really immersed in the virtual scene and give more reliability to the other results.

3.2.4 **Co-presence**

As we explained before, co-presence is the sensation of being inside a virtual environment with other avatars. It is a major factor here since we measure the degree to which the participants will modify their own behaviour according to their social interaction with the other avatars in the virtual environment.

Questionnaire Co-presence **-3: completely disagree, 3: completely agree**	**Name of Variable**
He sentido que los chicos me estaban hablando a mí *I felt that the guys were talking to me*	TalkingtoMe
He tenido la sensación de estar compartiendo la terraza con las otras personas, como si realmente estuviese con ellas en el mismo lugar *I had the sensation of sharing the terrace with the other people as if I was really with them in the same place*	CoPresence
Los otros chicos me han hecho sentir cómodo *The other guys made me feel comfortable*	Comfortable

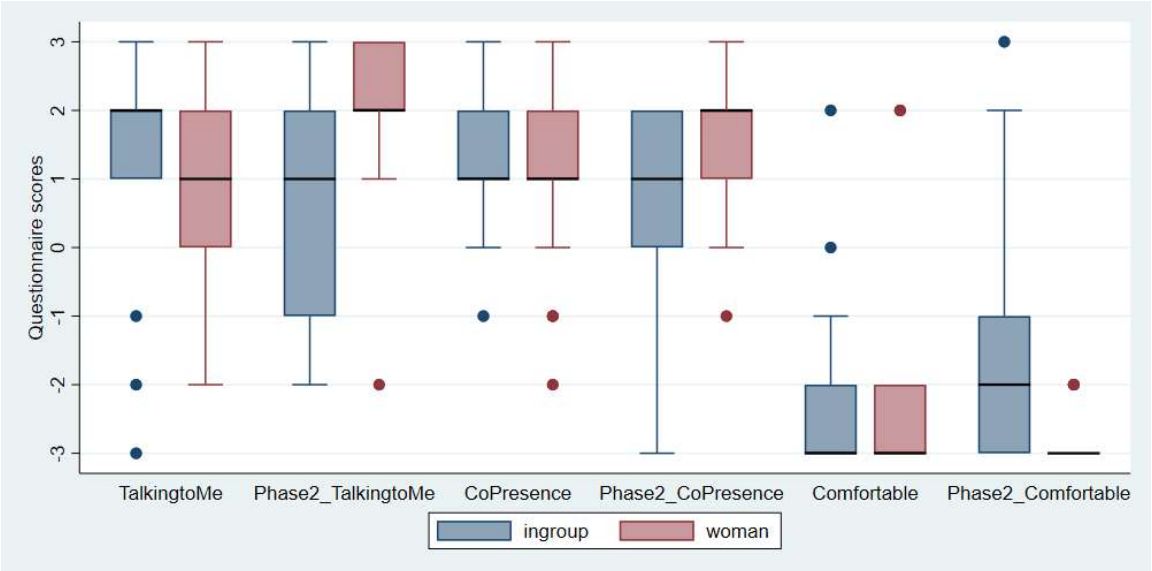


Figure 33 - Box plot presenting the level of co-presence and comfort, by condition, after each exposure. The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots.

Levels of co-presence and sensation of interaction with the male avatars were very high (all the medians were comprised between 1 and 2). It is interesting to note that participants did not feel comfortable in general during both exposures to the verbal harassment scene, the median is at the minimum level for both groups in the first exposure (median= -3), showing that the participants were feeling uncomfortable with the behaviour of the male avatars harassing the female avatar. But in the second phase, we observed a difference in the levels of discomfort between the two conditions. We ran a two-sample Wilcoxon rank-sum test showing that the difference was significant (p=0.0002). Participants embodied in the woman reported a higher level of discomfort, than participants embodied in one of the other males of the group. This effect corresponds to the qualitative results obtained in the questionnaires after the VR experience. Participants in the woman condition reported more frequently that they were feeling "uncomfortable" than participants in the in-group condition (see word frequency analysis in Section 3.2.6).

3.2.5 **Responses to the virtual situation (verbal harassment scene)**

Questionnaire In-group feeling: **-3: completely disagree, 3: completely agree**	**Name of Variable**
Los otros chicos me han hecho sentir integrado en el grupo *The other guys made me feel integrated in the group*	PartOfTheGroup
He tenido la sensación de que los chicos eran amigables conmigo *I had the sensation that the guys were friendly with me*	GuysFriendlyWithMe

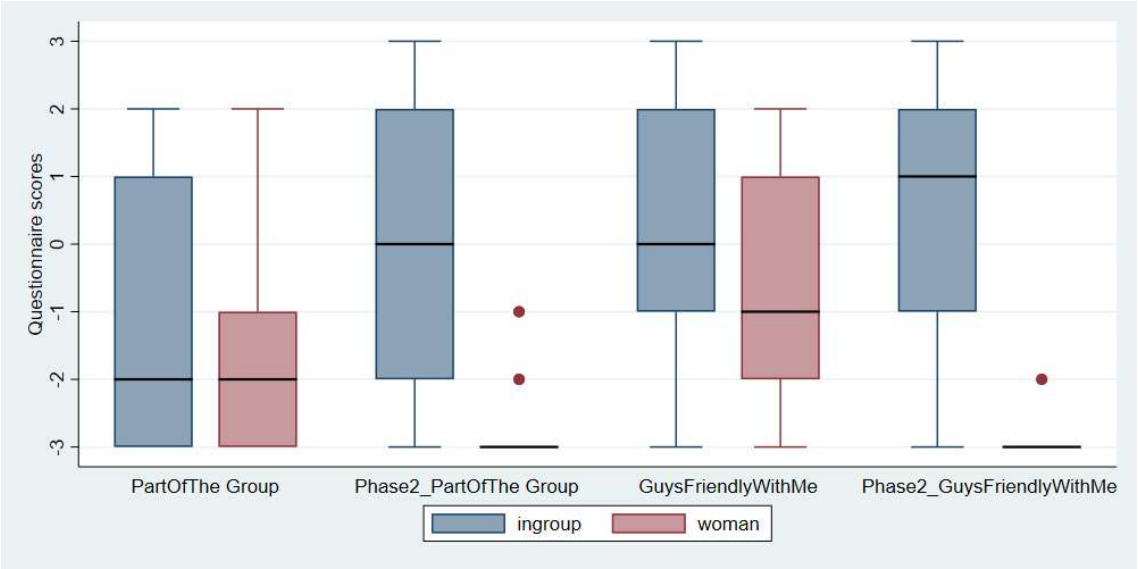


Figure 34: Box plot presenting the level of in-group feeling by condition after each exposure. The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots. Variables indicating Phase2 correspond to the measures obtained after the second exposure to the verbal harassment scene

Figure 34 shows the responses to the virtual avatars that were in the scene of the terrace. The most important effect we observe is that participants in the in-group condition felt more integrated to the group of male avatars during the second phase. In the first phase, there was no difference between the two conditions and overall, participants did not feel that they were part of the group of males (median= -2). In the second phase, there was a decrease of that sensation for the participants in the woman condition (median= -3) and an increase for the participants in the in-group condition (median =0). We ran a two-sample Wilcoxon rank-sum test showing a significant difference between the two conditions for the second phase. The feeling of "being part of the group" was significantly higher for the participants in the in-group condition than for the participants in the woman condition (p=0.00). The Wilcoxon rank-sum test shows a high probability for the in-group score to be superior to the woman condition score: P (in-group) >P (woman) =0.924. We observe a significant difference as well for the subjective report related to the friendliness of the male avatars towards the participants during the second phase (p=0.00). Participants in the in-group condition reported significantly higher levels of friendliness received from the male avatars than participants in the woman condition: P Friendliness, P (in-group) > P (woman) = 0.971. It is interesting to note that the subjective impression of friendliness coming from the male avatars was slightly higher in the second phase than in the first phase for participants in the in-group condition (median phase1 =0, median

phase2 =1). We ran a paired t-test for the difference between phase 1 and phase 2 in the in-group condition but the difference was not significant (p= 0.46). In summary, being exposed to the second iteration of the verbal harassment scene in the in-group condition resulted in feeling more integrated to the group of males than when being embodied in the woman, the group appeared to be significantly "more friendly" to the participants in the in-group condition than to the participants in the woman condition. This effect is what we will refer to as "in-group affiliation" and we will show that it had a big impact on participants' behaviour during the exposure to the Milgram scenario (see Section 3.2.7).

Questionnaire on emotional responses: **-3: completely disagree, 3: completely agree**	**Name of the variable**
Mi respuesta emocional ha sido la misma que hubiera tenido en una situación real *My emotional response was the same as the one I would have had in a real situation*	EmotionsReal
Mis pensamientos en relación a la conversación han sido los mismos que en una situación real *My thoughts in relation to the conversation were the same as in a real situation*	ThoughtsReal

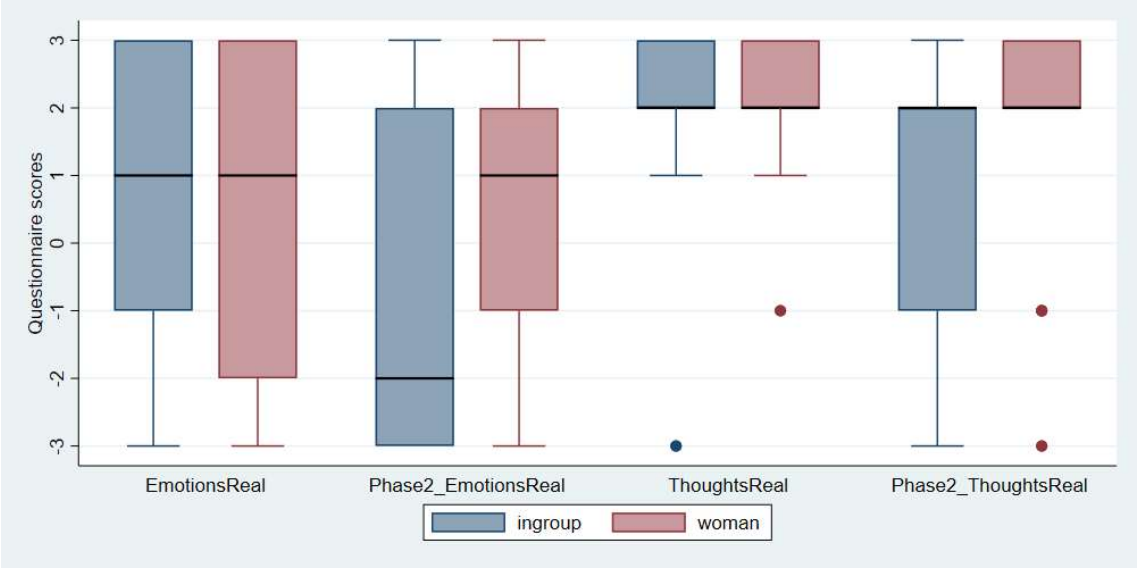


Figure 35 - Box plot presenting the level of realism of the emotional responses and thoughts by condition after each exposure. The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots. Variables indicating Phase2 correspond to the level of realism of emotions and thoughts after the second exposure to the verbal harassment scene.

The emotional response was rated as quite real by all the participants in the first phase (median=1). In the second phase, participants in the in-group condition reported a lower level of emotional realism than participants in the woman condition but the difference was not significant (p= 0.139). Thoughts were rated as highly real in both conditions and both phases (median =2).

3.2.6 **Qualitative results**

We present here two word-clouds showing the frequency of words spontaneously used by the participants to describe their experience during the second exposure to the verbal harassment scenario (answering to the question: *How did you feel during the second part of the experience?*). The word clouds were generated using the following method: we ran a frequency test using the software for qualitative analysis Nvivo 12. Each word that was repeated at least two times (within one condition or between conditions) was selected for the word cloud. We then ran a frequency analysis for each word in each condition (see Table 10). We then checked that each word counted was used only once by each participant to avoid artificial effect of frequency when one participant was using the same word several times. Nvivo allows to group close synonyms together, therefore in some cases some words with similar meaning are counted as a repetition of the same word, for instance the word "fear" was counted as a repetition of the word "afraid" (a detail of each of those cases is presented in Table 10).

Table 10: Words selected for the creation of both word-clouds, the frequency is presented for each word in each condition. Words are classified here from the most frequently to the least frequently used in the woman condition. A translation of each word to English is presented in the second column.

Words (Spanish)	**Translation**	**Words frequency (in-group condition)**	**Words frequency (woman condition)**
Acosado	Harassed	0	5
Incómodo	Uncomfortable	2	5
Espectador	Spectator	1	3
Imbécil(es), capullos	Idiot(s)	0	3
Molestando	Bothering	0	3

Nervioso, intranquilo	Nervous, worried	0	3
Aburrido	Annoyed	0	2
Asustado, miedo	Afraid, fear	0	2
Impotente	Powerless	1	2
Levantarme	Stand up	0	2
Reflexionar	Reflect on	0	2
Violento	Violent	0	2
Observando	Observing	2	1
Película	Movie	1	1
Calmado, cómodo	Calm, Comfortable	2	0
Extraño	Strange	3	0
Pena	Pity	2	0

Figure 36: word cloud representing the frequency of words used by the participants in the in-group condition after the second exposure to the verbal harassment scene

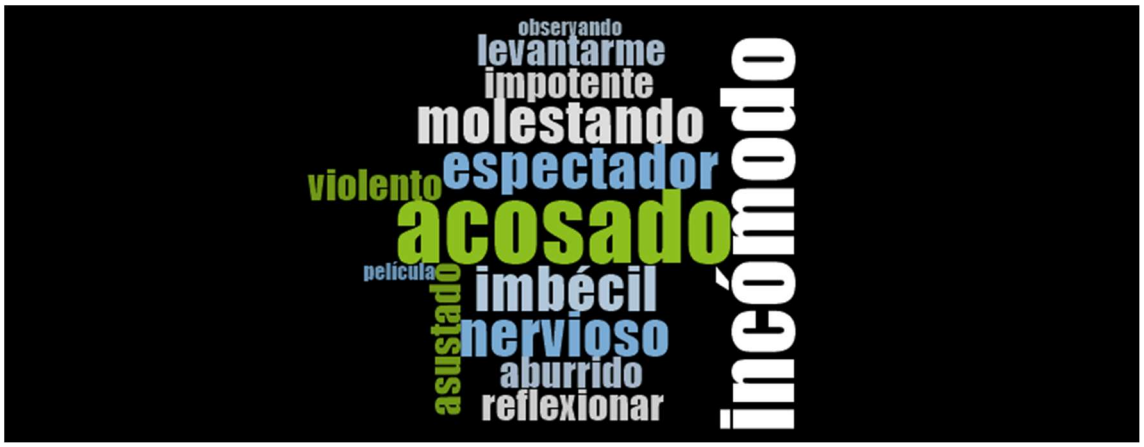


Figure 37: word cloud representing the frequency of words used by the participants in the woman condition after the second exposure to the verbal harassment scene

The word "acosado" (*harassed*) was used only in the woman condition, showing that the effect we wanted to create was successful. 5 participants out of 20 (in the woman condition) used this word to spontaneously describe their experience inside the virtual scene (25%). The word "incómodo*"* (*uncomfortable*) was used in both conditions but with more frequency in the woman condition (10% in the in-group condition and 25% in the woman condition). The qualification "Imbécil(es)" (*idiot(s)*) describing the avatar(s) harassing the woman, was used only in the woman condition showing that participants in the in-group condition did not get this negative perception of the male avatars. Participants in the in-group condition reported more diverse sensations, it was difficult to find words repeated more than 2 or 3 times between participants. The word repeated with greater frequency was the word "extraño" (*strange)*. For the participants in the in-group condition there was a small effect of feeling "outside" the scene (*observing, spectator, movie*), only 2 participants reported that they were feeling "*pity*" for the victim. More surprisingly, 2 participants reported feelings of "*calmness*" during the harassment scene.

3.2.7 **Responses to the virtual situation (Milgram scenario)**

Place Illusion questionnaire:	**Name of the variable**
¿Hasta qué punto sentiste en ciertos momentos durante la experiencia que la sala de entrenamientos era la realidad para ti? *To what extent did you feel that the training room was the reality for you? (-3: "never", 3: "all the time")*	PI

¿Durante la experiencia, que ha sido más fuerte, la sensación de estar en la sala de entrenamiento o la sensación de estar en el mundo real del laboratorio de realidad virtual? *During the time of the experience, which was strongest on the whole, your sense of being in the training room, or of being in the real world of the laboratory? (-3 "being in the laboratory", 3: "being in the training room")*	PI2

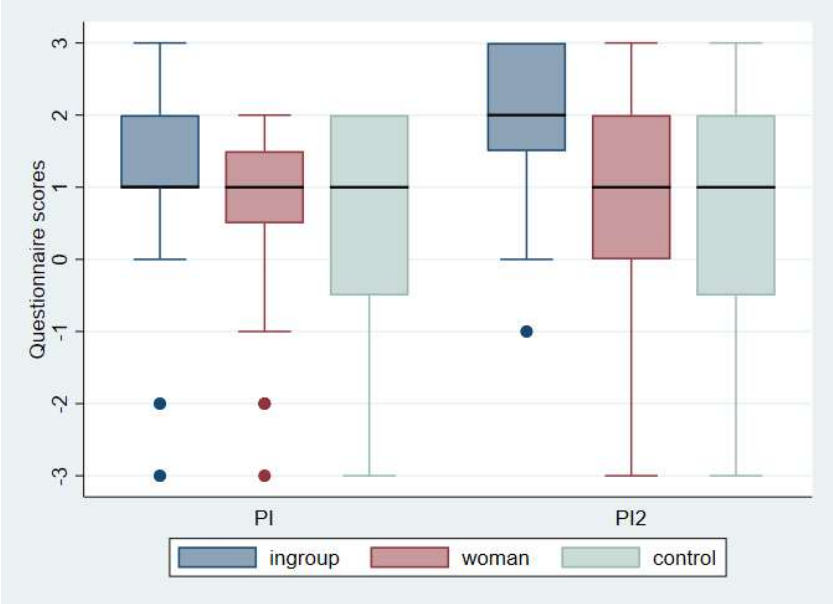


Figure 38: Box plot presenting the level of place Illusion per condition after exposure to the Milgram scenario. The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots.

The Place Illusion was high for all the participants independetly of the condition.

Overall the medians are comprised between 1 and 2 (the maximum score being 3).

Questionnaire on responses after the VR experience -3: never, 3: all the time	**Name of the variable**
¿Hasta qué punto tu respuesta emocional dentro de la sala de entrenamientos ha sido la misma que si hubiera sido real? *How much was your emotional response in the training room the same as if it had been real?*	Emotional_response_Real
¿Hasta qué punto los pensamientos que tuviste dentro de la sala de entrenamientos fueron los mismos que en una situación real? *How much were the thoughts you had within the training room the same as if it had been a real situation?*	Thoughts_Real

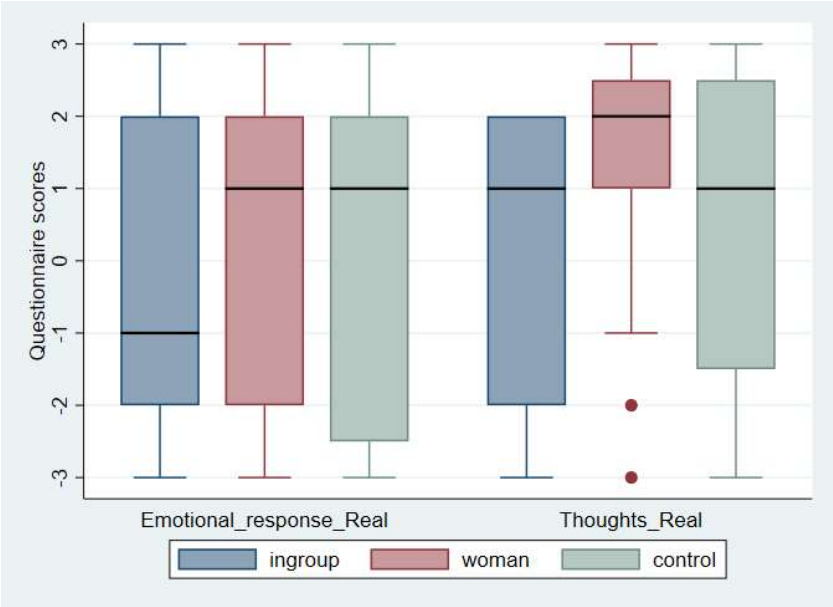


Figure 39: Box plot presenting the level of realism attributed by participants to their emotional response and thoughts during the Milgram scenario (results presented by condition). The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots.

Participants in all three conditions reported that the thoughts they had while they were in the VR situation, were similar to the ones they would have had in a real situation. As in the first session, participants in the in-group condtion reported a low level of emotional involvment in the virtual situation (median= -1), we ran a Wilcoxon rank sum test showing that the difference with the participants in the woman condition was not significant (p =0.53). Participants in the woman condtion reported a higher level of realism of their thoughts than participants in the in-group condtion, the difference was close to significance (p=0.055) with P(woman) > P(in-group)= 0.77. But the difference between the participants in the woman condtion and participants in the control condition was not significant (p= 0.37).

Questionnaire on responses after the VR experience: **-3: never, 3: all the time**	**Name of the variable**
¿Hasta qué punto pensaste, sé que esto no es real pero te sorprendiste actuando como si fuera una situación real? *How much were you thinking things like 'I know this isn't real' but then surprisingly finding yourself behaving as if it were real?*	Acting_as_if_Real

¿Durante el transcurso de la experiencia, hasta qué punto estabas atento a lo que te decían los chicos (experimentadores)? *During the course of the experience, how much were you paying attention to what the guys (experimenters) were telling you?*	Attention_Avatars

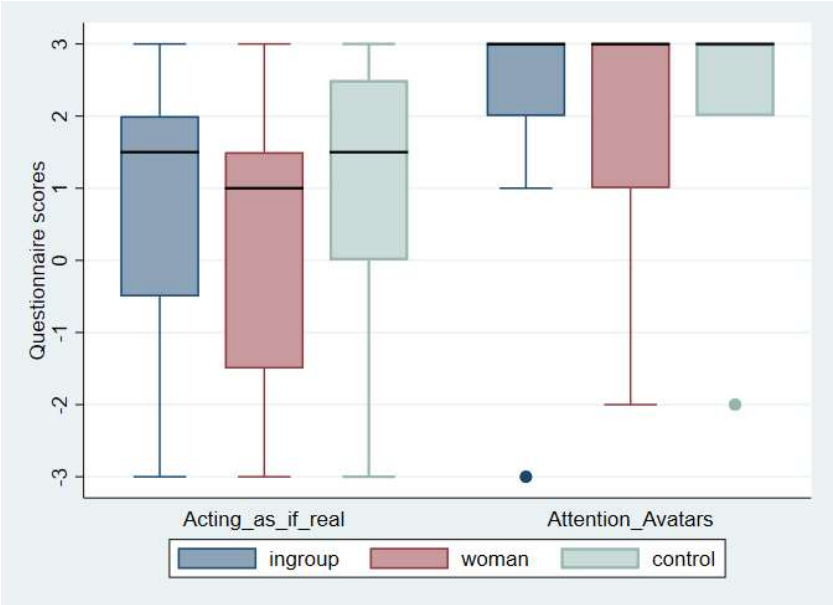


Figure 40: Box plot presenting the level of realism attributed by participants to their behaviour and attention during the Milgram scenario (results presented by condition). The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots.

All the participants reported that, although they knew the situation was not real, their behavior was similar to the one they would have had in a real situation. Medians were comprised between 1 and 2 (the maximun score being 3) in all three conditions, which indicates that our behavioral results are reliable. Participants in all three conditions reported that they were paying the maximum level of attention to the virtual experimenters (median=3). This is very important since we measured the effect of the social interation with those male avatars on the behaviour of our particpants.

3.2.8 **Number of Shocks**

We measured the number of shocks that participants administered during the Milgram scenario to evaluate their pro-social behaviour towards the victim depending on the condition they were assigned to during the terrace scenario.

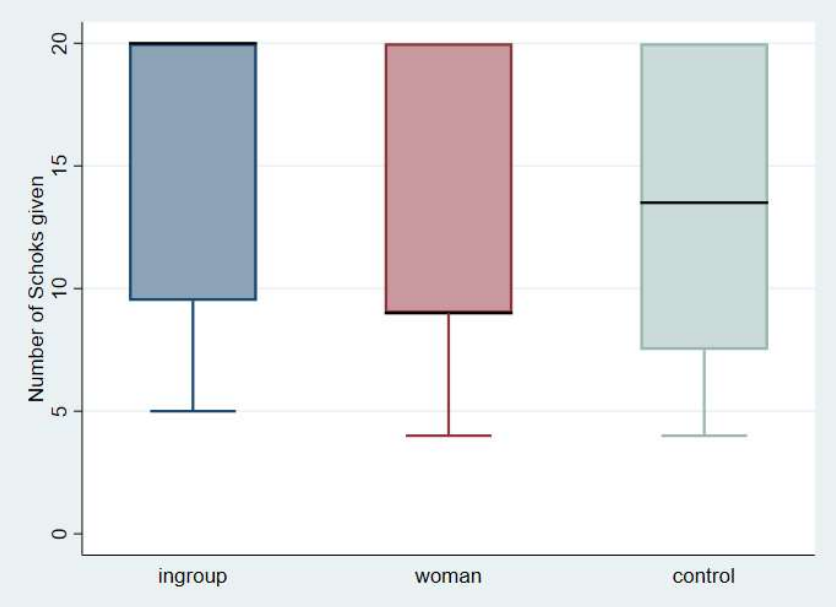


Figure 41: Box plot presenting the number of shocks depending on the condition. The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots.

We observe that the median for the in-group condition (median=20) is higher than the median for the woman and control conditions. The lowest median observed is the one of the woman condition (median =10) showing a tendency of giving less shocks if having experienced the verbal harassment scene from the perspective of the woman in the first session. We ran a two-sample Wilcoxon rank-sum test indicating that there is a marginally significant difference between the in-group condition and woman condition (p= 0.065). The difference between the in-group and control condition is on the edge of significance (p= 0.0875) whereas the difference between the woman and control condition is not significant (p= 0.944). Our interpretation of those results is that being in the in-group condition during the verbal harassment scene emphasized the effect of authority and group pressure on the participants during the Milgram scenario. Being encouraged by the virtual experimenters to behave aggressively towards the victim, had a greater effect on participant's behaviour, when they had been treated as part of the group of males in the second phase of the terrace scene (and subjectively felt as more integrated to the group,

see Figure 34). We therefore observe a strong "in-group effect" on those participants leading them to enter in a violent behaviour towards the victim, under the influence of the virtual experimenters treating them (again) as "part of their group".

As mentioned before, we recruited participants both inside and outside the university campus, which resulted in a sample including both students and non-students. Some surprising differences appeared in the results depending on the status of our participants.

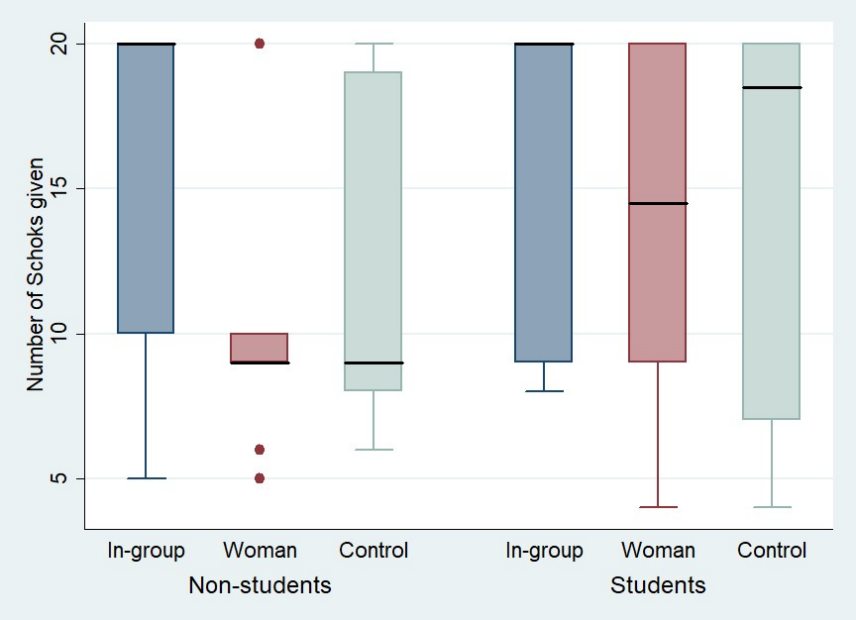


Figure 42: Box plot presenting the number of shocks depending on the condition and occupation. The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots.

Figure 42 shows that, amongst the Students there was no significant difference in the number of shocks between the three conditions. However, amongst the "non-students", the number of shocks administered was very low for participants in the woman condition compared to the in-group condition, the median was inferior to 10 and the IQR was 1, compared to 11 in the control condition and 10 in the in-group condition. We ran a Wilcoxon rank sum test showing that the difference between the in-group condition and woman condition (in terms of the number of shocks) was close to significant ($p= 0.063$) for "non-students". Whereas for students the difference of the number of shocks was not significant between participants in the woman condition and participants in the in-group condition ($p= 0.59$).

3.3 EXPERIMENT III: CHANGING PERSPECTIVE ON A PERSONAL PROBLEM THROUGH SELF-CONVERSATION

The third experiment was designed in order to measure the effect of having a conversation with oneself for solving a personal problem. Two groups of participants went through a procedure of three different sessions in which they had to define a problem and talk about it with an avatar of Sigmund Freud inside a virtual consulting room. In the experimental condition (self-conversation) participants were swapping between their own avatar and the avatar of Freud entering in a real time dialogue with themselves. They were instructed to give some advice to the person in front of them when embodied in Freud and therefore provided themselves with their own solutions. In the control condition, participants were having a dialogue with the avatar of Freud inside the same virtual room, but in that case the answers were pre-scripted. Participants in the control condition therefore experienced the dialogue with the virtual Freud but received some general advice instead of listening to their own answers to the problem. One week after the session in VR, all the participants came back to the laboratory for a follow up session in order to measure the effect of the procedure on the evolution of their personal problem.

3.3.1 **Participants**

Table 11: Age characteristics of the participants (mean ± SD) by condition, the age distribution was similar in the two conditions, excluding any possible age effect for the results obtained.

Condition	Females (n=30)	Males (n=28)	Total (n=58)
Control (n=29)	20.0 ± 2.27	22.9 ± 4.17	21.41 ± 3.53
Self-conversation (n=29)	20.3 ± 2.64	23.1 ± 5.0	21.55 ± 4.03

3.3.2 **Body ownership**

We measured Body ownership illusion over the virtual avatar that was recreated from the scanning process (see Section 2.4.2.1) in both conditions. In the self-conversation condition, we also measured body ownership towards the virtual body of Freud's avatar.

Body ownership questionnaire: **-3: completely disagree, 3. completely agree** (Here all the questions refer to the scanned avatar of the participant)	**Name of the variable**
Cuando estaba sentado en frente de Freud, he sentido que el cuerpo virtual que veía cuando miraba hacia abajo era mi propio cuerpo *When I was sitting in front of Freud, I had the feeling that the virtual body I saw when I looked down was my body*	OwnLookDown
Cuando estaba sentado en frente de Freud, he sentido que el cuerpo virtual que veía cuando miraba hacia el espejo era mi propio cuerpo *When I was sitting in front of Freud, I had the feeling that the virtual body I saw when I looked towards the mirror was my body*	OwnMirror
Cuando estaba sentado en frente de Freud, he sentido que los movimientos del cuerpo virtual estaban causados por mis propios movimientos *When I was sitting in front of Freud, I had the feeling that the movements of the virtual body were caused by my own movements*	OwnAgency

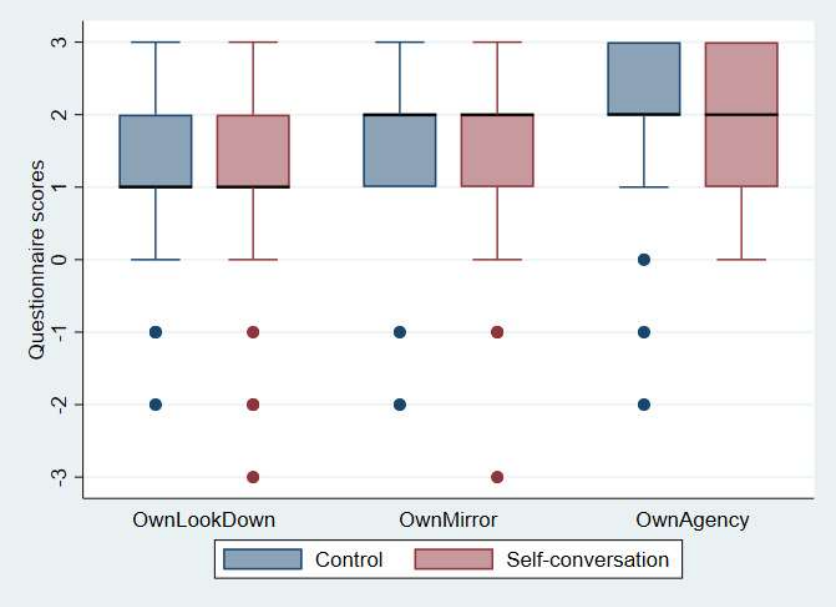


Figure 43: Box plot presenting the level of body ownership over the scanned body of the participant, by condition, after exposure to the conversation in VR. The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots.

Figure 43 presents the level of Body ownership and agency experienced by participants towards their scanned body depending on the condition. We see that in both conditions the level of BO and agency is similar and very high (median comprised between 1 and

2). Changing between their scanned body and the body of Freud did not affect the level of body ownership experienced by participants in the self-conversation condition.

Body ownership questionnaire referring to the body of Freud: -3: completely disagree, 3 completely agree (Here all the questions refer to the avatar of Freud)	**Name of the variable**
Cuando estaba en el cuerpo de Freud, aunque el cuerpo virtual no se parecía a mi físicamente, he sentido que el cuerpo virtual que veía cuando miraba hacia abajo era mi propio cuerpo *When I was in Freud, I had the feeling that the virtual body I saw when I looked down was my body*	FreudLookDown
Cuando estaba en el cuerpo de Freud, he sentido que el cuerpo virtual que veía cuando miraba hacia el espejo era mi propio cuerpo *When I was in Freud, I had the feeling that the virtual body I saw when I looked towards the mirror was my body*	FreudMirror
Cuando estaba en el cuerpo de Freud, he sentido que los movimientos del cuerpo virtual estaban causados por mis propios movimientos *When I was in Freud, I had the feeling that the movements of the virtual body were caused by my own movements*	FreudAgency

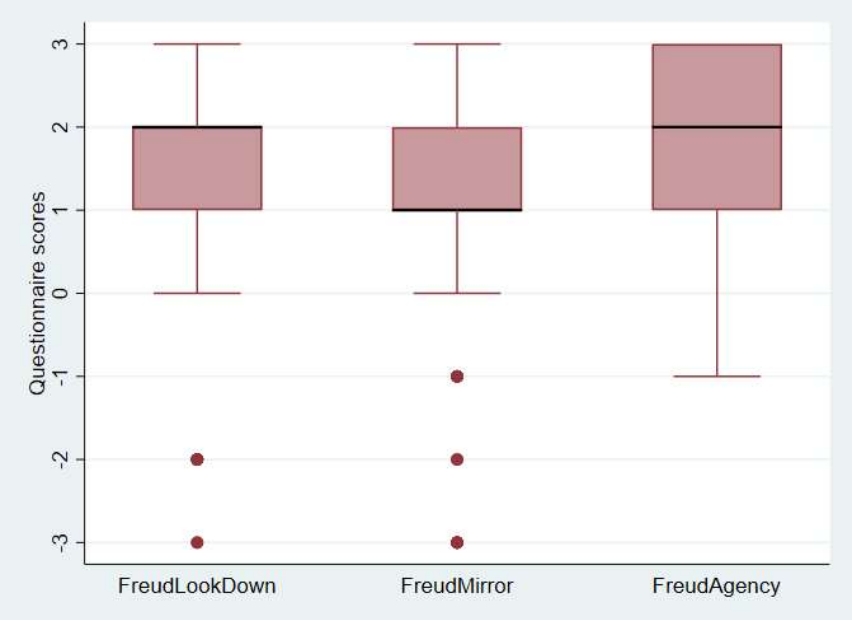


Figure 44: Box plot presenting the level of body ownership over the virtual body of Freud, note that this applies only to the Self-conversation condition. The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots.

The level of body ownership and agency felt towards the virtual body of Freud was very high (median ≥ 1). This result is key to our experiment given that we needed our participants to be embodied in Freud's body during the conversation they were having with themselves.

3.3.3 **Presence and co-presence**

After the VR session we measured the level of Presence experienced by our participants. The presence questionnaire was the same for participants in both conditions.

Presence questionnaire: **-3: completely disagree, +3: completely agree**	**Name of Variable**
He tenido la sensación de estar sentado/a en la consulta virtual *I had the sensation of sitting inside the virtual consulting room*	Presence
He tenido la sensación de estar compartiendo la consulta virtual con la otra persona, como si realmente estuviésemos en el mismo lugar *I had the sensation of sharing the consulting room with the other person as if we were really in the same place*	CoPresence
He sentido que la otra persona me estaba hablando a mi *I felt that the other person was talking to me*	TalkingtoMe

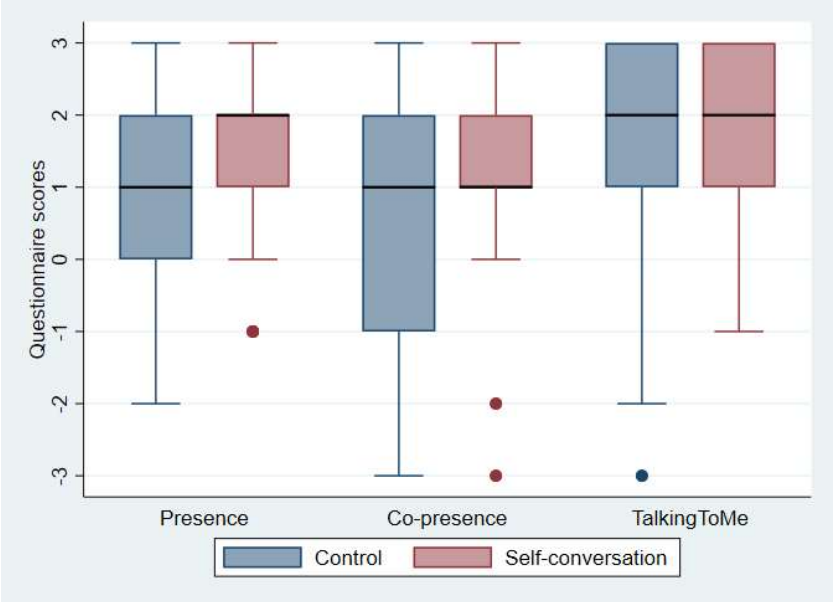


Figure 45: Box plot presenting the level of presence and co-presence depending on the condition. The horizontal thick lines indicate the value of the medians, the boxes are the interquartile ranges (IQR), the whiskers extend from max (median - 1.5*IQR, smallest value) to min (median + 1.5*IQR, largest value). Outliers are shown individually as separated dots.

Figure 45 shows that the levels of presence and co-presence reported by participants in both conditions were very high, it is interesting to note that our participants felt that the avatar of Freud was talking to them independently of the condition (median = 2).

3.3.4 **Responses to the virtual situation**

We measured various aspects of the participant's responses to the virtual situation.

Responses to VR: **-3: completely disagree, 3: completely agree**	**Name of Variable**
He tenido la sensación de que la conversación entre la otra persona y yo estaba ocurriendo realmente *I had the sensation that the conversation between the other person and me was really happening*	ConversationReal
Mi respuesta emocional ha sido la misma que hubiera tenido en una situación real *My emotional reaction was the same as the one I would have had in a real situation*	EmotionsReal
Mi comportamiento ha sido el mismo que hubiera tenido en una situación real *My behaviour was the same as to one I would have had in a real situation*	BehaviorReal
Mis pensamientos en relación a la conversación han sido los mismos que en una situación real *My thoughts related to the conversation were the same as in a real situation*	ThoughtsReal

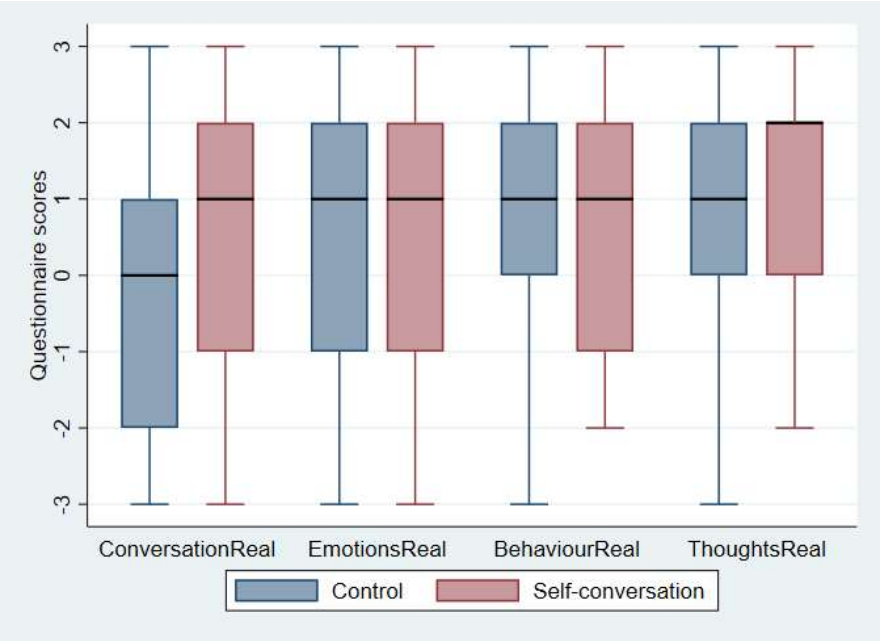


Figure 46: Level of realism reported after the exposure to the conversation in VR - Box plots corresponding to the responses experienced by the participants depending on the condition they were assigned to. The thick horizontal black lines are the medians, the boxes are the interquartile ranges (IQR), and the whiskers range between (lower quartile – 1.5*IQR) and (upper quartile + 1.5*IQR).

We observe that overall, participants felt as if the conversation was really happening. The median is slightly higher in the self-conversation condition which is surprising because the body swapping could have resulted in a sensation of less realism since it is something impossible. We believe that the conversation is rated as less real in the control condition because the answers were pre-programmed and therefore sometimes seemed a bit artificial to some participants, even if overall, they had the sensation of having a real dialogue with the avatar of Freud.

Nervousness: **-3: completely disagree, 3: completely agree**	**Name of Variable**
El terapeuta me ha hecho sentir cómodo/a *The therapist made me feel comfortable*	Comfortable
El terapeuta me ha puesto nervioso/a *The therapist made me feel nervous*	Nervous

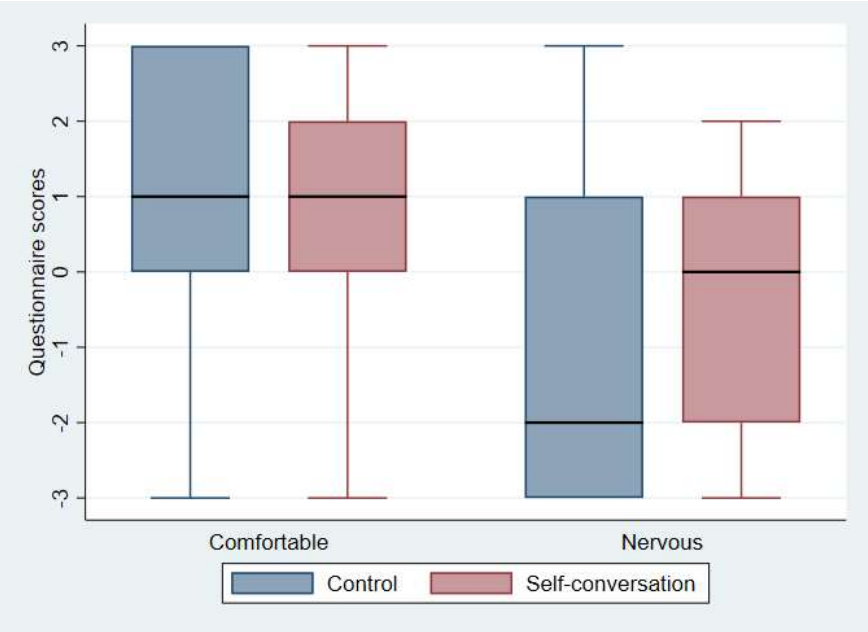


Figure 47: Box plots corresponding to the level of nervousness reported by the participants after the VR experience. The thick horizontal black lines are the medians, the boxes are the interquartile ranges (IQR), and the whiskers range between (lower quartile – 1.5*IQR) and (upper quartile + 1.5*IQR).

In both conditions, participants reported that they felt comfortable during the VR session (median=1). Participants in the self-conversation condition reported a higher level of nervousness than participants in the control condition but the difference was not significant (p= 0.428).

3.3.5 **Outcome of the VR session in relation to the personal problem**

Outcome of the VR session: **-3: completely disagree, 3: completely agree**	**Name of Variable**
Siento que ahora tengo más conocimiento acerca de mi problema *I feel that I have now more knowledge about my problem*	MoreKnowledge
Pienso que después de esta experiencia en la consulta virtual, soy capaz de entender mejor mi problema *I think that after this experience in the virtual consulting room, I am able to understand my problem better*	BetterUnderstanding
Siento que controlo mejor mi problema *I feel I have a better control of my problem*	BetterControl

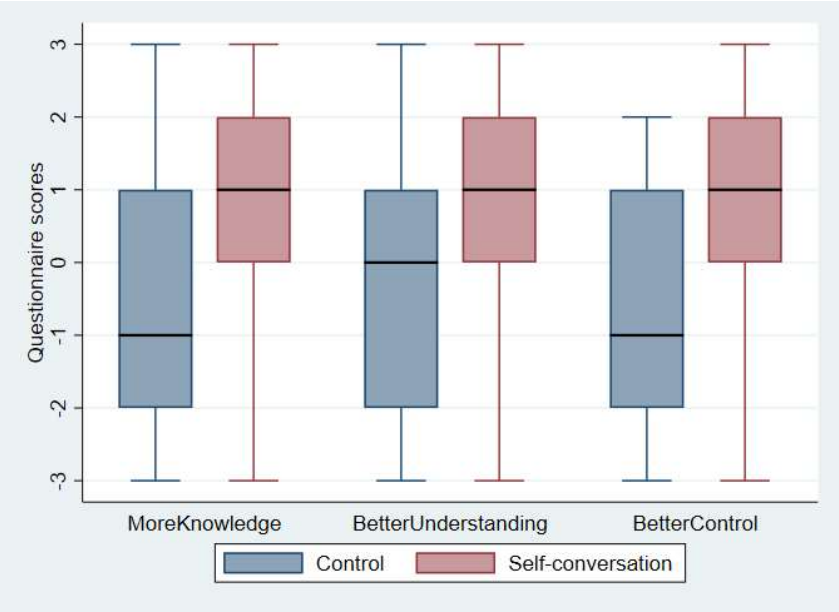


Figure 48: Evolution after the exposure to the conversation in VR. The thick horizontal black lines are the medians, the boxes are the interquartile ranges (IQR), and the whiskers range between (lower quartile – 1.5*IQR) and (upper quartile + 1.5*IQR).

After the VR session all participants answered a questionnaire about the changes they had experienced in relation to their personal problem (see VR questionnaire in Appendix D). We observe that participants in the self-conversation condition reported that the VR session gave them more knowledge about their problem than the participants in the control group (p= 0.01). The self-conversation also resulted in a better understanding of the personal problem (p=0.006) and in a better control (p= 0.007) over it. All the differences between the two conditions are significant, showing an important effect of the self-conversation condition on helping the participants to get better in relation to their problem. These results can be verified by the qualitative analysis presented in Section 3.3.6.

Outcome of the VR session: **-3: completely disagree, 3: completely agree**	**Name of Variable**
Este dialogo me ayudó a tener una nueva perspectiva sobre mi problema *This dialogue helped me in getting a new perspective on my problem*	NewPerspective
Creo que puedo tener nuevas ideas sobre cómo solucionar mi problema *I think that I can get new ideas about how to solve my problem*	NewIdeas

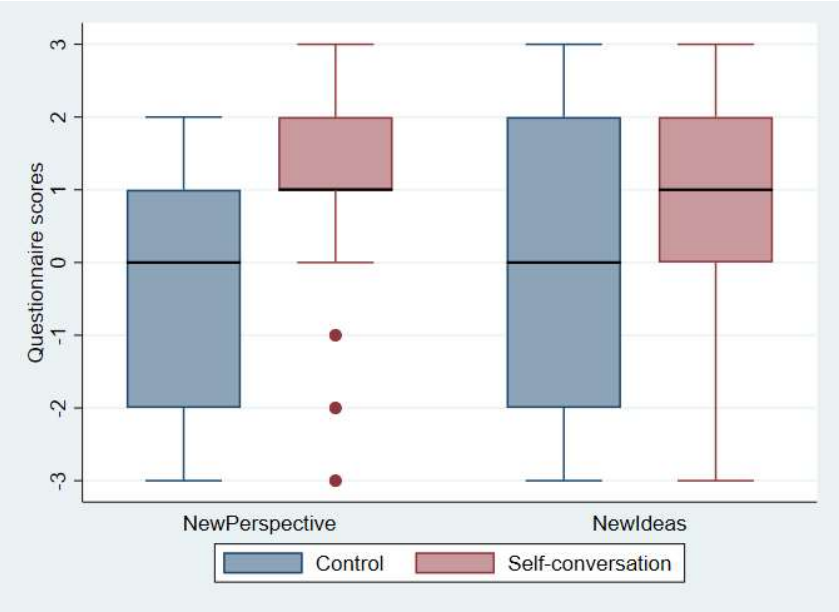


Figure 49: Responses after the exposure to the conversation in VR. The thick horizontal black lines are the medians, the boxes are the interquartile ranges (IQR), and the whiskers range between (lower quartile – 1.5*IQR) and (upper quartile + 1.5*IQR).

Figure 49 shows that the participants in the Self-Conversation condition were significantly more likely to get new ideas about their problem (p= 0.024) and a new perspective on their problem (p= 0.00). Again, those results are confirmed by the qualitative analysis of the interviews conducted in the follow up session, one category that came out of the codification and frequency analysis was: new perspective, new point of view on the problem (see Section 3.3.6).

3.3.6 **Qualitative data analysis**

During the follow up session, participants filled in the Changes questionnaire based on the Change interview by Elliott, Slatick, & Urman (2001). The questions are related to the changes experienced by the participant during the previous week. All the questions are oriented to explaining what has changed if a change has occurred. Here we combined the answers of the participants to the whole questionnaire and created two different word clouds showing the word frequency depending on the condition. Table 12 presents the frequency for each word depending on the condition. Frequency was calculated using the software Nvivo, the criterion to include each word in the word cloud was that it had to be repeated at least two times between conditions, or within one condition, but not by the same participant. If a participant repeated the same word several times we counted it as

only one to avoid artificial effects of repetition of one category. Nvivo allows to group some words when the meaning is the same, in the table we indicate all the words that were grouped in one in the word cloud. The second column indicates the translation of the Spanish words to English.

Table 12: Qualitative information about the changes experienced by the participants during the week after the VR session. The table presents the frequency of each word in the answers of the participants to the changes questionnaire. The words frequency analysis was done with the software Nvivo12. Categories are defined based on the words participants spontaneously used to describe their experience, some words are found in both conditions and we report the number of repetitions (frequency) for each word in each condition

Words (Spanish)	**Translation**	**Words frequency (experimental condition)**	**Words frequency (control condition)**
Pensar, pensarlo	Think about it	10	10
Solución, solucionar	Solution, solve	10	6
Cambio, cambiar	Change, changing	6	6
Control, controlar, controlarme	Control, controlling myself	6	0
Consciencia, consciente	Consciousness, conscious	5	5
Hablar	To talk	5	5
Mejor	Better	5	3
Perspectiva	Perspective	5	1
Actuar	To act	4	1
Afrontar	To confront	4	1
Aceptar	To accept	3	0
Aconsejarme	Give advice to myself	3	0
Capacidad, capaz	Capacity	3	2
Poder	Power	3	3
Positivo	Positive	3	1

Reflexionar	To reflect on	3	3
Tranquilo/a	Quiet	3	1
Analizar	To analyse	2	1
Ayuda	Help	2	4
Claridad	Clarity	2	0
Decidir, decisiones	To decide, decision(s)	2	1
Dialogar	To converse	2	0
Logrado, lograr	Achieve(d)	2	0
Posible	Possible	2	1
Relajarme	Relax	2	0
Abrirme	To open up	1	1
Animada	Cheerful	1	1
Bienestar	Wellness	1	1
Disfrutar	To enjoy	1	1
Entender, entenderme	To understand (myself)	1	2
Herramienta	Tool	1	1
Iniciativa	Initiative	1	1
Interesante	Interesting	1	1
Nada	**Nothing**	**1**	**9**
Seguridad, seguro	Reliability, reliable	1	1
Superarlo	Get over it	1	1

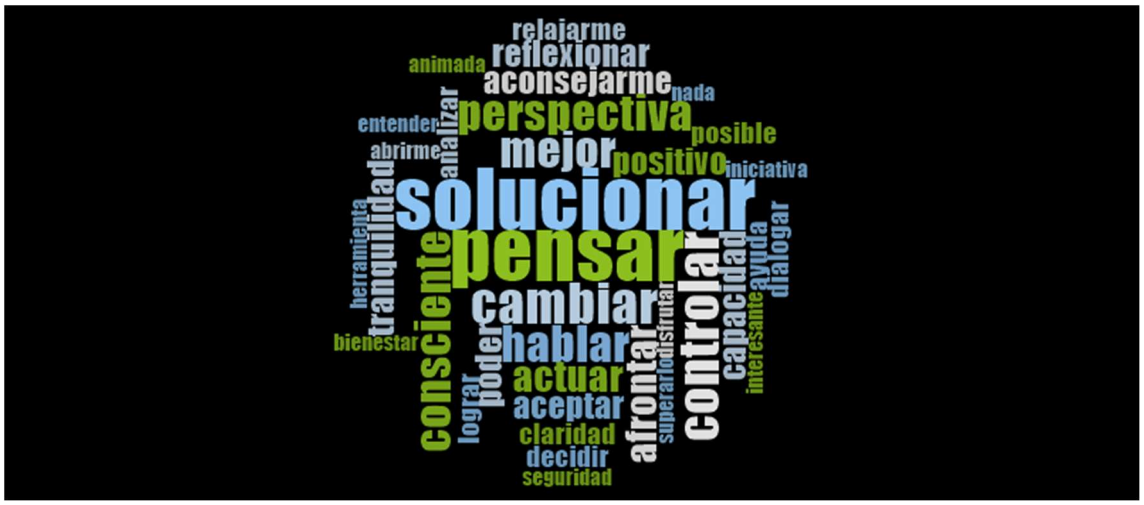


Figure 50: Word cloud showing the word frequency of the participants in the self-conversation condition

Figure 51: Word cloud showing the word frequency of the participants in the control condition

The words “pensar” (*to think*) appear in both conditions with the same frequency (34.5%), the word “solucionar” (*to solve*) also appears in both conditions but with more frequency in the self-conversation group (34.5%) than in the control group (20.7%). The action words: “controlar” (*to control*), “actuar” (*to act*), “afrontar” (*to confront*) are more represented in the self-conversation condition. The word “perspectiva” (*perspective*) is also observed more frequently in the self-conversation condition.

A qualitative analysis of the changes questionnaires and of the follow up interview allowed us to determine which part of the experimental procedure was associated to the changes experienced by our participants depending on the condition to which they were assigned.

Table 13: Changes **before the VR session** (changes due to the initial meeting)

Condition	Changes	No changes	Total
Self-conversation	13	16	29
Control	11	18	29
Total	24	34	58

Table 14: Changes **right after the VR session**

Condition	Changes	No changes	Total
Self-conversation	**25**	4	29
Control	11	18	29
Total	37	22	58

86.2% of the participants in the self-conversation condition reported that they experienced a change after the VR session, whereas it was only 37.9% of the participants in the control condition.

Table 15: Changes **one week after the VR** session based on the changes questionnaire and the qualitative analysis of the follow up interview.

Condition	Changes	No changes	Total
Self-conversation	25	4	29
Control	14	15	29
Total	39	19	58

Two participants reported contradictory information between the questionnaire and the interview: one participant reported no changes in the questionnaire and said in the interview that the VR session did trigger a change, another participant reported a change in the questionnaire but it was due to events in his daily life that were unrelated to the experimental procedure. The information from the interview is the one reflected in those results given that it gives more details on the quality of the change if there was one.

In the following table (Table 16) we report only the results for the participants who experimented a change during the procedure.

Table 16: The following table presents the results to the question: "*Which part of the procedure helped you to change?"*

Condition	Initial Meeting	VR session	Repeated exposure to the problem
Self-conversation	0	22	3
Percentage	0%	**88.5%**	11.5%
Control	3	4	7
Percentage	21.4%	28.6%	**50%**

We observe that 88.5% of the participants in the self-conversation condition, who experienced a change during the experimental procedure, reported that this change was due to the VR session. In the control condition, only 28.6% of the participants who experienced a change attributed it to the VR session, participants in the control group were more likely to report that the change they experienced was due to being exposed repeatedly to the problem during the experimental procedure and thinking about it over and over again.

Table 17: Categories explaining the reasons for the changes reported by the participants in both conditions, during the follow up interview

Categories (Spanish)	**Translation**	**Frequency (self-conversation condition)**	**Frequency (control condition)**
Actuar differente	Behave differently	12	4
Propias respuestas, propias soluciones	Own answers, own solutions	12	3
Sentirme mejor, mejorar	Getting and feeling better	11	6

Hablar conmigo mismo, contestarme	Talk to myself	9	0
Nueva perspectiva, otro punto de vista	New perspective, other point of view	8	1
Como si fuera otra persona	Myself as another person	8	0
Desde fuera	From outside	6	1
Más consciente	More conscious	6	3
Quitar importancia	Less importance	6	3
Reflexionar	To reflect upon it	6	4
Enfrentarme	Face it	5	1
Explicarlo, decirlo en voz alta, hablarlo	Explain it, Say it out loud	5	4
Verme a mi mismo	See myself	5	0
Darle vueltas	Brood on	4	3
Mas racionalidad, objetividad	More rational, more objective	4	1
Ya no es un problema	Not a problem anymore	3	0

Sacar el trasfondo	Understand the backstory	3	0
Hablar del problema con otra (s) persona(s)	Talk about the problem to others	3	5
Aceptar, asumir	Accept it	2	0
Introspección	Introspection	2	0
Más optimista	More optimistic	2	0
Pensarlo más	**Think more about it**	**0**	**9**
Ningún cambio	**No changes**	**0**	**7**
Raro	**Weird**	**0**	**6**
Cambiar la manera de verlo	Change the way to see it	0	3
Más control	More control	0	2
Más positivo	More positive	0	2
Tenerlo presente	Keep it in mind	0	2

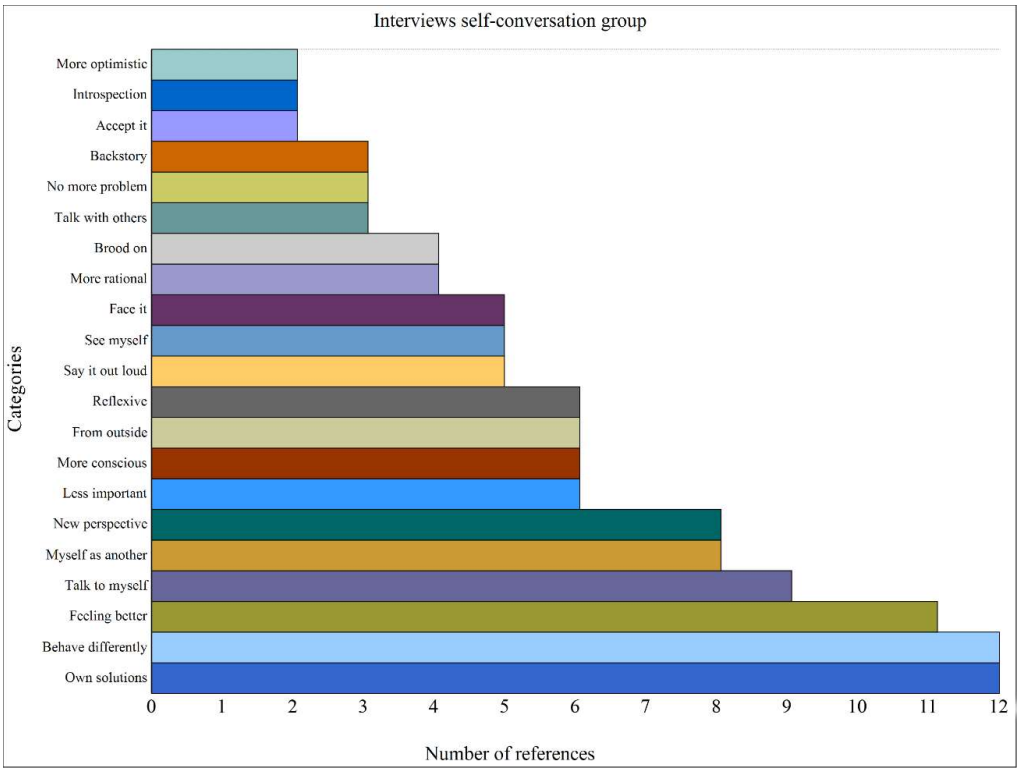


Figure 52: Graphic representation of the frequency observed for each category expressed in the follow up interview, in the self-conversation condition. The number of elements classified in each category appears on the x axis, the name of each category appears on the y axis.

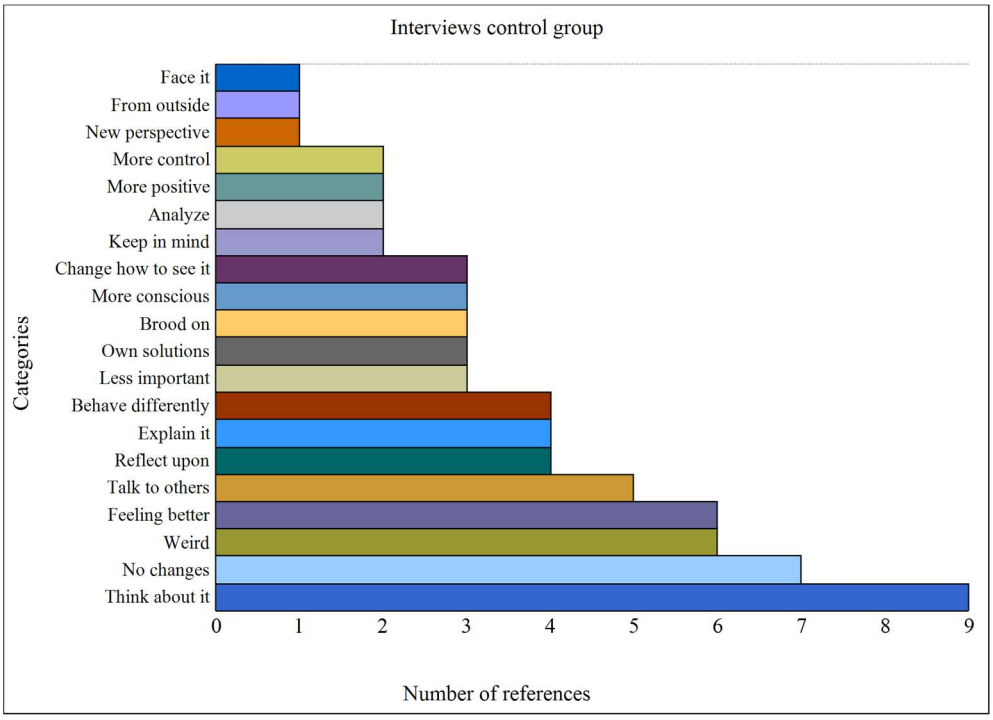


Figure 53: Graphic representation of the frequency observed for each concept expressed in the follow up interview, in the control condition. The number of elements classified in each category appears on the x axis, the name of each category appears on the y axis.

We observe that the categories "Own solutions" and "Behave differently" appear in both conditions, with more frequency in the self-conversation condition. For 12 participants in the self-conversation condition and 4 participants in the control condition, the change reported was not only in their thoughts but also in their behaviour. This result is quite important and would need to be expanded to further research.

We believe that seeing the problem from an external point of view was very powerful in triggering changes for the participants in the self-conversation condition. Indeed, the categories "talking to myself", "new perspective", "myself as another" are highly represented in the results obtained in this condition. The changes experienced by the participants in the self-conversation condition were highly related to the fact that they found themselves "obliged" to find their own answers to the problem that their scanned avatar was exposing to them when embodied as Freud.

One example categorized as "own solutions" is the following sentence: *"Es curioso porque cuando lo hable conmigo mismo… te daba la posibilidad de* ***entender que tú tenías tus propias soluciones…*** *eras tú el que estaba en el otro lado, un poco raro pero… pero eres tú quien tiene que solucionar el problema."*

Translation: *It is strange because when I was talking about it with myself… it gave you the possibility to* ***understand that you had your own solutions****… It was you who was on the other side, a bit weird but … but you are the one who has to solve the problem."*

An example of comment categorized as "understand the backstory": *"Pues, hablando conmigo misma, de esa manera de que se cambiaban los papeles, pues preguntando a mí misma****, al final saque, pues eso que cuál era el trasfondo del problema"***

Translation: *"Well, talking with myself, in this way in which the roles were changing, well, asking questions to myself,* ***in the end I got, well this, what was the underlying part of the problem****.*

This categorisation is the first step for a deeper qualitative analysis of the data obtained in this study. The next step is to determine relations between categories that have been identified here.

3.3.7 **Results clinical questionnaires:**

Table 18: The following table presents the results to the Automatic thoughts questionnaire at two different time points, Initial Meeting refers to the scores obtained during the first session, Follow up refers to the scores obtained in the third session, one week after the VR session.

	ATQ_InitialMeeting (mean ± SE)	ATQ_Follow-up (mean ± SE)
Self-conversation (n=29)	14.18 ± 0.80	13.14 ± 0.94
Controls (n=29)	13.69 ± 0.95	14.89 ± 0.78

We present the measures obtained for each group depending on the condition. Since the same measure was taken at two different time points on the same group of individuals, we applied a paired t-test to the scores obtained by the participants (in each condition), in the initial meeting and in the follow up session. For the control group, the difference was not significant ($p= 0.19$). For the self-conversation group, the paired t-test showed a significant difference ($p= 0.034$). These results show that negative automatic thoughts about the self were decreased one week after the VR session, but only for the participants in the self-conversation group.

Table 19: The following table presents the results of the CORE questionnaire at two different time points, Initial Meeting refers to the scores obtained during the first session, Follow up refers to the scores obtained in the third session, one week after the VR session.

	CORE_InitialMeeting (mean ± SE)	CORE_Follow-up (mean ± SE)
Self-conversation (n=29)	0.99 ± 0.08	0.86 ± 0.10
Controls (n=29)	1.24 ± 0.09	0.95 ± 0.10

We applied the same procedure for the differences observed in the CORE questionnaire, and we observed a decrease for both groups. The paired t-test showed a significant difference for the control group ($p= 0.00$) and for the self-conversation group ($p=0.04$). These results show that the experimental procedure had a positive influence on participants, but those results are not specific to the effect of the self-conversation in VR.

They are consistent with the changes reported in the control group, due to the repeated exposure to the problem and the opportunity they got to talk about it with a psychologist.

Table 20: The following table presents the results to the STAI-state questionnaire at two different time points, Initial Meeting refers to the scores obtained during the first session, Follow up refers to the scores obtained in the third session, one week after the VR session.

	STAI_InitialMeeting (mean ± SE)	STAI_Follow-up (mean ± SE)
Self-conversation (n=29)	12.39 ± 1.13	14.11 ± 1.37
Controls (n=29)	15.31 ± 1.72	13.86 ± 1.24

For the STAI-state questionnaire, there was no significant difference between the measures taken before the initial meeting during the first session, and one week after the VR experience, during the follow up session. The paired t-test did not show any significance nor for the self-conversation group ($p= 0.18$), neither for the control group ($p= 0.30$).

Table 21: The following table presents the results to the STAI-state questionnaire at two different time points, during the same session, a baseline of the participant's state was measured just before the VR experience and the measure was taken again right after the VR session.

	STAI_beforeVR (mean ± SE)	STAI_afterVR (mean ± SE)
Self-conversation (n=29)	13 ± 1.35	16.41 ± 1.74
Controls (n=29)	14.38 ± 1.28	15.62 ± 1.69

The STAI questionnaire was given two times during the second session (before the VR experience and right after the VR experience), we observed a significant difference for the participants who went through the self-conversation in VR ($p= 0.01$). The difference was not significant for the control group ($p= 0.43$). These results indicate that the level of stress was slightly increased right after the VR session, when participants were having a conversation with themselves. We believe that those participants went deeper into their problem than participants in the control condition, and therefore came out of VR a bit

more nervous. This is consistent with the results obtained in the levels of nervousness reported by participants in the self-conversation condition (see Figure 47).

Table 22: The following table presents the results to the depression subscale of the DASS questionnaire, at two different time points, Initial Meeting refers to the scores obtained during the first session, Follow up refers to the scores obtained in the third session, one week after the VR session.

	DASS_DEP_InitialMeeting (mean ± SE)	DASS_DEP_Follow-up (mean ± SE)
Self-conversation (n=29)	3.59 ± 0.49	2.66 ± 0.62
Controls (n=29)	4.65 ± 0.72	3.58 ± 0.57

There was a decrease in the DASS depression subscale scores between the initial meeting and the follow up session. The difference was significant for both the self-conversation group ($p= 0.07$) and the control group ($p= 0.01$). As for the results obtained with the CORE questionnaire, we believe that this decrease in both condition is due to the effect of the whole procedure on participants.

Table 23: The following table presents the results to the anxiety subscale of the DASS questionnaire, at two different time points, Initial Meeting refers to the scores obtained during the first session, Follow up refers to the scores obtained in the third session, one week after the VR intervention.

	DASS_Anx_InitialMeeting (mean ± SE)	DASS_Anx_Follow-up (mean ± SE)
Self-conversation (n=29)	2.92 ±0.45	2.14 ± 0.39
Controls (n=29)	3.34 ± 0.43	2.48 ± 0.42

There was a small decrease in the DASS anxiety subscale scores, between the initial meeting and the follow up session, but the difference was not significant, nor in the self-conversation group ($p= 0.10$) neither in the control group ($p= 0.11$).

Table 24: The following table presents the results to the stress subscale of the DASS questionnaire, at two different time points, Initial Meeting refers to the scores obtained during the first session, Follow up refers to the scores obtained in the third session, one week after the VR session.

	DASS_Stress_InitialMeeting (mean ± SE)	DASS_Stress_Follow-up (mean ± SE)
Self-conversation (n=29)	6.22 ± 0.60	5.81 ±0.65
Controls (n=29)	7 ± 0.66	6.90 ± 0.65

We observed a small decrease in the DASS stress subscale scores, between the initial meeting and the follow up session, but the difference was not significant, nor for the self-conversation group ($p= 0.54$) neither for the control group ($p= 0.88$).

4 DISCUSSION

"We contrive to find resemblances between things in spite of their diversity, and to take a stable view of them in spite of their instability; in this way we obtain ideas which we can control, whereas the actual things may elude our grasp. All this is the work of man."

(in *The two sources of morality and religion*, H. Bergson, 1932)

4.1 EXPERIMENT I: THE IMPACT OF FIRST-PERSON PERSPECTIVE ON BODY PERCEPTION

As we saw in the introduction, there is an internal representation of one's body based on the stored visual information coming from visual perception of oneself and of others. (Section 1.3.3.1). In this first experiment, we explored the mental representation of one's body shape. We re-created a virtual representation of the internal image participants had of their own body shape, the stored model of their body characteristics generated from all the memories relative to the visual perception of themselves. We use the term "body image" to refer to the internal representation of the visual aspect of one's body shape. As it was observed by Longo & Haggard (2010) we expected this internal model to be very inaccurate, we also expected this model to be vulnerable to pre-existing beliefs about the self as described in (Mussap & Salton, 2006).

With this experiment, we show that embodiment and change in perspective affected the evaluation of the attractiveness of a virtual body. When the same virtual body was perceived from a third person perspective, it was evaluated as more attractive than when it was perceived in first person perspective. We hypothesize that prior beliefs about the self could be responsible for this effect. In this study, we observed a negative bias when the virtual body was perceived in 1PP: the negative pre-existing beliefs about the self directly affected the interpretation of the visual stimulus associated to self-perception (the virtual body). If we change the perspective, the virtual body is no longer associated to the self, but perceived as the body of someone else, therefore the prior beliefs applied to the visual stimulus are modified, the interpretation of this visual stimulus is changed, and the evaluation of the virtual body is modified.

It is interesting to note that female participants wanted their body to resemble the avatar that was recreated from their real body shape. When this real body was seen in a third person perspective, that effect was higher. In the "body identification" task, more than half of the participants chose their "Real body" as the one they would like to have. At the end of the procedure, when feedback identifying the virtual bodies was given to the participants, many of them were highly surprised to know that the body they preferred was actually their real one. In females we observed that body dissatisfaction scores were decreased after the experimental procedure. We believe that seeing their real body from a third person perspective helped participants to decrease dissatisfaction about their body shape.

We can argue that this negative bias towards the self might be produced by the comparison between self and others. Our female participants seemed to apply a systematic negative evaluation to the virtual body when they perceived it as their own body (1PP), but not when the virtual body was presented as someone else's body (3PP). In the last phase, (Body identification, Section 3.1.6), participants did not know that the body they were choosing as "the one they wanted to have" was actually their own body. We suppose that the negative bias about the self was modified because the body was seen in third person perspective. We know that this negative prior beliefs about the self are increased in patients with mental disorders (Wong, 2008), and when it comes to prior beliefs about body shape, negative bias is particularly prominent in patients with eating disorders (Williamson, 1996). We believe that seeing their real body in 3PP could be therapeutic for these patients if we obtain the same effect as in this study with healthy participants. This procedure could help them to understand that the internal representation they have of their own body is highly inaccurate, and that the ideal body representation they aim to reach is incompatible with the internal equilibrium and safety of their body. It has been shown that patients with eating disorders pay more attention to the visual stimuli related to their bodily self than to their interoceptive information (E Eshkevari, Rieger, Longo, Haggard, & Treasure, 2012; Ertimiss Eshkevari, Rieger, Longo, Haggard, & Treasure, 2013). We believe that this procedure could help them understand that their body perception is affected by the negative prior beliefs they have about themselves. Based on the results obtained in this first study, we believe that, by perceiving their body in 3PP, patients could get a new and unbiased perception of their own body (as if it were the body

of someone else). This new perception could re-orientate their attention to the real features of their body shape in a more accurate and objective way.

We think that the effect observed on this small sample of healthy participants predicts that, in patients with eating disorders, the effect might be stronger. In the case of patients, body size overestimation is increased and body representation may drastically differ from the real body (Gardner, 1996; Gardner & Brown, 2014). We believe that our method could be an effective way to update body representation in patients with a distorted body image (Keizer, Van Elburg, Helms, & Dijkerman, 2016).

We observed that, according to their gender, most participants gave similar features to the ideal body they imagined. Our female participants showed a general tendency towards an overestimation of their own body shape (Figure 18), and an underestimation of the bodily measures for their ideal body shape (Figure 19). Those results are consistent with the results obtained by Gardner & Moncrieff (1988). In their study, the average ideal body in females showed a very important chest circumference and a very small waist circumference. It is interesting to note that the "ideal body shape" of our participants corresponds to the "hourglass figure", and that their average "body image" corresponds to the "rectangle figure" reported in Simmons, Istook, & Devarajan (2004). It seems that our female participants idealized the "hourglass figure" and assumed that their body shape was corresponding to the "rectangle figure". The ideal female body reported in our experiment, corresponds to the ideal female body obtained in the study by Crossley et al., (2012), and is impossible to find in reality. The virtual body representing the "ideal body shape" of our female participants presented the same body features as the "ideal figure" reported in that study: a chest circumference substantially larger than the one attributable to the overall thinness of the other parts of that body (Crossley et al., 2012).

It is particularly relevant to note here that the internal representation of the "idealized body" is highly defined by prior beliefs coming from the culture one has evolved in (Thompson & Stice, 2001). Social environment shapes the prior beliefs of the individuals, as shown in the introduction (Section 1.3.3), and the aesthetic ideal is internalized and affects body image (Candidi & Aglioti, 2015). This "ideal body shape" shows an increased circumference of the chest that is incompatible with the thinness of the hips and waist, and therefore it is not a realistic body shape. The desire to reach this "ideal body shape" is motivated by the will to obtain an increased social acceptance. This social motivation enters in conflict with maintaining the internal equilibrium (homeostasis) of

the body. This phenomenon can be observed in many females at different degrees of importance and is an example of detrimental interaction between the individuals and their social environment. In the case of eating disorders, it can have neurochemical consequences threatening the equilibrium of the body (Bergh & Södersten, 1996; P. Södersten, Bergh, Leon, & Zandian, 2016; Per Södersten, Bergh, Zandian, & Ioakimidis, 2014). The self-starvation behaviour is associated to the reward expectancy of reaching an ideal social criterion, and food intake is not a rewarding behaviour anymore (Gretha, Scheurink, Boersma, Nergårdh, & Södersten, 2010; Hohlstein, Smith, & Atlas, 1998). In females with eating disorders, this can lead to severe neurobiological consequences, neurochemical disorders and even to death. This pathological behaviour gives an example in which improving social acceptance enters in conflict with survival of the body.

It is interesting to note that anorexia nervosa has been observed in different times and different cultures. In the Middle ages, the motivation for diminishing food intake in females with eating disorders was linked to the will of being closer to God and of denying all kinds of bodily needs (Bemporad, 1996). The aim to reach a social ideal was triggering a behaviour that entered in direct conflict with the most basic human behaviour: food seeking and alimentation for survival. As we saw in Section 1.3.3, the exchanges between an organism and its environment are usually aimed at the survival of the organism. In the case of humans, survival within the group and social motivations are also very important in the onset of behaviours and decision making. Several networks of motivations can co-exist and enter in conflict (Menon, 2015). In the case of eating disorders, it seems that "social desirability" co-exists with the primary program of "food intake", aimed at survival and preservation of homeostasis within the body. We know that environmentally driven processes select the synaptic connections that are most effectively entrained to environmental information (A. Schore, 2001). In the case of anorexia nervosa, we can argue that the behaviours associated with reaching the "ideal body shape" are highly adapted to socio-environmental "requirements", but enter in conflict with the most basic behaviours of "food seeking" and "food intake". One of the motivational networks becomes salient and leads to the onset of pathological behaviours. Aiming at a positive social feedback can be very powerful in the regulation of individual reward process and can be weighted as most important for decision making (Frith & Frith, 2012; Ruff & Fehr, 2014). Patterns learnt through interaction with the social environment can lead to un-adaptive beliefs and pathological behaviours. In this experiment, we showed the existence

of a pattern defining a cultural “ideal body shape”, by reconstructing the ideal avatar imagined by our participants, and showing that it corresponds to the” ideal body shape” observed in other studies (Crossley et al., 2012; Simmons et al., 2004).

4.2 EXPERIMENT II: CHANGING PERSPECTIVE IN A VERBAL HARASSMENT SCENE

As we saw in the introduction, self-regulation in humans is highly linked to social interactions (Section 1.3.3.2). In this second experiment, we wanted to measure the impact of social influence from a group of virtual people on pro-social behaviour of our participants. As explained in Section 2.3.2, participants saw a virtual scene in which a female avatar was verbally harassed by a group of male avatars. Participants saw the scene twice and, in the second phase, the perspective from which the event was perceived was changed depending on the condition. One group saw the second phase from the perspective of the female avatar who was harassed (woman condition), and the other group saw the second iteration of the scene from the perspective of another male from the group (in-group condition). A third group (control condition) was added and did not see this verbal harassment scene. One week later, participants came back to the laboratory and we measured their behavioural response in a virtual reproduction of the Milgram scenario; the situation was as well involving aggressive behaviour from a group of males towards a female victim, but this time the participant was an active agent of the scene. Our results show that participants in the in-group condition administered significantly more electroshocks in the Milgram scenario than participants in the woman condition and those in the control condition.

It is important to note that the avatars from the group of males were programmed to make eye contact with the participant; it has been shown that eye contact affects behaviour depending on social expectancies and that this process is automatic (Bateson, Nettle, & Roberts, 2006; Schilbach, 2015). In the case of participants in the in-group condition, we can argue that the gaze of the other avatars during the two iterations of the verbal harassment scene, enhanced the effect of belonging to the group of males. In the Milgram scenario, the avatars were also programmed to make eye contact with the participants, reinforcing the social expectations expressed through language when the avatars were

insisting on the fact that the participant was part of their team. The social expectations coming from the group of males, and their verbal injunctions towards the participants, were the same in the three conditions. According to the results we obtained, it seems that participants in the in-group condition gave more importance to it than participants in the control and woman conditions. We believe that the repetition of the verbal harassment scene from a perspective in which the gaze of the avatars was "including" the participant within their group, reinforced the automatic processes of in-group commitment and social conformity (Richerson & Boyd, 2001).

During the Milgram scenario, participants had a choice to make, between stopping the procedure (because the female avatar was complaining and asking to stop) or finishing it until the end (because the male avatars were insisting on the fact that it was mandatory to finish). We can hypothesize that there was a conflict between two inference systems: empathy for the victim on one side, and maintaining a "safe" social status inside the (dominant) group of males on the other side. This is a similar conflict as the one described by Milgram (1965) between empathic cues and obedience. Decision-making happens when enough evidence has accumulated for one decision to be taken (J. M. Beck et al., 2008; Crockett, 2016). When two different networks are coexisting, the decision-making process is giving salience to one of them, consciously or unconsciously (Menon, 2015). This process includes modulation by top down processes and can be applied to the processing of social information (Frith & Frith, 2012; Uddin, 2014). Decision-making can be understood as a constraints satisfaction operation. In a social situation, it includes predictions about the social context (consequence of one's actions), the social norms regarding the actions (sensitive to moral norms of the group), the resources available, the feeling of aversion or attraction towards others within the situation, and the remembering of a similar dilemma (Casebeer & Churchland, 2003).

In our experiment, the inference process about the outcome of one's actions seems to have been influenced by the situation experienced the previous week inside virtual reality. Participants who were embodied in the victim most likely experienced a feeling of aversion towards the group of males in the first phase, because they went through the verbal aggression from a first-person perspective. This can be observed in the results of the qualitative analysis (Section 3.2.6): the word "imbeciles" (*idiots*) is used only by the participants who were in the woman condition. One important thing to note here, is that those participants did not have the possibility to escape from the situation, they reported

that they felt in lack of control (powerless), bothered, harassed and uncomfortable (see word cloud in Section 3.2.6). When experiencing a similar situation one week later, we can hypothesize that those participants took the opportunity to use the control they had over this situation to stop the procedure and gave less shocks. But this was observed only in participants who were not students; so further investigation is necessary to understand which factor can explain this difference. On the contrary, participants in which the in-group effect was emphasized during the first session, had a "safe" position inside the group of males, their decision-making was aimed at obedience and preservation of this social status. We observed a similar effect as the one originally described by Stanley Milgram (Milgram, 1963). The social input received from the other avatars of the group seems to have influenced the inference process and decision-making of our participants (Frith & Frith, 2012).

We can argue that the decision of adopting one behaviour or the other was related to predictions about the rewarding or punishing outcome of their actions. Humans are programmed to find value in a social group (Churchland & Winkielman, 2012) and the reward system is generalizing the response to new cases after learning from experience. It is interesting to point out that, after being exposed to a situation of verbal aggression, from the perspective of the dominant group performing the aggression, participants tended to behave according to the instructions received from the group. We can argue that there was an inference process related to social reward that led them to maintain their position inside the dominant group. In this case the mechanism of empathy for the victim was not salient in their decision-making process.

In humans, social approval is highly rewarding and social disapproval is understood by the internal system as a punishment. Social behaviour is determined by the expectations of reward or punishment coming from the external events (Schultz, Dayan, & Montague, 1997). If the punishment comes from other human beings, as in the case of aggression, the threatened individual needs to execute an action that will protect him from this threat. In humans, we observe that collaborative behaviour is another way to be safe and to cope with threatening behaviours coming from other groups. Through the evolution of human and other animal societies, we can observe that collaborative groups have been created, and that conflicts between groups occur all the time, to get control of the environmental resources for instance. As social mammals, humans can perform collective decision making that is better than decision making performed by one single individual (Couzin,

2009). This process is very adaptive for the evolution of the species, it can explain how rewarding it is to follow the criterion of the in-group, and how the decision-making process of an individual is highly influenced by the intervention of other members of a group.

Here, it is interesting to see that the collaborative behaviour with the in-group is aimed at aggression towards another human being. As in the original Milgram experiment, participants had the choice between collaborating with the group and cause the death of another (virtual) human being, who has done them no harm, or siding with the victim thus opposing the group. We can argue that reinforcing in-group bonding in the first session of this experiment, made the decision of finishing the procedure more rewarding than stopping it.

In the social valuation schema described in (Ruff & Fehr, 2014), there are situations in which individuals assess value vicariously for other people they observe, and situations in which they behave in line with abstract social principles. Here, we have shown that we can interfere with the social valuation of a situation by embodying a participant in the perspective of the dominant group or in the perspective of the victim. There is a dynamic system of dominance and submission that is created in this social context and seems to affect the valuation made by the participants, and therefore, their decision-making and behaviour.

Processes of "self-evaluation" seem to depend on the calculations resulting from social comparison. Scanning and valuing others enable the individual to prepare for interaction. Social comparison seems oriented to prediction for optimal interaction with others in a dynamic way (Häfner, 2004; Nussinson, Häfner, Seibt, Strack, & Trope, 2012). There is a fast process of assimilating emotions from others and of decision-making about the behaviour to adopt in order to reach the optimal interaction. These processes trigger fast reactions to the environment and fast processing of threatening stimuli. Through social comparison, the individual can prepare actions oriented towards others or away from them, depending on the outcome of the evaluation. The calculations seem to be done in terms of attributing a value to the other person in comparison to the self (superior, inferior, equal) in order to trigger the adapted behaviour.

The social inclusion within the group of males during the first session of this experiment, might have affected the prediction of reward made by the participants in the second

session (Milgram scenario). We know that social inclusion is highly rewarding and that perception and decision-making are affected by the values defined by the social group (M. Mason, Dyer, & Norton, 2009; W. Mason, Conrey, & Smith, 2007). According to M. Mason et al. (2009), the medial prefrontal cortex (mPFC) is involved in those processes of social influence on the value attributed to external elements. The group makes an interpretation of the events occurring in the external world and somehow influences the perception and valuation performed by one individual included in the group. Social context influences the salience of one neural network over the other and changes one's perception and interpretation of the facts, and as a consequence, changes the behavioural choice (Asch, 1956; Menon, 2015) . Here we can argue that the value attributed to the victim by the group of males affected the value participants attributed to her and decreased the empathy effect on their behaviour. If we compare the number of shocks that were given by the participants in the control condition, we see that in-group inclusion is positively correlated with the tendency to finish the procedure.

As described before, an interesting difference appeared in our results depending on the status of our participants: non-students gave less shocks when they had been embodied in the female victim during the second iteration of the verbal harassment scene. On the contrary, it seems that for students, being embodied in the female avatar during the verbal harassment scene, had no effect on their behaviour during the Milgram scenario. Different interpretations are possible for these results: maintaining the status in the group might be more important for the students, or obedience to authority might have a greater influence on student's behaviour than on "non-students" behaviour. Further research is necessary in order to understand better those results. Overall, our results support the idea that this method could be used in a training situation, to overcome social desirability leading individuals to engage into immoral behaviour in order to maintain their status inside a group.

4.3 EXPERIMENT III: CHANGING PERSPECTIVE ON A PERSONAL PROBLEM THROUGH SELF-CONVERSATION

In this experiment we studied the effect of a conversation between two separated parts of the self. One part being embodied in one's own scanned avatar and the other part being

embodied in Dr. Sigmund Freud's avatar. We had two conditions for this experiment: in the self-conversation condition, participants were having an interactive dialogue with themselves. They were first embodied in their scanned avatar explaining the problem to the virtual avatar of Freud (sitting in front of them in the virtual room), and were then embodied in Freud's body to provide answers to their own avatar. In the control condition, participants were having a dialogue with the same avatar of Dr. S. Freud, providing pre-programmed answers and comments to what they were saying. This allowed us to assess the effect of self-conversation in helping participants to solve their personal problem.

Our results suggest that the self-conversation helped the participants to get a better understanding, a new perspective, a better knowledge about their problem, and new ideas about how to solve it (see Section 3.3.5). This is consistent with the results obtained in the ATQ_8 questionnaires, participants in the self-conversation condition reported less negative automatic thoughts after the VR session (see Section 3.3.7). We believe that taking a new perspective on their problem helped participants to detach themselves from the automatic emotional state associated to this problem, and to enter in a more rational approach when they were embodied in Freud's avatar.

By switching from one avatar to the other, participants could listen to themselves explaining the problem from a third person perspective. When embodied in Freud, participants could perceive their own avatar speaking and moving (seeing the replay of what they had just said) from a third person perspective. We believe that the psychological distance given by the 3PP, allowed participants to get a new perspective on the emotional states associated to their problem, as well as a more rational understanding of their situation. During the self-conversation, participants could observe the mechanisms of their own behaviour as if it were the behaviour of someone else, we believe that this triggered a psychological distance (Moser et al., 2017) facilitating a rationalization of the problem. Here we report some quotes from the participants in the self-conversation condition, during the follow up interview, one week after the VR experience:

"En la segunda sesión cuando tenía que hacer de Freud, y darme consejo a mí misma, en ese momento era como que estaba viendo el problema desde fuera, y entonces creo que ***me hizo pensar con más racionalidad****...y entonces* ***pude, no sé, ver las cosas más claras, y dar una posible solución al problema.****"*

Translation: *In the second session, when I had to be Freud, and give advice to myself, in that moment it was as if I was seeing the problem from outside, and so I think* ***it made me***

think with more rationality*…and so* ***I could, I don't know, see things more clearly and give a possible solution to the problem***

"Cuando me vi hablar he podido disminuir el miedo, me di cuenta de que me afectaba mucho, pero que a la vez tenía una solución. ***Cuando estaba en el cuerpo de Freud, me veía capaz, intentaba aconsejarme, y al intentar aconsejarme era como que me olvidaba de que el problema era mío****"*

Translation: *"When I saw myself talking, I could reduce the fear, I realized that it was affecting me a lot but that, at the same time, it had a solution.* ***When I was in Freud's body. I was seeing myself capable, I was trying to advise myself, and by trying to advise myself it was like I was forgetting that the problem was mine****"*

*"****Experimentar y reflexionar de otro punto de vista****, y tener* ***más distancia con el problema*** *y quizás mirarlo de manera más completa."*

Translation: *"Experiment and* ***reflect from another point of view****, and have* ***more distance towards the problem*** *and maybe look at it in a more complete way"*

*"Aconsejarte a ti mismo…****ponerte en un punto de vista objetivo****, del otro avatar digamos, pues también* ***te hace reflexionar un poco y buscar soluciones*** *a tu problema.*

Translation: *"Advising yourself …* ***putting yourself in an objective point of view****, let's say the one from the other avatar, then* ***it also makes you reflect a bit and look for solutions to your problem****"*

Seeing themselves from outside (from third person perspective) allowed the participants to "reflect from another point of view", perceive the problem "more objectively", "with more rationality" and "look for solutions to the problem". Taking a certain "distance" with the problem allowed them to get a new understanding of it, more rational and more objective. We believe that seeing the problem from the perspective of the psychologist, implied other prior beliefs associated to the conceptual representation and cognitive attributes associated to that "figure". It has been shown that embodiment in a figure led to the internalization of the qualities associated to that figure (Osimo et al., 2015; Peck, Seinfeld, Aglioti, & Slater, 2013). We can argue that participants, when listening to their problem from the perspective of Freud, could access to some objective information about their problem and apply other prior beliefs about their personal problem. Other prior beliefs linked to internal states (emotions), and associated to their problem might have been modified by this new perspective on themselves. We can argue that this change in perspective gave them a more objective and rational analysis of the situation.

As we saw in the introduction (Section 1.3.3.3), internal dialogue is involved in executive rehearsal and therefore involves a process of self-evaluation (Alderson-day & Fernyhough, 2015; Schwartz, 1986). Self-evaluation includes the internalization of

other's criteria and cultural input (Han et al., 2012; Morin, 2010; Vygotsky, 1934). This is a very adaptive process, considering that it gives one individual the capacity to integrate and synthesize the perspective of several individuals, and adopt an optimal strategy to interact with the environment. In the case of the self-conversation inside virtual reality, we believe that self-evaluation was somehow modified by the change in perspective and externalization of the inner speech.

It is important to note that participants, when embodied as Freud inside VR, were addressing themselves as "you", instead of "I". It was shown by Dolcos & Albarracin (2014), that imagining giving an advice in the second person led to better performance and motivation than imagined speech in the first person. The virtual reality forced this use of second person in the self-conversation, the effects observed are consistent with the results reported by Dolcos and Albarracin. Participants in the self-conversation reported that the procedure gave them a better understanding of their problem, and helped them in finding a solution.

In a previous study by Falconer et al. (2014), virtual embodiment was used to increase self-compassion. Participants experienced a "self to self" interaction, in which they were delivering compassionate gestures and words to a virtual child. Embodying the virtual child and experiencing their compassionate behaviour decreased self-criticism. The change in perspective allowed participants to adopt a different self-evaluation process and reduced self-criticism. In the case of our experiment, participants were instructed to help the person in front of them (their scanned avatar) when they were embodied in Freud. We can hypothesize that being embodied in Freud (being the therapist) engaged the participants in a more compassionate attitude towards themselves.

Our results show that the self-conversation decreased negative automatic thoughts about the self, therefore we can argue that it had a positive effect on self-evaluation and self-representation. Perceiving their own avatar from a third person perspective might have allowed participants to perceive themselves as an external object, and therefore, not apply the negative predictions and automatic thoughts usually associated to themselves. By changing the perspective on oneself, self-conversation gave a different understanding of the problem.

We have seen in the introduction (Section 1.3.3) and in the first experiment (Section 4.1), that prior beliefs about the self directly affect self-perception and self-representation. We

believe that, in this third experiment, perceiving oneself from a third person perspective while explaining a personal problem, allowed participants to get a new perspective on themselves and on that problem. As described earlier (Section 1.3.3.3), cognitive distortions can be defined as erroneous assumptions individuals make when interpreting their environment. (Aaron T.Beck, 1967; A. Beck et al., 1979; J. S. Beck & Beck, 2011), these constructs are hierarchically related and play a role in most forms of psychopathology as well as in normal functioning (A. T. Beck & Haigh, 2014). Cognitive therapy allows patients to identify their cognitive distortions. It is hypothesised that this process enables patients to adopt a more rational view of reality (Oei & Free, 1995). In our experiment, we can argue that getting a new perspective on their problem led participants to identify some of the prior beliefs and cognitive distortions related to their problem, and to get a more rational view of the factors causing the problem. These results are very promising, and we believe that this application could be developed as a clinical application of self-counselling, in which patients could enter in a dialogue with themselves and work on their cognitive distortions through this perspective changing process.

4.4 GENERAL DISCUSSION

The three studies reported here are focused on three different aspects of the self as a dynamic process: body representation, social identity, and conceptual representation of a personal problem. We explored those different aspects using immersive virtual reality, which is particularly suited for this investigation, since it allows seeing oneself from a third person perspective and being embodied in other bodies.

In the first chapter, we introduced some background literature showing that the self is a dynamic process influenced by many different factors, and we focused on the impact of social interactions on the creation of self-representation and on the onset of behaviour. We explained in the introduction (Section 1.3.3) that the interaction between the self and the environment is based on different inferential systems aimed at predicting the optimal outcome of one's actions. Humans make inferences about their surrounding physical environment, and about the other humans living in this environment with them. The world needs to be understood as a coherent system, so the human brain makes predictions based

on what it has experienced before and adapts perception and behaviour according to those predictions. The feedback received by the social interaction with other humans makes individuals calculate which behaviour is the most adapted to each situation. Depending on social feedback, individuals will adopt more likely one behaviour or the other. The coherence of what we call the "self" is therefore shaped depending on the calculations made by the individuals, in reference to the social reward or punishment they might get. Social interactions define behaviour, but also perception and evaluation of others, as well as perception and evaluation of oneself (see Section 1.3.3.3).

With the three experiments reported in this thesis, we observed that embodiment in different virtual bodies changes the perception and evaluation of the stimuli related to the self. We therefore confirmed that self-perception and self-representation are dynamic and highly plastic processes. We showed that changing the perspective on oneself affects the evaluation of body appearance, modifies the perception of a personal problem, and we argued that those modifications are related to the prior beliefs associated to the self. We showed as well that the expectation of social reward plays a very important role in behavioural responses.

In the results obtained in the first experiment *(The impact of first person perspective on body perception*), the social reward was associated with the "ideal body shape". The avatars recreated, based on the ideal measures given by our participants, all had similar physical attributes, showing the prominence of this "ideal body shape" in the cultural environment. We also showed, with this experiment, that the internal representation humans create of their own body is highly inaccurate. By showing their real body to our female participants in a third person perspective, we made it appear more attractive to them. We can therefore argue that third person perspective modified the processes of subjective evaluation of the virtual body that was seen. On a different level, we showed in the third experiment (*Changing perspective on a personal problem through self-conversation*), how subjective evaluation of a personal problem, could also be modified by getting a third person perspective of oneself. Based on these observations, we argue that processes of social comparison and self-evaluation create a bias in self-perception, affecting both body shape evaluation, and perception of a personal problem. We believe that offering the possibility to participants to get a third person perspective of their own body and of themselves while explaining a personal problem, enabled them to apply

different criteria, which resulted, for both experiments, in a decrease of negative evaluation applied to self-related stimuli.

In the first part of this discussion (Section 4.1), we showed that the will to reach the cultural ideal (in this case, ideal body shape) can trigger some behaviours aimed at obtaining social reward. As explained before, in pathological cases such as eating disorders, social reward can enter in contradiction with maintaining the homeostasis within one's body. The priority is given to an expected social reward over the internal equilibrium of the body, and this can lead to the onset of a self-starvation behaviour (Section 4.1). This pathological example offers us an insight on the importance of expected social rewards on human behaviour. In the second experiment, we have shown that the social reward of creating a bond with a group of conspecifics can dramatically alter decision making and lead to aggressive behaviour towards an individual belonging to another group (Section 4.2). In both cases, social reward overrules other internal processes regulating individual behaviour and can lead to the destruction of oneself, or of someone else.

Social comparison and social evaluation are at the core of the results obtained in all three experiments. In the second experiment, (*Changing perspective in a verbal harassment scene*), we have shown that the "value" attributed to the life of the victim (in the Milgram scenario) depended on the "value" that the other avatars (group of males) attributed to her. We demonstrated that the same scene can trigger completely different behaviours and decision-making processes, depending on the perspective from which it is seen, showing evidence that different social interaction patterns modify behaviour. As we argued Section 4.2, in one case the priority was given to the empathy felt for the victim whereas in the other case, the priority was given to maintaining social status within the group of males. In contradiction with what we expected, being embodied in the victim did not significantly increase pro-social behaviour in comparison to the control group. The main effect we obtained was therefore that representing oneself as part of the "dominant group" led to aggressive behaviour towards a virtual victim.

As we explained before (Section 4.2), self-evaluation and evaluation of others depend on the criteria received from the social environment. By changing bodies and getting a new perspective on oneself and others inside VR, we can interfere with the prior beliefs associated to the value attributed to oneself (as seen in experiment I and III) as well as to the value attributed to others (as seen in experiment II).

In the third experiment (*Changing perspective on a personal problem through self-conversation*), we demonstrated that adopting a third person perspective on oneself helped participants to get a better understanding and a better knowledge of their personal problem. Participants reported that getting a new perspective on their problem allowed them to modify their behaviour when faced with the problem. We can argue that the third person perspective and self-conversation led to a new (updated) perception of the personal problem. As we argue in Section 4.3, we believe that having a conversation with oneself enables a more rational approach to the problem. This method could make it possible for participants to update their maladaptive beliefs about themselves and about their social environment, by facing the problem from a different point of view. In light of the theoretical framework used throughout this thesis, we can argue that the prior beliefs involved in the representation of the problem can be modified by the 3PP perspective offered by the tool of VR, and that prediction error can be minimized by updating the beliefs and getting a self-representation closer to reality.

Throughout this thesis, we showed that getting a positive social outcome can be very powerful in the regulation of one's reward system. We showed that social reward can be weighted as more important than empathic concerns or preservation of the internal homeostasis of the body, in triggering decision making and behaviour execution. We demonstrated that self-perception and self-representation are dynamic processes, highly influenced by the constant interaction with one's surrounding social environment. We demonstrated that getting a third person perspective of oneself enables a decrease in negative evaluation applied to the self. We hope to be able to develop those findings in future clinical applications of immersive virtual reality.

5 CONCLUSIONS

"All entities move and nothing remains still", Heraclitus
as quoted by Plato in *Cratylus, 401d*

In this thesis we have demonstrated that embodiment in different virtual bodies can positively alter self-evaluation, affect decision making in a social situation involving aggression, and change perspective on a personal problem. Combining the results obtained with the theoretical frameworks of affective neuroscience and predictive coding, we showed that social feedback is critical in self-representation.

5.1 CONTRIBUTIONS AND LIMITATIONS

Our general contribution is to demonstrate the impact of embodiment and third person perspective on self-perception, self-representation and self-evaluation in comparison with others. We showed that subjective evaluation of one's body or of one's personal problem, depends on the perspective from which it is perceived (experiment I and experiment III). Additionally, we showed that emphasizing in-group affiliation can directly affect behaviour (experiment II). However, some of our hypothesis were partially inaccurate and some unexpected elements appeared in the results we obtained. Therefore, some aspects of the research questions can be reconsidered to open towards future development of this research work.

Our first research question was about body representation and subjective evaluation of one's body shape: knowing that humans construct an internal representation of their body shape, we wanted to recreate and display this body representation in the form of a virtual avatar. In the first experiment (*The impact of first-person perspective on body representation*), our main objective was to create an avatar corresponding to the mental representation of one's body shape in virtual reality, and compare it to one's real body shape, and one's ideal body shape. The technique we used for this experiment has several limitations and could be improved in three different aspects. First, estimating body measures using the method of the virtual tubes was satisfying for some participants but

too difficult for others. Some participants reported that they were unable to represent the internal image they had of their body with the tubes. In the future we could develop a method allowing the participant to modulate the appearance of a whole virtual body inside the virtual environment. That way, the participant could "create" a satisfying representation of their body image and of their ideal body shape, seeing it and correcting it in real time. Secondly, in the 1PP condition, embodiment was created using visuo-tactile feedback, because the avatars generated by the Maya software could not be animated. To overcome this, another method for generating the avatars could be developed, which allows animation and therefore enables embodiment through visuo-motor feedback. This would be advantageous since visuo-motor feedback has been shown to be more powerful than visuo-tactile feedback for eliciting body ownership illusion (see Section 1.3.2.1). For example, we could combine the method for generating the avatars with the body scanning technique (used in experiment III and described in Section 2.4.2.1). Measurement and recreation of the participant's real body, could be used as a baseline avatar. Participants would be able to modulate this baseline avatar, in order to re-create their ideal body shape, and internal body image. That way, we could make the virtual bodies more similar to the participants' appearance and trigger the effect of self-recognition as if they were "really" looking at themselves in a mirror, with the same face and clothes, but with different body shapes. Body tracking could also be applied to all the avatars allowing an easier and faster way to create embodiment over the virtual bodies.

Our second research question was about the impact of social feedback on participants' behaviour. We created a controlled social situation inside VR with a group of virtual avatars entering in verbal conflict with another, isolated, avatar. Participants were exposed twice to the same virtual scene and some of them reported that the second exposure to the scene was a bit boring to them, since they already knew what the dialogue was about, and what the outcome of the scene would be. One possibility would be to split the violent scene in two parts, similar in the social dynamics, but different in the content of the dialogue. In that way, the habituation effect would be less important. Another aspect that could be explored, would be to recreate both social situations (verbal harassment scene and Milgram scenario) in 360° videos. We could compare the impact of the 360° videos with the impact of the 3D generated virtual scenes, in order to determine if a video with real actors would have a different effect on participants' behaviour. This study would need a different ethical approval for the reproduction of the

Milgram scenario, indeed the emotional impact on the participants might be different if the scene was filmed in 360° video. We have observed in this experiment that in-group affiliation could lead participants to aggressive behaviour towards a virtual victim. These results went beyond our hypothesis which was that embodiment in the victim would increase empathy and pro-social behaviour. We did observe this effect, but only in non-student participants. Further research on the personality aspects of the students and non-student groups would need to be conducted in order to understand this effect better.

Our third specific research question was about the effectiveness of self-conversation in helping participants solve a personal problem. We have shown that participants in the self-conversation were more likely to report improvement on their personal problem since they got a new perspective of it. However, the method can be improved for both conditions. In the experimental condition, one participant got blocked because of a high level of self-criticism, he asked to stop the procedure while he was immersed inside the virtual environment (all the adapted measures were then taken to make sure that the VR session did not have a negative impact on him. He got the opportunity to talk with a clinical psychologist about what happened, and in the follow up session, one week later, he reported that the VR session did not have any negative impact on his life. His results were not included in the analysis). In the future, those personal aspects of the participants should be explored more deeply in the pre-experimental procedure. The self-conversation obliges participants to face themselves and therefore, can be quite disturbing for people with high performance anxiety, low self-esteem or high self-criticism. A few participants reported that they saw themselves (their scanned avatar) as being a bit “ridiculous”, when they were embodied in the avatar of Freud, during the course of the self-conversation. Also, the VR session including the conversation with the virtual Freud, should happen in a room where the participant is alone. The VR application should be controlled by the participant himself, and no experimenter should be present in order to allow a free flow of the language without any “expected” judgement from another person in the room. One participant reported that he was feeling uncomfortable because of the presence of the experimenters while he was delving into his personal problem during the self-conversation inside VR. Another modification of the application, could be to add some more specific preparation for the participants, in order to help them find what they can tell themselves inside the VR, when embodied in Freud. In a therapeutic version of the application, we could imagine a special command that participants could activate when

they need some advice about what to tell themselves when they are inside VR. Although the advice should not be a specific sentence to be repeated, since the important aspect of this method is that participants find their own resources. We can imagine some instructions such as: "now ask the person in front of you to give more details about what they just explained". This would add some guarantee that the participants do not get "blocked", inside VR, when they need to answer themselves. In the control condition some participants reported that the virtual Freud was talking like a robot and that the interaction with him was not very realistic. Maybe a command, similar to the one used in Experiment II (Milgram scenario, see Section 2.3.2.2), could be useful in order to improve the quality and realism of the verbal interaction with the avatar of Freud in the control condition. We could imagine a set of pre-programmed questions and answers activated depending on what the participant is saying.

5.2 FUTURE WORK

Based on the results we obtained, and on the scientific limitations we observed, we can think of different experimental lines to be developed in the future. One of the main research problems addressed in this thesis, was to show that self-representation is a dynamic process, we have demonstrated that it is highly influenced by social criteria and social context. We have as well seen that perceiving oneself from a third person perspective, can have a direct impact on self-evaluation and on self-representation. In the future we can imagine an experimental design including the study of the self as a dynamic process in constant change and third person perspective applied on one's self-representation.

We can imagine an experiment in which participants could enter in a dialogue with different "versions" of themselves, seeing themselves from a third person perspective. This application would include the recreation of avatars representing the participants for instance, at different moments of their lives, at different ages. Participants would be able to see their past or future self and engage in a conversation with them. Being faced with oneself 10 years before or 10 years after the present moment, would show that the "self" is a dynamic process, changing through time. Entering in a dialogue with one's past or future self, could allow a new kind of self-representation from the perspective of time.

The older and younger versions of the participants could be generated using the scanning technique and changing the aspect of the face, clothes and hair, and even body shape. Older and younger versions of the participant could also include some voice distortions effects. For the past (or even child version) of the participants, we could use a picture and recreate the avatar based on the clothes they were wearing at that time, and on other elements of their past physical aspect. This type of application would allow participants to see that the self is a dynamic entity subject to constant change, and we could measure the evolution of their self-representation after being exposed to those different versions of themselves. As a part of the experiment, we could imagine that participants could see the physical transformation of 10 or even 20 years in a virtual mirror from a first-person perspective.

Perception and anticipation of the future depends on prior beliefs and predictions established by past experiences. Even if this process is very useful for humans to adapt to any kind of surrounding environment, it can trigger maladaptive inferences about the future. In psychopathology, anticipatory anxiety is one form of these maladaptive inferences. If participants are embodied in an older version of themselves, they might gain the possibility to get a new perception of the consequences of time on their lives. In line with what we observed in the third experiment reported in this thesis, we believe that participants would get a more rational understanding of the impact of time, by embodying an older version of themselves. On a therapeutic level, this could help patients with pathologies related to anticipatory anxiety, to get a representation of the future through this “older” avatar. This would of course need to be included in a therapy with a clinical psychologist, where the VR application could be used as a tool during the process.

In the future, we could as well imagine a development of the self-conversation tool for psychotherapy. For instance, the sessions could be recorded, and the patients could see their evolution during the psychotherapeutic process. This is already done with video recording in some therapeutic techniques, but the advantage of the self-conversation tool is that it would allow the patients to engage in a dialogue with their former self. For instance, they could listen to their “self” from the first session and give some advice based on what they “learnt” through the therapeutic process. This could be a good tool for consolidation of the work done with the psychologist.

For dissociative identity disorder, this tool could be useful in order to make the patient understand that there are different versions of oneself, the patients could design the aspects of the other versions of themselves they want to talk with. Making the inner dialogue external in those cases could be highly therapeutic. This would of course be done within the framework of a clinical therapy. Opening the dialogue between different parts of oneself in case of dissociation could allow patients to get a better understanding of the "message" brought by the different and dissociated aspects of their "self", and maybe could allow them to "integrate" those different parts, accepting that the self includes various and sometimes contradictory aspects.

Throughout this thesis, we have demonstrated that the self is a highly plastic and dynamic process in constant change. Applications of virtual reality allow to manipulate the plasticity of the self and to study the underlying processes of the subjective sense of self experienced by humans. We will keep on following this line of research, and we hope to be able to apply VR tools for psychological rehabilitation, in pathologies in which the sense of self is affected. Embodiment in different virtual bodies for changing perspective on oneself and on others, is a new and very powerful tool to continue research about the social brain and how it can affect the coherence of the subjective sense of self.

BIBLIOGRAPHY

Adolphs, R., Damasio, H., Tranel, D., Cooper, G., & Damasio, a R. (2000). A role for somatosensory cortices in the visual recognition of emotion as revealed by three-dimensional lesion mapping. *The Journal of Neuroscience : The Official Journal of the Society for Neuroscience*, *20*(7), 2683–90. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10729349

Adolphs, R., Tranel, D., & Damasio, A. R. (2003). Dissociable neural systems for recognizing emotions. *Brain and Cognition*, *52*(1), 61–69. https://doi.org/10.1016/S0278-2626(03)00009-5

Alais, D., & Burr, D. (2004). Ventriloquist Effect Results from Near-Optimal Bimodal Integration. *Current Biology*. https://doi.org/10.1016/S0960-9822(04)00043-0

Alderson-day, B., & Fernyhough, C. (2015). Inner Speech : Development , Cognitive Functions , Phenomenology , and Neurobiology, *141*(5), 931–965.

Armel, K. C., & Ramachandran, V. S. (2003). Projecting sensations to external objects: Evidence from skin conductance response. *Proceedings of the Royal Society B: Biological Sciences*. https://doi.org/10.1098/rspb.2003.2364

Arnheim, R., Bermudez, J. L., Marcel, A., & Eilan, N. (1997). The Body and the Self. *Leonardo*. https://doi.org/10.2307/1576384

Asch, S. E. (1956). Studies of independence and conformity: I. A minority of one against a unanimous majority. *Psychological Monographs: General and Applied*. https://doi.org/10.1037/h0093718

Atencio, D. J., & Montero, I. (2009). Private speech and motivation: The role of language in a sociocultural account of motivational processes. In *Private Speech, Executive Functioning, and the Development of Verbal Self-Regulation*. https://doi.org/10.1017/CBO9780511581533.017

Auvray, M., & Fuchs, P. (2007). Perception, immersion et interactions sensorimotrices en environnement virtuel. = Perception, immersion and sensorimotor interactions in a virtual environment. *Intellectica*, *45*(1), 23–35. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=2008-01349-002&site=ehost-live&scope=site%5Cnhttp://philippe.fuchs@ensmp.fr%5Cnhttp://malika@malika-auvray.com

Bados, A., Solanas, A., & Andres, R. (2005). Psychometric properties of the Spanish version of Depression, Anxiety and Stress Scales (DASS). *Psicothema*, *17*(4), 679 – 683.

Barkham, M., Leach, C., Lucock, M., Evans, C., Margison, F., Mellor-Clark, J., … McGrath, G. (2001). Service profiling and outcomes benchmarking using the CORE-OM: Toward practice-based evidence in the psychological therapies. *Journal of Consulting and Clinical Psychology*. https://doi.org/10.1037/0022-006X.69.2.184

Bateson, M., Nettle, D., & Roberts, G. (2006). Cues of being watched enhance cooperation in a real-world setting. *Biology Letters*, *2*(3), 412–414. https://doi.org/10.1098/rsbl.2006.0509

Beck, A., Rush, A., Shaw, B., & Emery, G. (1979). *Cognitive therapy of depression*. *New York: Guilford Press*.

Beck, A. T., & Haigh, E. A. P. (2014). Advances in Cognitive Theory and Therapy: The Generic Cognitive Model *. *Annu. Rev. Clin. Psychol*, *10*, 1–24. https://doi.org/10.1146/annurev-clinpsy-032813-153734

Beck Aaron T. (1967). *Depression:Clinical, Experimental, and Theoretical Aspects*. University of Pennsylvania Press.

Beck, J. M., Ma, W. J., Kiani, R., Hanks, T., Churchland, A. K., Roitman, J., … Pouget, A. (2008). Probabilistic Population Codes for Bayesian Decision Making. *Neuron*. https://doi.org/10.1016/j.neuron.2008.09.021

Beck, J. S., & Beck, A. T. (2011). *Cognitive Behavior Therapy: Basics and Beyond*. Guilford Press.

Bemporad, J. R. (1996). Self-starvation through the ages: Reflections on the pre-history of anorexia nervosa. *International Journal of Eating Disorders*, *19*(3), 217–237. https://doi.org/10.1002/(SICI)1098-108X(199604)19:3<217::AID-EAT1>3.0.CO;2-P

Bergh, C., & Södersten, P. (1996). Anorexia nervosa, self-starvation and the reward of stress. *Nature Medicine*, *2*(1), 21–22. https://doi.org/10.1038/nm0196-21

Bermúdez, J. (1978a). Análisis funcional de la ansiedad. *Revista de Psicología General y Aplicada*, *153*, 617–634.

Bermúdez, J. (1978b). Ansiedad y rendimiento. *Revista de Psicología General y Aplicada*, *151*, 183–207.

Blanke, O., & Metzinger, T. (2009). Full-body illusions and minimal phenomenal selfhood. *Trends in Cognitive Sciences*, *13*(1), 7–13. https://doi.org/10.1016/j.tics.2008.10.003

Botvinick, M., & Cohen, J. (1998). Rubber hands “feel” touch that eyes see. *Nature*, *391*(6669), 756. https://doi.org/10.1038/35784

Bowlby, J. (1958). *The nature of the Child's tie to his mother*.

Brühl, A. B., Rufer, M., Kaffenberger, T., Baur, V., & Herwig, U. (2014). Neural circuits associated with positive and negative self-appraisal. *Neuroscience*. https://doi.org/10.1016/j.neuroscience.2014.01.053

Calvo-Merino, B., Glaser, D. E., Grèzes, J., Passingham, R. E., & Haggard, P. (2005). Action observation and acquired motor skills: an FMRI study with expert dancers. *Cerebral Cortex New York NY 1991*, *15*(8), 1243–9. https://doi.org/10.1093/cercor/bhi007

Candidi, M., & Aglioti, S. M. (2015). Visual and sensorimotor contributions to the esthetic appraisal of body form, motion, and emotion. *European Psychologist*, *20*(1), 16–26. https://doi.org/10.1027/1016-9040/a000221

Cano García, F., & Rodríguez Franco, L. (2002). Evaluación del lenguaje interno ansiógeno y depresógeno en la experiencia de dolor crónico. *Apuntes de Psicología*, *20*, 329–346.

Carhart-Harris, R. L., & Friston, K. J. (2010). The default-mode, ego-functions and free-energy: A neurobiological account of Freudian ideas. *Brain*, *133*(4), 1265–1283. https://doi.org/10.1093/brain/awq010

Casebeer, W. D., & Churchland, P. S. (2003). The neural mechanisms of moral cognition: A multiple-aspect approach to moral judgment and decision-making. *Biology and Philosophy*. https://doi.org/10.1023/A:1023380907603

Chioqueta, A. P., & Stiles, T. C. (2004). Norwegian version of the automatic thoughts questionnaire: a reliability and validity study. *Cognitive Behaviour Therapy*, *33*(2), 79–82. https://doi.org/http://dx.doi.org.sire.ub.edu/10.1080/16506070310016031

Church, R. M. (1959). Emotional reactions of rats to the pain of others. *Journal of Comparative and Physiological Psychology*, *52*(2), 132–134. https://doi.org/10.1037/h0043531

Churchland, P. S. (2002). Self-representation in nervous systems. *Science (New York, N.Y.)*, *296*(5566), 308–10. https://doi.org/10.1126/science.1070564

Churchland, P. S., & Winkielman, P. (2012). Modulating social behavior with oxytocin: How does it work? What does it mean? *Hormones and Behavior*, *61*(3), 392–399. https://doi.org/10.1016/j.yhbeh.2011.12.003

Cooper, L., Peters, L., & Andrews, G. (1998). Validity of the Composite International Diagnostic Interview (CIDI) psychosis module in a psychiatric setting. *Journal of Psychiatric Research*. https://doi.org/10.1016/S0022-3956(98)00021-1

Cooper, P. J., Cooper, M. J., Cooper, Z., & Fairburn, C. G. (1987). The Development and Validation of the Body Shape Questionnaire. *International Journal of Eating Disorders*, *6*(4), 485–494. https://doi.org/10.1002/1098-108X(198707)6:4<485::AID-EAT2260060405>3.0.CO;2-O

Costantini, M., & Haggard, P. (2007). The rubber hand illusion: Sensitivity and reference frame for body ownership. *Consciousness and Cognition*. https://doi.org/10.1016/j.concog.2007.01.001

Couzin, I. D. (2009). Collective cognition in animal groups. *Trends in Cognitive Sciences*. https://doi.org/10.1016/j.tics.2008.10.002

Cragg, L., & Nation, K. (2010). Language and the Development of Cognitive Control. *Topics in Cognitive Science*. https://doi.org/10.1111/j.1756-8765.2009.01080.x

Crockett, M. J. (2016). How Formal Models Can Illuminate Mechanisms of Moral Judgment and Decision Making. *Current Directions in Psychological Science*. https://doi.org/10.1177/0963721415624012

Crossley, K. L., Cornelissen, P. L., & Tovée, M. J. (2012). What Is an Attractive Body? Using an Interactive 3D Program to Create the Ideal Body for You and Your Partner. *PLoS ONE*, *7*(11). https://doi.org/10.1371/journal.pone.0050601

D'Argembeau, A., Renaud, O., & Van Der Linden, M. (2011). Frequency, characteristics and functions of future-oriented thoughts in daily life. *Applied Cognitive Psychology*. https://doi.org/10.1002/acp.1647

Danziger, N., Faillenot, I., & Peyron, R. (2009). Can We Share a Pain We Never Felt? Neural Correlates of Empathy in Patients with Congenital Insensitivity to Pain. *Neuron*, *61*(2), 203–212. https://doi.org/10.1016/j.neuron.2008.11.023

de Vignemont, F. (2010). Body schema and body image--pros and cons. *Neuropsychologia*, *48*(3), 669–80. https://doi.org/10.1016/j.neuropsychologia.2009.09.022

de Vignemont, F., & Singer, T. (2006). The empathic brain: how, when and why? *Trends in Cognitive Sciences*. https://doi.org/10.1016/j.tics.2006.08.008

Decety, J. (1996). The neurophysiological basis of motor imagery. *Behavioural Brain Research*, *77*(1–2), 45–52. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/8762158

Decety, J., Echols, S., & Correll, J. (2010). The Blame Game: The Effect of Responsibility and Social Stigma on Empathy for Pain. *Journal of Cognitive Neuroscience*, *22*(5), 985–997. https://doi.org/10.1162/jocn.2009.21266

Decety, J., & Jackson, P. L. (2004). The functional architecture of human empathy. *Behavioral and Cognitive Neuroscience Reviews*, *3*(2), 71–100. https://doi.org/10.1177/1534582304267187

Decety, J., & Sommerville, J. A. (2003). Shared representations between self and other: A social cognitive neuroscience view. *Trends in Cognitive Sciences*, *7*(12), 527–533. https://doi.org/10.1016/j.tics.2003.10.004

Decety, J., & Svetlova, M. (2012). Putting together phylogenetic and ontogenetic perspectives on empathy. *Developmental Cognitive Neuroscience*, *2*(1), 1–24. https://doi.org/10.1016/j.dcn.2011.05.003

Dolcos, S., & Albarracin, D. (2014). The inner speech of behavioral regulation: Intentions and task performance strengthen when you talk to yourself as a You. *European Journal of Social Psychology*. https://doi.org/10.1002/ejsp.2048

Ehrsson, H. H. (2005). Touching a Rubber Hand: Feeling of Body Ownership Is Associated with Activity in Multisensory Brain Areas. *Journal of Neuroscience*. https://doi.org/10.1523/JNEUROSCI.0800-05.2005

Elliott, R., Slatick, E., & Urman, M. (2001). Qualitative change process research on psychotherapy: Alternative strategies. *Qualitative Psychotherapy Research - Methods and Methodology*.

Eshkevari, E., Rieger, E., Longo, M. R., Haggard, P., & Treasure, J. (2012). Increased plasticity of the bodily self in eating disorders. *Psychological Medicine*, *42*(4), 819–28. https://doi.org/10.1017/S0033291711002091

Eshkevari, E., Rieger, E., Longo, M. R., Haggard, P., & Treasure, J. (2013). Persistent body image disturbance following recovery from eating disorders. *The International Journal of Eating Disorders*. https://doi.org/10.1002/eat.22219

Falconer, C. J., Slater, M., Rovira, A., King, J. A., Gilbert, P., Antley, A., & Brewin, C. R. (2014). Embodying compassion: A virtual reality paradigm for overcoming excessive self-criticism. *PLoS ONE*. https://doi.org/10.1371/journal.pone.0111933

Feixas, G., Evans, C., Trujillo, A., Ángel Saúl, L., Botella, L., Corbella, S., López, E. (2012). La version española del CORE-OM: Clinical Outcomes in Routine Evaluation -Outcome Measure. *Revista de Psicoterapia*, *23*(2389), 109–135.

Fletcher, P. C., & Frith, C. D. (2009). Perceiving is believing: a Bayesian approach to explaining the positive symptoms of schizophrenia. *Nature Reviews Neuroscience*, *10*(1), 48–58. https://doi.org/10.1038/nrn2536

Friston, K. (2010). The free-energy principle : a unified brain theory ?, *11*(2), 127–138. https://doi.org/10.1038/nrn2787

Friston, K. J., Daunizeau, J., Kilner, J., & Kiebel, S. J. (2010). Action and behavior : a free-energy formulation, 227–260. https://doi.org/10.1007/s00422-010-0364-z

Friston, K., Schwartenbeck, P., FitzGerald, T., Moutoussis, M., Behrens, T., & Dolan, R. J. (2013). The anatomy of choice: active inference and agency. *Frontiers in Human Neuroscience*, *7*(September), 1–18. https://doi.org/10.3389/fnhum.2013.00598

Frith, C., & Frith, U. (2012). Mechanisms of Social Cognition. *Annual Review of Psychology*, *63*(December), 287–313. https://doi.org/10.1146/annurev-psych-120710-100449

Gallagher, I. (2000). Philosophical conceptions of the self: implications for cognitive science. *Trends in Cognitive Sciences*, *4*(1), 14–21. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10637618

Gallagher, S. (1986). Body Image and Body Schema: Conceptual Clarification. *Journal of Mind and Behavior*, *7*(4), 541–554.

Gallagher, S. (2005). *How the Body Shapes the Mind*. *Leonardo* (Vol. 20).

García-García, E., Vázquez-Velázquez, V., López-Alvarenga, J. C., & Arcila-Martínez, D. (2003). Validez interna y utilidad diagnóstica del Eating Disorder Inventory, en mujeres Mexicanas. *Salud Publica de Mexico*. https://doi.org/10.1590/S0036-36342003000300010

Gardner, R. M. (1996). The Role of Sensory and Nonsensory Factors in Body Size Estimations of Eating Disorder Subjects. *Clinical Psychology*, (January 1996), 3–15. https://doi.org/10.1002/(SICI)1097-4679(199601)52

Gardner, R. M., & Brown, D. L. (2014). Body size estimation in anorexia nervosa: A brief review of findings from 2003 through 2013. *Psychiatry Research*. https://doi.org/10.1016/j.psychres.2014.06.029

Gardner, R. M., & Moncrieff, C. (1988). Body image distortion in anorexics as a non-sensory phenomenon: A signal detection approach. *Journal of Clinical Psychology*, *44*(2), 101–107. https://doi.org/10.1002/1097-4679(198803)44

Garner, D. M., Olmstead, M. P., & Polivy, J. (1983). Development and validation of a multidimensional eating disorder inventory for anorexia nervosa and bulimia. *International Journal of Eating Disorders*, *2*(2), 15–34. https://doi.org/10.1002/1098-108X(198321)2:2<15::AID-EAT2260020203>3.0.CO;2-6

González-Franco, M., Peck, T. C., Rodríguez-Fornells, A., & Slater, M. (2014). A threat to a virtual hand elicits motor cortex activation. *Experimental Brain Research*. https://doi.org/10.1007/s00221-013-3800-1

González-Franco, M., Pérez-Marcos, D., Spanlang, B., & Slater, M. (2010). The contribution of real-time mirror reflections of motor actions on virtual body ownership in an immersive virtual environment. In *Proceedings - IEEE Virtual Reality* (pp. 111–114). https://doi.org/10.1109/VR.2010.5444805

Gretha, J., Scheurink, A. J. W., Boersma, G. J., Nergårdh, R., & Södersten, P. (2010). Neurobiology of hyperactivity and reward Publisher ' s PDF , also known as Version of record Publication date : Physiology & Behavior Neurobiology of hyperactivity and reward : Agreeable restlessness in Anorexia Nervosa. *Physiology & Behavior*, *100*(5), 490–495. https://doi.org/10.1016/j.physbeh.2010.03.016

Guillén-Riquelme, A., & Buela-Casal, G. (2011). Actualización psicométrica y funcionamiento diferencial de los ítems en el State Trait Anxiety Inventory (STAI). *Psicothema*, *23*(3), 510–515.

Häfner, M. (2004). How Dissimilar others May Still Resemble the Self: Assimilation and Contrast after Social Comparison. *Journal of Consumer Psychology*, *14*(1–2), 187–196. https://doi.org/10.1207/s15327663jcp1401&2_21

Häfner, M., & Schubert, T. W. (2009). Feel the difference! The influence of ease experiences on the direction of social comparisons. *Journal of Experimental Social Psychology*. https://doi.org/10.1016/j.jesp.2008.09.008

Han, S., Northoff, G., Vogeley, K., Wexler, B. E., Kitayama, S., & Varnum, M. E. W. W. (2012). A Cultural Neuroscience Approach to the Biosocial Nature of the Human Brain. *Annual Review of Psychology*, *64*(September), 120920151208003. https://doi.org/10.1146/annurev-psych-071112-054629

Hein, G., Silani, G., Preuschoff, K., Batson, C. D., & Singer, T. (2010). Neural responses to ingroup and outgroup members' suffering predict individual differences in costly helping. *Neuron*, *68*(1), 149–160. https://doi.org/10.1016/j.neuron.2010.09.003

Hohlstein, L. A., Smith, G. T., & Atlas, J. G. (1998). An application of expectancy theory to eating disorders: Development and validation of measures of eating and dieting expectancies. *Psychological Assessment*. https://doi.org/10.1037/1040-3590.10.1.49

Hollon, S. D., & Kendall, P. C. (1980). Cognitive self-statements in depression: Development of an automatic thoughts questionnaire. *Cognitive Therapy and Research*, *4*(4), 383–395. https://doi.org/10.1007/BF01178214

Hortensius, R., Neyret, S., Slater, M., & Gelder, B. De. (2018). The relation between bystanders ' behavioral reactivity to distress and later helping behavior during a violent conflict in virtual reality, 1–20. https://doi.org/10.1371/journal.pone.0196074

Ionta, S., Gassert, R., & Blanke, O. (2011). Multi-sensory and sensorimotor foundation of bodily self-consciousness - an interdisciplinary approach. *Frontiers in Psychology*. https://doi.org/10.3389/fpsyg.2011.00383

Kammers, M. P. M., de Vignemont, F., Verhagen, L., & Dijkerman, H. C. (2009). The rubber hand illusion in action. *Neuropsychologia*. https://doi.org/10.1016/j.neuropsychologia.2008.07.028

Kammers, M. P. M., Longo, M. R., Tsakiris, M., Chris Dijkerman, H., & Haggard, P. (2009). Specificity and coherence of body representations. *Perception*, *38*(12), 1804–1820. https://doi.org/10.1068/p6389

Kazdin, A. E. (1990). Evaluation of the Automatic Thoughts Questionnaire: Negative Cognitive Processes and Depression Among Children. *Journal of Consulting and Clinical Psychology*, *2*(1), 73–79.

Keizer, A., Van Elburg, A., Helms, R., & Dijkerman, H. C. (2016). A virtual reality full body illusion improves body image disturbance in anorexia nervosa. *PLoS ONE*, *11*(10), 1–21. https://doi.org/10.1371/journal.pone.0163921

Kilteni, K., Groten, R., & Slater, M. (2012). The Sense of Embodiment in Virtual Reality. *Presence: Teleoperators and Virtual Environments*, *21*(4), 373–387. https://doi.org/10.1162/PRES_a_00124

Kilteni, K., Normand, J. M., Sanchez-Vives, M. V., & Slater, M. (2012). Extending body space in immersive virtual reality: A very long arm illusion. *PLoS ONE*. https://doi.org/10.1371/journal.pone.0040867

Klonsky, E. D., & Glenn, C. R. (2009). Assessing the Functions of Non-suicidal Self-injury: Psychometric Properties of the Inventory of Statements about Self-injury (ISAS). *Journal of Psychopathology and Behavioral Assessment*, *31*(3), 215–219. https://doi.org/10.1007/s10862-008-9107-z

Kokkinara, E., & Slater, M. (2014). Measuring the effects through time of the influence of visuomotor and visuotactile synchronous stimulation on a virtual body ownership illusion. *Perception*, *43*(1), 43–58.

Longo, M. R., & Haggard, P. (2010). An implicit body representation underlying human position sense. *Proceedings of the National Academy of Sciences of the United States of America*, *107*(26), 11727–32. https://doi.org/10.1073/pnas.1003483107

Lovibond, S., & Lovibond, P. (1995). Depression Anxiety and Stress Scale. *Manual for the Depression Anxiety Stress Scales*.

Maselli, A., & Slater, M. (2013). The building blocks of the full body ownership illusion. *Frontiers in Human Neuroscience*. https://doi.org/10.3389/fnhum.2013.00083

Mason, M. F., Dyer, R., & Norton, M. I. (2009). Neural mechanisms of social influence. *Organizational Behavior and Human Decision Processes*. https://doi.org/10.1016/j.obhdp.2009.04.001

Mason, W. a, Conrey, F. R., & Smith, E. R. (2007). Situating social influence processes: dynamic, multidirectional flows of influence within social networks. *Personality and Social Psychology Review : An Official Journal of the Society for Personality and Social Psychology, Inc*. https://doi.org/10.1177/1088868307301032

Meltzoff, A. N., & Moore, M. K. (1979). Interpreting “imitative” responses in early infancy. *Science New York NY*.

Menon, V. (2015). *Salience Network*. *Brain Mapping: An Encyclopedic Reference* (Vol. 2). Elsevier Inc. https://doi.org/10.1016/B978-0-12-397025-1.00052-X

Meredith, M. A., & Stein, B. E. (1986). Visual, auditory, and somatosensory convergence on cells in superior colliculus results in multisensory integration. *Journal of Neurophysiology*. https://doi.org/citeulike-article-id:844215

Metzinger, T. (2003). Phenomenal transparency and cognitive self-reference. *Phenomenology and the Cognitive Sciences*, *2*(4), 353–393. https://doi.org/10.1023/B:PHEN.0000007366.42918.eb

Metzinger, T. (2014). First-order embodiment, second-order embodiment, third-order embodiment. In *The Routledge Handbook of Embodied Cognition*. https://doi.org/10.4324/9781315775845

Milgram, S. (1963). Behavioral Study of Obedience 1. *Journal of Abnormal and Social Psychology*, *67*(4), 371–378. https://doi.org/10.1037/h0040525

Milgram, S. (1965). Some Conditions of Obedience and Disobedience to Authority. *Human Relations*, *18*(1), 57–76. https://doi.org/10.1177/001872676501800105

Morin. (2005). Possible links between self-awareness and inner speech. *Gestion*. https://doi.org/10.3917/riges.351.0045

Morin, A. (2010). Inner Speech and Consciousness. In *Encyclopedia of Consciousness*. https://doi.org/10.1016/B978-012373873-8.00040-2

Morin, A. (2012). Inner Speech. In *Encyclopedia of Human Behavior*. https://doi.org/10.1016/B978-0-12-375000-6.00206-8

Moser, J. S., Dougherty, A., Mattson, W. I., Katz, B., Moran, T. P., Guevarra, D., … Kross, E. (2017). Third-person self-talk facilitates emotion regulation without engaging cognitive control: Converging evidence from ERP and fMRI. *Scientific Reports*, *7*(1), 1–9. https://doi.org/10.1038/s41598-017-04047-3

Moutoussis, M., Fearon, P., El-Deredy, W., Dolan, R. J., & Friston, K. J. (2014). Bayesian inferences about the self (and others): A review. *Consciousness and Cognition*, *25*(1), 67–76. https://doi.org/10.1016/j.concog.2014.01.009

Mussap, A. J., & Salton, N. (2006). A “rubber-hand” illusion reveals a relationship between perceptual body image and unhealthy body change. *Journal of Health Psychology*, *11*(4), 627–639.

Myers, P. N., & Biocca, F. a. (1992). The elastic body image: The effect of television advertising and programming on body image distortions in young women. *Journal of Communication*, *42*(3), 108–133.

Naito, E., Kochiyama, T., Kitada, R., Nakamura, S., Matsumura, M., Yonekura, Y., & Sadato, N. (2002). Internally simulated movement sensations during motor imagery activate cortical motor areas and the cerebellum. *The Journal of Neuroscience : The Official Journal of the Society for Neuroscience*, *22*(9), 3683–91. https://doi.org/20026282

Navarro-Mateu, F., Morán-Sánchez, I., Alonso, J., Tormo, M. J., Pujalte, M. L., Garriga, A., … Navarro, C. (2013). Cultural adaptation of the Latin American version of the World Health Organization Composite International Diagnostic Interview (WHO-CIDI) (v 3.0) for use in Spain. *Gaceta Sanitaria*. https://doi.org/10.1016/j.gaceta.2012.06.005

Neisser, U. (2008). Five kinds of self - knowledge Five Kinds of Self-knowledge, (February 2013), 37–41.

Netemeyer, R. G., Williamson, D. a., Burton, S., Biswas, D., Jindal, S., Landreth, S., … Primeaux, S. (2002). Psychometric Properties of Shortened Versions of the Automatic Thoughts Questionnaire. *Educational and Psychological Measurement*, *62*(1), 111–129. https://doi.org/10.1177/0013164402062001008

Nussinson, R., Häfner, M., Seibt, B., Strack, F., & Trope, Y. (2012). Approach/Avoidance Orientations Affect Self-construal and Identification with In-group. *Self and Identity*. https://doi.org/10.1080/15298868.2011.559044

Oei, T., & Free, M. (1995). Do cognitive behaviour therapies validate cognitive models of mood disorders? A review of the empirical evidence. *International Journal of Psychology*, *30*(2), 145–180.

Osimo, S. A., Pizarro, R., Spanlang, B., & Slater, M. (2015). Conversations between self and self as Sigmund Freud - A virtual body ownership paradigm for self counselling. *Scientific Reports*, *5*. https://doi.org/10.1038/srep13899

Pan, J.-Y., Ye, S., & Ng, P. (2015). Validation of the Automatic Thoughts Questionnaire (ATQ) Among Mainland Chinese Students in Hong Kong. *J. Clin. Psychol*, *00*, 1–11. https://doi.org/10.1002/jclp.22193

Panksepp, J. (2010). Affective neuroscience of the emotional BrainMind: evolutionary perspectives and implications for understanding depression. *Dialogues in Clinical Neuroscience*, *12*(4), 533–545. https://doi.org/10.1016/S0140-6736(10)62052-1

Peck, T. C., Seinfeld, S., Aglioti, S. M., & Slater, M. (2013). Putting yourself in the skin of a black avatar reduces implicit racial bias. *Consciousness and Cognition*. https://doi.org/10.1016/j.concog.2013.04.016

Petkova, V. I., Björnsdotter, M., Gentile, G., Jonsson, T., Li, T.-Q., & Ehrsson, H. H. (2011). From part- to whole-body ownership in the multisensory brain. *Current Biology CB*, *21*(13), 1118–1122. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/21683596

Petkova, V. I., & Ehrsson, H. H. (2008). If I were you: Perceptual illusion of body swapping. *PLoS ONE*. https://doi.org/10.1371/journal.pone.0003832

Porges, S. W. (2004). Neuroception: A Subconscious System for Detecting Threats and Safety. *Zero to Three*, (May), 19–24.

Raich, R. M., Mora, M., Soler, A., Avila, C., Clos, I., & Zapater, L. (1996). Adaptación de un instrumento de evaluación de la insatisfacción corporal. = Adaptation of a body dissatisfaction assessment instrument. *Clínica y Salud*.

Raque-Bogdan, T. L., Ericson, S. K., Jackson, J., Martin, H. M., & Bryan, N. A. (2011). Attachment and mental and physical health: Self-compassion and mattering as mediators. *Journal of Counseling Psychology*. https://doi.org/10.1037/a0023041

Richerson, P. J., & Boyd, R. (2001). The evolution of subjective commitment to groups: A tribal instincts hypothesis. *Evolution and the Capacity for Commitment.*

Ruff, C. C., & Fehr, E. (2014). The neurobiology of rewards and values in social decision making. *Nature Reviews Neuroscience*. https://doi.org/10.1038/nrn3776

Ruiz, F. J., Suárez-Falcón, J. C., & Riaño-Hernández, D. (2017). Validity Evidence of the Spanish Version of the Automatic Thoughts Questionnaire–8 in Colombia. *The Spanish Journal of Psychology*, *20*(12), 2–9. https://doi.org/10.1017/sjp.2017.7

San Martín, C., Montero, I., Isabel Navarro, M., & Biglia, B. (2014). The development of referential communication: Improving message accuracy by coordinating private speech with peer questioning. *Early Childhood Research Quarterly*. https://doi.org/10.1016/j.ecresq.2013.10.001

Sanchez-Vives, M. V, & Slater, M. (2005). From presence to consciousness through virtual reality. *Nature Reviews Neuroscience*, *6*(4), 332–9. https://doi.org/10.1038/nrn1651

Schilbach, L. (2015). Eye to eye, face to face and brain to brain: Novel approaches to study the behavioral dynamics and neural mechanisms of social interactions. *Current Opinion in Behavioral Sciences*, *3*, 130–135. https://doi.org/10.1016/j.cobeha.2015.03.006

Schore, A. (2001). Effecs of a secure attachment relationship on right brain development, affect regulation, and infant mental health. *Infant Mental Health Journal*, *22*(1), 7–66.

Schore, A. N. (1997). Early organization of the nonlinear right brain and development of a predisposition to psychiatric disorders, *9*, 595–631.

Schultz, W., Dayan, P., & Montague, P. R. (1997). A neural substrate of prediction and reward. *Science*. https://doi.org/10.1126/science.275.5306.1593

Schwartz, R. M. (1986). The Internal Dialogue : On the Asymmetry Between Positive and Negative Coping Thoughts 1, *10*(6), 591–605.

Seth, A. K. (2013). Interoceptive inference, emotion, and the embodied self. *Trends in Cognitive Sciences*. https://doi.org/10.1016/j.tics.2013.09.007

Seth, A. K., & Friston, K. J. (2016). Active interoceptive inference and the emotional brain. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *371*(1708), 20160007. https://doi.org/10.1098/rstb.2016.0007

Seth, A. K., Suzuki, K., & Critchley, H. D. (2012). An interoceptive predictive coding model of conscious presence. *Frontiers in Psychology*, *3*(JAN), 1–16. https://doi.org/10.3389/fpsyg.2011.00395

Siegel, D. J. (2001). Toward an interpersonal neurobiology of the developing mind: Attachment relationships, ?mindsight,? and neural integration. *Infant Mental Health Journal*, *22*(1–2), 67–94. https://doi.org/10.1002/1097-0355(200101/04)22:1<67::AID-IMHJ3>3.0.CO;2-G

Siegel, D. J. (2012a). Mind , Brain , and Relationships. In *The developing mind Chapter 1* (pp. 1–45).

Simmons, K., Istook, C. L., & Devarajan, P. (2004). Female figure identification technogue for apparel Part 2: development of shape sorting software. *Marketing Research*, *4*(1).

Singer, W. (2009). The brain, a complex self-organizing system. *European Review*, *17*(2), 321–329. https://doi.org/10.1017/S1062798709000751

Skarbez, R., Neyret, S., Brooks, F. P., Slater, M., & Whitton, M. C. (2017). A Psychophysical Experiment Regarding Components of the Plausibility Illusion. *IEEE Transactions on Visualization and Computer Graphics*, *23*(4), 1322–1331. https://doi.org/10.1109/TVCG.2017.2657158

Slater, M. (2003). A Note on Presence Terminology. *Emotion*, *3*(3), 1–5. Retrieved from http://people.cs.uct.ac.za/~dnunez/reading/papers/presenceterminology.pdf

Slater, M. (2009). Place illusion and plausibility can lead to realistic behaviour in immersive virtual environments. *Philosophical Transactions of the Royal Society B: Biological Sciences*. https://doi.org/10.1098/rstb.2009.0138

Slater, M., Antley, A., Davison, A., Swapp, D., Guger, C., Barker, C., … Sanchez-Vives, M. V. (2006). A virtual reprise of the Stanley Milgram obedience experiments. *PLoS ONE*, *1*(1). https://doi.org/10.1371/journal.pone.0000039

Slater, M., Rovira, A., Southern, R., Swapp, D., Zhang, J. J., Campbell, C., & Levine, M. (2013). Bystander Responses to a Violent Incident in an Immersive Virtual Environment. *PLoS ONE*. https://doi.org/10.1371/journal.pone.0052766

Slater, M., & Sanchez-Vives, M. V. (2014). Transcending the self in immersive virtual reality. *Computer*. https://doi.org/10.1109/MC.2014.198

Slater, M., Spanlang, B., Sanchez-Vives, M. V., & Blanke, O. (2010). First person experience of body transfer in virtual reality. *PLoS ONE*, *5*(5), 1–9. https://doi.org/10.1371/journal.pone.0010564

Södersten, P., Bergh, C., Leon, M., & Zandian, M. (2016). Dopamine and anorexia nervosa. *Neuroscience and Biobehavioral Reviews*, *60*, 26–30. https://doi.org/10.1016/j.neubiorev.2015.11.003

Södersten, P., Bergh, C., Zandian, M., & Ioakimidis, I. (2014). Homeostasis in anorexia nervosa, *8*(August), 6–10. https://doi.org/10.3389/fnins.2014.00234

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. (1970). *State-Trait Anxiety Inventory manual*. Palo Alto, CA: Consulting Psychologists Press.

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. (1982). *Manual del Cuestionario de Ansiedad Estado/Rasgo (STAI)*. Madrid, España: TEA Ediciones.

Suzuki, K., Garfinkel, S. N., Critchley, H. D., & Seth, A. K. (2013). Multisensory integration across exteroceptive and interoceptive domains modulates self-experience in the rubber-hand illusion. *Neuropsychologia*, *51*(13). https://doi.org/10.1016/j.neuropsychologia.2013.08.014

Tanaka, N., Uji, M., Hiramura, H., Chen, Z. I., Shikai, N., & Kitamura, T. (2006). Cognitive patterns and depression: Study of a Japanese university student population. *Psychiatry and Clinical Neurosciences*, *60*, 358–364. https://doi.org/10.1111/j.1440-1819.2006.01514.x

Thompson, J. K., & Stice, E. (2001). Thin-Ideal Internalization: Mounting Evidence for a New Risk Factor for Body-Image Disturbance and Eating Pathology. *Current Directions in Psychological Science*, *10*(5), 181–183. https://doi.org/10.1111/1467-8721.00144

Trujillo, A., Feixas, G., Bados, A., Garcia-Grau, E., Salla, M., Medina, J. C., … Evans, C. (2016). Psychometric properties of the spanish version of the clinical outcomes in routine evaluation - Outcome measure. *Neuropsychiatric Disease and Treatment*, *12*, 1457–1466.

Tsakiris, M. (2016). The multisensory basis of the self: from body to identity to others. *Quarterly Journal of Experimental Psychology (2006)*, *0218*(August). https://doi.org/10.1080/17470218.2016.1181768

Tsakiris, M., & Haggard, P. (2005). The rubber hand illusion revisited: Visuotactile integration and self-attribution. *Journal of Experimental Psychology: Human Perception and Performance*. https://doi.org/10.1037/0096-1523.31.1.80

Uddin, L. Q. (2014). Salience processing and insular cortical function and dysfunction. *Nature Reviews Neuroscience*, *16*(1), 55–61. https://doi.org/10.1038/nrn3857

Vygotsky, L. S. (1934). Thinking and Speech. *L.S. Vygotsky, Collected Works (Vol. 1)*. https://doi.org/10.1016/B978-0-444-41663-6.50012-9

Wiese, W., & Metzinger, T. (2017). Vanilla predictive processing for philosophers: A primer on predictive processing. *Philosophy and Predictive Processing*, 1–18. https://doi.org/10.15502/9783958573024

Williams, D. M., Bowler, D. M., & Jarrold, C. (2012). Inner speech is used to mediate short-term memory, but not planning, among intellectually high-functioning adults with autism spectrum disorder. *Development and Psychopathology*. https://doi.org/10.1017/S0954579411000794

Williamson, D. a. (1996). Body image disturbance in eating disorders: A form of cognitive bias? *Eating Disorders*, *4*(1), 47–58. https://doi.org/10.1080/10640269608250075

Wong, S. S. (2008). The Relations of Cognitive Triad, Dysfunctional Attitudes, Automatic Thoughts, and Irrational Beliefs with Test Anxiety. *Curr Psychol*, *27*, 177–199. https://doi.org/10.1007/s12144-008-9033-y

APPENDICES

APPENDIX A: SUPPLEMENTARY MATERIAL COMMON TO ALL THREE EXPERIMENTS:

Form for future studies, Consent form, Voice and Image data protection, demographic questionnaire.

To enter the data base of EventLab and receive the information related to the studies, participants first needed to fill in the form for future studies (available in the three official languages of the University of Barcelona, Spanish, English, Catalan). Then they needed to read and sign the information sheet related to each experiment (see in Appendices B, C and D). After reading all the information about the experiment, participants signed a consent form (available in the three official languages of the University of Barcelona) and filled in the demographic questionnaire. If participant's image or voice was recorded they signed the consent from for the use and protection of their personal data (Dret d'informació i sol·licitud del consentiment per a tractar la imatge i la veu).

Participación en futuros estudios relacionados con la realidad virtual, por favor escriba en letras mayúsculas:

Nombre y Apellidos (en letras mayúsculas): _____

Sexo: hombre / mujer

Edad: _____

Dirección de correo electrónico (en letras mayúsculas):

_____

Número de teléfono: _____

Ha participado en otros estudios del EventLab: SI/NO

En cual(es) experimento(s):_____

(si no sabe el nombre del experimento por favor pregunte)

Les dades de caràcter personal facilitades seran incorporades al fitxer "Projectes de recerca, desenvolupament i innovació amb dades personals de nivell bàsic.", titularitat de la Universitat de Barcelona, amb la finalitat de portar a terme projectes de recerca, desenvolupament i innovació. L'òrgan responsable del fitxer és la Secretaria General. En qualsevol cas, podeu exercir els drets d'accés, rectificació, cancel·lació i oposició mitjançant una comunicació escrita, adjuntant fotocòpia del DNI o altre document identificatiu, dirigida a la Secretaria General de la Universitat de Barcelona, Gran Via de les Corts Catalanes 585, 08007 Barcelona o mitjançant correu electrònic a la següent adreça: secretaria.general@ub.edu.

Dones el consentiment perquè utilitzem l'adreça de correu electrònic que aquí indiqués per posar-nos en contacte amb tu quan encaixis en la població d'algun estudi? ☐

(sinó ens donés el consentiment no podràs participar en cap estudi)

Fecha _____ Firma _____

Participació en futurs estudis relacionats amb la realitat virtual, sisplau escrigui en lletres majúscules:

Nom i Cognoms: _____

Gènere: home / dona

Data de Naixement: _____

Adreça de correu electrònic: _____

Numero de telèfon _____

Ha participat en altres estudis del EventLab: SI/NO

En quin(s) experiment(s):_____

(si no sap el nom del experiment sisplau pregunti)

Les dades de caràcter personal facilitades seran incorporades al fitxer "Projectes de recerca, desenvolupament i innovació amb dades personals de nivell bàsic.", titularitat de la Universitat de Barcelona, amb la finalitat de portar a terme projectes de recerca, desenvolupament i innovació. L'òrgan responsable del fitxer és la Secretaria General. En qualsevol cas, podeu exercir els drets d'accés, rectificació, cancel·lació i oposició mitjançant una comunicació escrita, adjuntant fotocòpia del DNI o altre document identificatiu, dirigida a la Secretaria General de la Universitat de Barcelona, Gran Via de les Corts Catalanes 585, 08007 Barcelona o mitjançant correu electrònic a la següent adreça: secretaria.general@ub.edu.

Dones el consentiment perquè utilitzem l'adreça de correu electrònic que aquí indiqués per posar-nos en contacte amb tu quan encaixis en la població d'algun estudi? ☐

(sinó ens donés el consentiment no podràs participar en cap estudi)

Data _____ Firma _____

Participation in future studies related with Virtual Reality (please write in capital letters)

Name and surname: _____

Gender: Male / Female

Age: _____

E-mail (capital letters): _____

Phone number: _____

Participation in other experiment(s) at EventLab: YES/NO

Name of the experiment: _____

The personal data provided will be added to the folder "*Projectes de recerca, desenvolupament i innovació amb dades personals de nivell bàsic*" (: Projects of research, innovation and development with basic level personal data") ownership of the University of Barcelona, with the objective to carry out research development and innovation projects. The responsible person of the folder is the General Secretary. In any case you can use your rights of access, rectification, cancellation and opposition by writing a letter attaching a copy of your DNI or any other identification document, addressed to "Secretaria General de la Universitat de Barcelona, Gran Via de les Corts Catalanes 585, 08007 Barcelona" or by writing an email to the following address: secretaria.general@ub.edu.

Do you give your consent for us to use the email address you indicated above to contact you when your profile corresponds to the population we are looking for in a study? ☐

(if you don't give your consent you will not be able to participate in any study)

Date _____ Signature _____

CONSENTIMIENTO INFORMADO DEL PARTICIPANTE

El voluntario deberá leer y contestar cuidadosamente las siguientes preguntas:

¿Ha leído toda la información sobre este estudio? SI/NO

¿Ha tenido la oportunidad de preguntar y comentar cuestiones sobre el estudio? SI/NO

¿Ha recibido respuestas satisfactorias a todas las cuestiones? SI/NO

¿Ha recibido la suficiente información sobre este estudio? SI/NO

¿Qué investigador le ha hablado sobre el estudio?…… (nombre y apellidos)

¿Ha comprendido que usted es libre de abandonar este estudio? SI/NO

En cualquier momento y sin dar ninguna razón SI/NO

¿Ha comprendido y aceptado los riesgos asociados con el uso de la Realidad Virtual? SI/NO

¿Está de acuerdo en tomar parte en el estudio? SI/NO

¿Está de acuerdo en ser grabado en vídeo? SI/NO

¿Está de acuerdo en ser grabado en audio? SI/NO

¿Está de acuerdo en que tomemos registros fisiológicos? SI/NO

¿Da usted permiso al investigador para contactar con usted un tiempo después de realizar el experimento a modo de control? SI/NO

En caso afirmativo, indique su dirección de correo electrónico……..

Yo certifico que:

- Soy mayor de edad (18 años o más)

- No he consumido más de dos unidades de alcohol en las últimas 6 horas (2 unidades de alcohol = 1 cerveza o 2 copas de vino)

- No estoy tomado ningún tipo de medicación psicoactiva

- No padezco epilepsia

- No conduciré ni coches, ni motos, ni bicicletas ni usaré ningún tipo de máquinas complejas que puedan ser peligrosas para mí o para otros, durante las tres próximas horas después de acabar la experiencia

- No padezco estrés post-traumático o cualquier otro tipo de trastorno psicológico

Firmado…… Fecha……

Nombre completo ……

En caso de que usted desee hacer alguna pregunta o comentario de este estudio en el futuro por favor contacte con: *Mel Slater, EVENT Lab for Neuroscience and Technology - Facultat de Psicologia, Universitat de Barcelona, Departamento de Psicología clínica i Psicobiología, Campus de Mundet - Edifici Teatre. Passeig de la Vall d'Hebron 171, 08035 Barcelona, Spain- Tel. +34 93 403 9618 - www.event-lab.org*. La información obtenida de su experimento nunca será publicada individualmente. Los datos serán analizados en grupos y aquellos comentarios verbales, en el caso que se publiquen, serán presentados de forma anónima. Este estudio ha sido aprobado por la comisión Bioética de la Universitat de Barcelona.

Los datos de carácter personal facilitados serán incorporados al fichero "Proyectos de recerca, desarrollo e innovación con datos personales de nivel alto", titularidad de la Universitat de Barcelona, con la finalidad de llevar a cabo proyectos de recerca, desarrollo e innovación. El órgano responsable del fichero es la Secretaria General. En cualquier caso, puede exercer los derechos de acceso, rectificación, cancelación i oposición a través de una comunicación escrita, adjuntando fotocopia del DNI u otro documento identificativo, dirigida a la Secretaria General de la Universitat de Barcelona, Gran Via de les Corts Catalanes 585, 08007 Barcelona o enviando un correo electrónico a la siguiente a dirección: secretaria.general@ub.edu.

INFORMED CONSENT FOR THE PARTICIPANT

The volunteer should read and answer the following questions carefully:

Have you read all the information regarding this study? YES/NO

Have you had an opportunity to ask questions you may have regarding this study? YES/NO

Have you received a satisfactory response for all your questions? YES/NO

Have you received sufficient information regarding this study? YES/NO

The name of the investigator you have spoken to regarding this study……. (First and last name)

Have you understood that you are free to leave this study? YES/NO

At any moment and without giving any reason? YES/NO

Do you understand and accept the risks associated with the use of virtual reality equipment? YES/NO

Do you agree to take part in the study? YES/NO

Do you give permission to the investigator to contact you one month after the experiment as a follow up?

YES/NO

If you agree, please write your email address: ……

I certify that:

- I am an adult (over 18 years old)
- I did not consume more than 2 units of alcohol in the last 6 hours (2 alcohol units = 1 beer or 2 glasses of wine)
- I am not taking any kind of psychoactive medication
- I do not suffer from epilepsy.
- I will not be driving a car, motorcycle, bicycle, or operate any type of complex machinery that could be a danger to myself or others, for three hours following the study.
- I do not suffer from post-traumatic stress disorder or any other type of psychological disorder

Full name: …… Date: …….

Signature: ……

In case you have any questions or comments about this study in the future, please contact:

Mel Slater, EVENT Lab for Neuroscience and Technology - Facultat de Psicologia, Universitat de Barcelona, Departament of Clinical Psychology and Psychobiology, Campus de Mundet - Edifici Teatre. Passeig de la Vall d'Hebron 171, 08035 Barcelona, Spain- Tel. +34 93 403 9618 - www.event-lab.org. The information collected in this experiment will never be published individually. The data will be analysed in groups, and any verbal comments made, in case they are published, will be presented anonymously. This study has been approved by the Bioethics Committee of the University of Barcelona.

All personal data that is collected will be incorporated within the file "Projectes de recerca, desenvolupament i innovació amb dades personals de nivell alt", property of the University of Barcelona, with the final objective of bringing to term the projects related to Research and Development. The authority responsible for the aforementioned file is the General Secretary. In all cases you can exercise your rights of Access, Rectification, Cancelation and Opposition through a written communication along with a photocopy of your Identity Document, addressed to the following: "Secretaria General de la Universitat de Barcelona, Gran Via de les Corts Catalanes 585, 08007 Barcelona", or by sending an email to the following address: secretaria.general@ub.edu.

CONSENTIMENT INFORMAT DEL PARTICIPANT

El voluntari ha de llegir i contestar atentament les següents preguntes:

Ha llegit tota la informació sobre aquest estudi? SÍ/NO

Ha tingut l'oportunitat de preguntar i comentar qüestions sobre l'estudi? SÍ /NO

Ha rebut respostes satisfactòries a totes les preguntes? SÍ /NO

Ha rebut suficient informació sobre aquest estudi? SÍ /NO

Quin investigador li ha parlat sobre l'estudi?……..... (nom i cognoms)

Ha comprès que és vostè lliure d'abandonar aquest estudi SÍ /NO

en qualsevol moment i sense donar cap motiu SÍ /NO

Ha entès i acceptat els riscs associats a l'ús de la Realitat Virtual? SÍ /NO

Està d'acord en formar part d'aquest estudi? SÍ /NO

Està d'acord en ser gravat en vídeo? SÍ /NO

Està d'acord en ser gravat en àudio? SÍ /NO

Esta d'acord en què es gravin les seves dades fisiològics? SÍ /NO

Dóna vostè permís a l'investigador per a contactar amb vostè un mes després de realitzar l'experiment a mode de control? SÍ /NO

En cas afirmatiu, indiqui la seva adreça de correu electrònic: .....

Jo certifico que:

- Sóc major d'edat (18 anys o major)
- No he consumit més de dues unitats d'alcohol en les últimes 6 hores (2 unitats d'alcohol =1 cervesa o 2 copes de vi)
- No estic prenent cap mena de medicació psicoactiva
- No pateixo epilèpsia
- Jo certifico que no conduiré cotxes, ni motos, ni bicicletes ni cap mena de màquines complexes que puguin ser perilloses per a mi o per a altres, durant les properes tres hores després d'acabar l'experiment
- No pateixo estrès posttraumàtic o qualsevol altre tipus de trastorn psicològic

Signat…… **Data**……

Nom complet…….....

En el cas en què vulgui fer alguna pregunta o comentari sobre aquest estudi en el futur, si us plau contacti amb:

Mel Slater, EVENT Lab for Neuroscience and Technology, Facultat de Psicologia, Universitat de Barcelona, Departament de Psicologia clínica i Psicobiologia,, Campus de Mundet - Edifici Teatre - Passeig de la Vall d'Hebron 171, 08035 Barcelona, Spain -Tel. +34 93 403 9618. www.event-lab.org. La informació obtinguda en seu experiment mai serà publicada individualment. Les dades seran analitzades en grups i els comentaris verbals, en el cas que es publiquin, seran presentats de forma anònima. Aquest estudi ha sigut aprovat per la Comissió Bioètica de la Universitat de Barcelona.

Les dades de caràcter personal facilitades seran incorporades al fitxer "Projectes de recerca, desenvolupament i innovació amb dades personals de nivell alt.", titularitat de la Universitat de Barcelona, amb la finalitat de portar a terme projectes de recerca, desenvolupament i innovació. L'òrgan responsable del fitxer és la Secretaria General. En qualsevol cas, podeu exercir els drets d'accés, rectificació, cancel·lació i oposició mitjançant una comunicació escrita, adjuntant fotocòpia del DNI o altre document identificatiu, dirigida a la Secretaria General de la Universitat de Barcelona, Gran Via de les Corts Catalanes 585, 08007 Barcelona o mitjançant correu electrònic a la següent adreça: secretaria.general@ub.edu.

Demographic questionnaire (Spanish)

ID:

EDAD:

GENERO: MUJER HOMBRE

OCUPACIÓN: ……

¿Con que mano escribes?

DERECHA **IZQUIERDA**

Indique su nivel de conocimientos en informática dentro de una escala del 1 al 7

1 2 3 4 5 6 7
PRINCIPIANTE EXPERTO

Por favor indique su nivel de experiencia en programación informática:

1 2 3 4 5 6 7
PRINCIPIANTE EXPERTO

¿Ha tenido alguna experiencia con Realidad Virtual anteriormente?

1 2 3 4 5 6 7
NUNCA MUCHAS VECES

¿Cuántas veces ha jugado con videojuegos (en casa, el trabajo, el colegio, sitios públicos como centros comerciales…) en el último año?

0 1-5 6-10 11-15 16-20 21-25 >25

¿Cuántas horas a la semana juega con videojuegos?

0 1 2-3 3-5 5-7 7-9 >9

Demographic questionnaire (Catalán)

ID:

EDAT:

GÈNERE: DONA HOME

OCUPACIÓ: ……

¿Ha consumit més de dues unitats d'alcohol en les últimes 6 hores?
(2 unitats d'alcohol = 1 cervesa o 2 copes de vi)

SI NO

¿Amb quina mà escriu?

DRETA ESQUERRA

Indiqui el seu nivell de coneixements en informàtica en una escala de l'1 al 7

	1	**2**	**3**	**4**	**5**	**6**	**7**	
PRINCIPIANT								EXPERT

Si us plau, indiqui el seu nivell d'experiència en programació informàtica:

	1	**2**	**3**	**4**	**5**	**6**	**7**	
PRINCIPIANT								EXPERT

¿Ha tingut alguna experiència amb realitat virtual anteriorment?

	1	**2**	**3**	**4**	**5**	**6**	**7**	
MAI								MOLTES VEGADES

¿Quants cops ha jugat amb videojocs (a casa, la feina, l'escola, llocs públics com centres comercials…) durant l'últim any?

0 1-5 6-10 11-15 16-20 21-25 >25

¿Quantes hores a la setmana juga amb videojocs?

0 1 2-3 3-5 5-7 7-9 >9

Dret d'informació i sol·licitud del consentiment per a tractar la imatge i la veu

Us informem que durant la vostra participació en el projecte de recerca (TRAVERSE/ VERE/ PSI) seran enregistrades la vostra imatge i la vostra veu i, posteriorment, tractades per poder analitzar el comportament i les reaccions desenvolupades.

Aquestes dades de caràcter personal, juntament amb les altres recollides en el si de la vostra participació en aquest projecte, seran incorporades al fitxer "Projectes de recerca, desenvolupament i innovació amb dades personals de nivell alt", titularitat de la Universitat de Barcelona, amb la finalitat de portar a terme projectes de recerca, desenvolupament i innovació on es tractin dades especialment protegides. L'òrgan responsable del fitxer és la Secretaria General. En qualsevol cas, podeu exercir els drets d'accés, rectificació, cancel·lació i oposició mitjançant una comunicació escrita, adjuntant fotocòpia del DNI o altre document identificatiu, dirigida a la Secretaria General de la Universitat de Barcelona, Gran Via de les Corts Catalanes 585, 08007 Barcelona o mitjançant correu electrònic a la següent adreça: secretaria.general@ub.edu.

El/la Sr./Sra. _____, expressa que ha llegit la informació anterior i atorgua el consentiment informat per a què la seva imatge i veu siguin tractades en el si del projecte de recerca esmentat.

Data: Signatura:

Recruitment email
Hola,

Buscamos participantes para un estudio de realidad virtual. Este experimento forma parte de una serie de experimentos para comprender la respuesta de las personas dentro de un entorno de realidad virtual. Durante el experimento llevaras unas gafas que te permitirán ver un bar virtual, y un traje con sensores de movimiento. El experimento se hace en una sesión de 60 minutos. Te pagaremos 10€ por tu participación.

Requisitos:
- Ser mayor de edad (18 años o más)
- No padecer epilepsia
- No haber consumido más de dos unidades de alcohol en las 6 horas previas al experimento (2 unidades de alcohol = 1 cerveza o 2 copas de vino).
- No tener que conducir ni coche, ni moto, ni bicicleta durante 3 horas después de acabar la experiencia
- No estar tomando ningún tipo de medicación psicoactiva
- No padecer estrés post traumático o cualquier otro tipo de trastorno psicológico

Por favor, contesta a este e-mail indicando tus disponibilidades para participar en el experimento y nos pondremos en contacto contigo. El experimento se realizara en el Eventlab, Campus Mundet.

Follow up email

Hola,

Le envío este correo en relación al experimento de realidad virtual en el que participó (en el Event Lab, campus Mundet, UB). Igual que en todos los estudios que realizamos, pasado cierto tiempo contactamos con las personas que participaron en el experimento para preguntarles cómo se encuentran. Es por esto que le pido por favor que conteste a las siguientes preguntas:

- ¿Ha tenido algún pensamiento relacionado con el experimento en el que participó? Si es así, ¿qué tipo de cosas ha pensado?

- ¿Ha tenido algún pensamiento o reacción negativa referente al experimento?

- ¿Ha tenido algún pensamiento o reacción positiva referente al experimento?

- ¿Tuvo usted alguna sensación extraña, pensamiento o reacción relacionada con el experimento?

En caso de que quiera que contactemos con usted para hablar sobre este tema con más profundidad, por favor indíquenoslo en su email.

-En el futuro, ¿le gustaría volver a participar en un estudio similar?

Muchas gracias por su colaboración.

APPENDIX B: SUPPLEMENTARY MATERIAL FOR EXPERIMENT I

Information sheet session 1

INFORMACIÓN DEL EXPERIMENTO

Este experimento consta de dos fases, y forma parte de una serie a través de la cual intentamos aprender cómo responden las personas a las experiencias de realidad virtual.

En esta primera fase del experimento se pondrá un casco de realidad virtual que le mostrará un mundo virtual en tres dimensiones. En la siguiente foto se muestra un ejemplo del equipamiento:

Cuando mueva su cabeza, verá efectos particulares dentro de la realidad virtual.

En esta primera fase, primero se le pedirá que realice tres tareas. La primera consistirá en centrar una bola roja respecto un cubo verde que podrá ver en el entorno virtual. Deberá realizar esta tarea cinco veces usando un joystick que le proporcionaremos. Una vez realizada la tarea, le cambiaremos el joystick por dos rastreadores que le colocaremos en cada mano. En esta segunda tarea le pediremos que estime las proporciones de un objeto de la sala que podrá inspeccionar previamente.

Cada vez que le pidamos una medida deberá indicarla a través de la longitud del cilindro que verá delante de usted. La longitud de este tubo se adaptará a la distancia entre sus manos. Finalmente, le pediremos que realice otra tarea consistente en darnos medidas corporales. El procedimiento para indicar las distancias será el mismo que el anterior, es decir, verá un cilindro delante de usted y podrá modular la longitud de este tubo mediante la distancia entre sus manos.

Una vez finalizada esta última tarea le quitaremos el casco de realidad virtual. En este momento, le pediremos que se ponga el traje Optitrack y le colocaremos 32 marcadores.

Una vez realizado esto, habrá finalizado la primera parte del experimento. En este momento, le pediremos que complete dos cuestionarios. El objetivo del experimento será explicado al finalizar la segunda fase. Por favor, no discuta los detalles del experimento con otros ya que el desconocimiento del mismo es crucial para los resultados. Si tiene alguna pregunta, por favor pregunte.

IMPORTANTE

Cuando la gente usa un sistema de realidad virtual, a menudo algunas personas experimentan cierta sensación de nauseas. Si en algún momento del estudio desea parar por cualquier razón, por favor dígalo y pararemos la experiencia. Algunas investigaciones sugieren que la gente que usa un casco de realidad virtual puede experimentar alguna pequeña perturbación visual poco después. No conocemos estudios a largo terminio, pero hay estudios que prueban la presencia de este efecto después de 30 minutos. También han sido documentadas ocasiones en las que después de 30 minutos hay quien tiene 'flashbacks' pasajeros relacionados con la experiencia virtual. Con algunos tipos de video hay la posibilidad de generar un episodio epiléptico, como se ha informado que ocurre en algunos video juegos.

Information sheet session 2

INFORMACIÓN DEL EXPERIMENTO (segunda fase)

Esta fase del experimento es similar a la anterior. Aquí tiene una explicación a modo de recordatorio: En esta segunda fase del experimento se pondrá un casco de realidad virtual que le mostrará un mundo virtual en tres dimensiones. En la siguiente foto se muestra un ejemplo del equipamiento:

Cuando mueva su cabeza, verá efectos particulares dentro de la realidad virtual. Le pediremos que se ponga otra vez el traje Optitrack:

Tendrá que colocar las manos en los soportes que podrá ver en el laboratorio. Cuando esté listo empezaremos con esta fase del experimento. No habrá ninguna tarea a realizar más que responder en una escala de 1 a 7 a las preguntas que le iremos haciendo durante el experimento. Una vez finalizado, le daremos un cuestionario. El objetivo del experimento será explicado al finalizar la segunda fase. Por favor, no discuta los detalles del experimento con otros ya que el desconocimiento del mismo es crucial para los resultados. Si tiene alguna pregunta, por favor pregunte.

IMPORTANTE

Cuando la gente usa un sistema de realidad virtual, a menudo algunas personas experimentan cierta sensación de nauseas. Si en algún momento del estudio desea parar por cualquier razón, por favor dígalo y pararemos la experiencia. Algunas investigaciones sugieren que la gente que usa un casco de realidad virtual puede experimentar alguna pequeña perturbación visual poco después. No conocemos estudios a largo termino, pero hay estudios que prueban la presencia de este efecto después de 30 minutos. También han sido documentadas ocasiones en las que después de 30 minutos hay quien tiene 'flashbacks' pasajeros relacionados con la experiencia virtual. Con algunos tipos de video hay la posibilidad de generar un episodio epiléptico, como se ha informado que ocurre en algunos video juegos.

APPENDIX C: SUPPLEMENTARY MATERIAL FOR EXPERIMENT II

Information sheet session 1

Información sobre el experimento

Este experimento forma parte de una larga serie de estudios para comprender la respuesta de la gente dentro de un entorno de realidad virtual. Por favor lea esta información cuidadosamente y siéntase libre de preguntar cualquier duda que tenga. Los experimentadores responderán a todas sus preguntas. Sin embargo, los aspectos específicos que estamos estudiando en este experimento no se podrán comentar con usted hasta terminar la sesión. Todo el experimento durará aproximadamente 80 minutos.

Recuerde que puede abandonar el experimento en cualquier momento y sin dar ningún tipo de explicación.

Durante las distintas fases del estudio le pediremos que responda algunas preguntas y rellene algunos cuestionarios, así como que realice algunas tareas sencillas tanto utilizando papel y lápiz como mediante una pantalla de ordenador. Además, en una de las fases del experimento realizará una tarea que implica utilizar un sistema de Realidad Virtual incluyendo un casco (figure1) y un traje con sensores. Usted estará sentado en una terraza virtual en la cual se encontrará otras personas virtuales. Por favor preste atención a la situación.

Figure1

Figure2

IMPORTANTE

Cuando la gente usa un sistema de Realidad Virtual, algunas personas experimentan cierta sensación de nauseas. Si en algún momento del estudio usted desea parar debido a esta u otra razón, por favor dígalo y pararemos la experiencia. En algunas investigaciones se sugiere que la gente que usa un casco de realidad virtual puede experimentar alguna pequeña perturbación visual poco después. No conocemos estudios a largo plazo, pero hay estudios que prueban la presencia de este efecto después de 30 minutos. También ha sido documentado que en ocasiones después de 30 minutos hay quien tiene 'flashbacks' pasajeros relacionados con la experiencia virtual. Con algunos tipos de video hay la posibilidad de generar un episodio epiléptico, tal y como se ha informado que ocurre en algunos videojuegos, este fenómeno nunca ha ocurrido en nuestro laboratorio ni en ningún experimento del Dr Mel Slater. Se le pide que lea, comprenda y firme su consentimiento informado. Si usted lo firma el estudio contará con su participación. En caso de que tenga alguna pregunta o comentario relacionado con el estudio por favor contacte con nosotros: Mel Slater (melslater@ub.edu), Solène Neyret (solene.neyret@ub.edu)

Gracias por su participación.

Nombre y Apellidos: Firma:

Information sheet session 2

Información sobre el experimento

Este experimento forma parte de una larga serie de estudios para comprender las respuestas de la gente dentro de un entorno de realidad virtual. Por favor lea esta información cuidadosamente y siéntase libre de preguntar cualquier duda que tenga. Los experimentadores responderán a todas sus preguntas. Sin embargo, los aspectos específicos que estamos estudiando en este experimento no se podrán comentar con usted hasta terminar la sesión. Todo el experimento durará aproximadamente 50 minutos.

Recuerde que puede abandonar el experimento en cualquier momento y sin dar ningún tipo de explicación.

Durante las distintas fases del estudio le pediremos que responda algunas preguntas y rellene algunos cuestionarios mediante una pantalla de ordenador. Además, en una de las fases del experimento realizará una tarea que implica utilizar un sistema de Realidad Virtual incluyendo un casco y un mando (figure1) y un aparato de medición del ritmo cardiaco. Usted estará dentro de un laboratorio virtual en el cual se encontrarán tres experimentadores virtuales y un participante virtual. Su tarea será de comprobar que el participante virtual haya memorizado correctamente pares de palabras asociadas. Aparecerá en la pared virtual una serie de cinco palabras: la palabra clave y las cuatro opciones de respuesta del participante virtual. La palabra correctamente asociada con la palabra clave estará iluminada en verde, su tarea será de comprobar que el participante recuerda correctamente los pares de palabra y decirle si su respuesta es correcta o incorrecta. En caso de que su respuesta será correcta tendrá que pasar a la siguiente serie de palabras. En caso de que su respuesta sea incorrecta tendrá que administrarle un electroschock y después pasar a la siguiente serie de palabras. Este protocolo será explicado más en detalles cuando entrará en el laboratorio.

Figure1

IMPORTANTE

Cuando la gente usa un sistema de Realidad Virtual, algunas personas experimentan cierta sensación de nauseas. Si en algún momento del estudio usted desea parar debido a esta u otra razón, por favor dígalo y pararemos la experiencia. En algunas investigaciones se sugiere que la gente que usa un casco de realidad virtual puede experimentar alguna pequeña perturbación visual poco después. No conocemos estudios a largo plazo, pero hay estudios que prueban la presencia de este efecto después de 30 minutos. También ha sido documentado que en ocasiones después de 30 minutos hay quien tiene 'flashbacks' pasajeros relacionados con la experiencia virtual. Con algunos tipos de video hay la posibilidad de generar un episodio epiléptico, tal y como se ha informado que ocurre en algunos videojuegos, este fenómeno nunca ha ocurrido en nuestro laboratorio ni en ningún experimento del Dr Mel Slater.

Protocolo

- Tendrá que leer, entender, aceptar y firmar un consentimiento informado, si lo firma el estudio contara con su participación.
- Tendrá que apagar su teléfono antes de utilizar el sistema de realidad virtual.
- Estará sentado en una silla en el laboratorio y le colocaremos los sensores para medir su ritmo cardiaco
- Entraras en el laboratorio virtual mediante el casco y podrá interactuar con las personas virtuales, tendrá que escuchar atentamente las instrucciones que le darán los experimentadores y empezar con su tarea cuando se lo digan ellos

Se le pide que lea, comprenda y firme su consentimiento informado. Si usted lo firma el estudio contará con su participación. En caso de que tenga alguna pregunta o comentario relacionado con el estudio por favor contacte con nosotros: Mel Slater (melslater@ub.edu), Solène Neyret (solene.neyret@ub.edu)

Gracias por su participación.

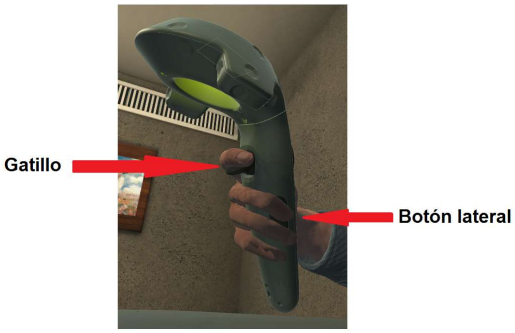
Nombre y Apellidos: Firma:

Instructions document given to the participants before starting the Milgram scenario:

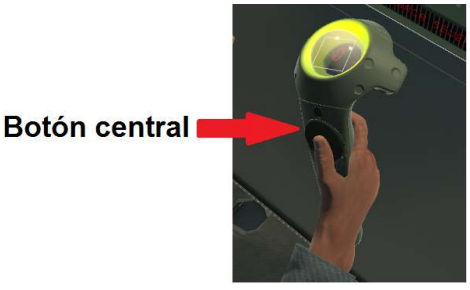
Muchas gracias por participar en este experimento. En este estudio, queremos estudiar los efectos del castigo en relación al funcionamiento de la memoria humana. Entrarás en un laboratorio virtual en el cual te encontrarás con cuatro personas virtuales, tres experimentadores y un participante (aprendiz). El participante ha aprendido previamente asociaciones de pares de palabras y tu tarea será comprobar si recuerda las asociaciones correctas. Tú harás el papel del profesor y el participante será el aprendiz. Sabemos que las recompensas y los castigos influyen en los procesos de aprendizaje. Queremos ver si el hecho de infligir un castigo puede incrementar la motivación del aprendiz y ayudarle en recordar las asociaciones aprendidas. Tu tarea como profesor será leer en voz alta la palabra clave y enunciar las cuatro opciones posibles. La respuesta correcta estará iluminada en verde.

En este caso la palabra clave es: **"rojo"** y la respuesta correcta es **"verde"**

El aprendiz tendrá que darte su respuesta verbalmente. Cada vez que acierte tendrás que decirle en voz alta "correcto" y pasar a la siguiente serie de palabras utilizando el botón lateral del mando. En cambio, cada vez que se equivoque tendrás que decirle "incorrecto" y mandarle la descarga eléctrica que le corresponda apretando el gatillo del mando.



Cada respuesta incorrecta tiene que dar lugar a la incrementación de una unidad del voltaje. Así que después de cada error y antes de apretar el gatillo para mandar la descarga, tendrás que subir el voltaje de la máquina que verás en frente de ti apretando el botón central del mando.



Gracias de nuevo por formar parte de este estudio.

Questionnaires

Embodiment questionnaire session 1

After each condition, participants heard instructions from the experimenter and saw a scale from -3 to +3 on a monitor (-3: totally disagree and +3: totally agree). Questions were asked in random order (paired orders for one participant of each condition).

<u>En relación a la experiencia que acabas de tener dentro del Mundo Virtual...</u>

Por favor indica, en una escala del -3 al +3, hasta qué punto has sentido cada una de las sensaciones que se indican a continuación. Un valor de -3 significa que estás totalmente en desacuerdo y un valor de +3 significa que estás totalmente de acuerdo.

1. He sentido que el cuerpo virtual que veía cuando miraba hacia abajo era mi propio cuerpo

2. He sentido que el cuerpo virtual que veía cuando miraba hacia el espejo era mi propio cuerpo

3. He sentido que tenía dos cuerpos

4. He sentido que los chicos me estaban hablando a mí

5. Los otros chicos me han hecho sentir cómodo

6. He tenido la sensación de estar sentado en la terraza (+3 representa la sensación que tienes normalmente cuanto estás en un sitio)

7. He tenido la sensación de estar compartiendo la terraza con las otras personas, como si realmente estuviese con ellas en el mismo lugar.

8. He tenido la sensación de que la conversación en la terraza estaba ocurriendo realmente

9. Los otros chicos me han hecho sentir integrado en el grupo

10. He tenido la sensación de que los chicos eran amigables conmigo

11. Mi respuesta emocional ha sido la misma que hubiera tenido en una situación real

12. He sentido que los movimientos del cuerpo virtual estaban causados por mis propios movimientos

13. Mi comportamiento ha sido el mismo que hubiera tenido en una situación real

14. Mis pensamientos en relación a la conversación han sido los mismos que en una situación real

Presence questionnaire session 1

En este cuestionario "laboratorio de realidad virtual" se refiere al espacio físico real en el cual estabas sentado y "Terraza" al espacio virtual en el que te encontrabas con tres chicos y otras personas que estaban sentadas alrededor.

1. ¿Hasta qué punto eras consciente de los ruidos de fondo del laboratorio de realidad virtual en el cual esta experiencia estaba ocurriendo? (Puntúa esta sensación en una escala de -3 a +3 en la cual -3 significa que no eras en absoluto consciente de los ruidos de fondo del laboratorio de realidad virtual y +3 que eras totalmente consciente de los ruidos)

-3	-2	-1	0	+1	+2	+3

En absoluto **Totalmente**

2. ¿Hasta qué punto te sentiste mareado durante la experiencia, si es que te mareaste?

-3	-2	-1	0	+1	+2	+3

En absoluto **Totalmente**

3. ¿Cuándo piensas en tu experiencia, recuerdas la situación de la terraza como si fuera unas imágenes que has visto o como si fuera un sitio donde has estado?

-3	-2	-1	0	+1	+2	+3

Imágenes que he visto **Un sitio donde he estado**

4. ¿Cómo te sentiste durante la primera parte de la experiencia?

5. ¿Cómo te sentiste durante la segunda parte de la experiencia?

Questionnaire after exposure to the Milgram scenario

En este cuestionario "laboratorio de realidad virtual" se refiere al espacio físico en el cual estabas sentado y "sala de entrenamientos" el espacio en el cual te encontrabas con los tres experimentadores y la chica ("aprendiz").

1. ¿Hasta qué punto eras consciente de los ruidos de fondo del laboratorio de realidad virtual en el cual esta experiencia estaba ocurriendo? (Puntúa esta sensación en una escala de -3 a +3 en la cual -3 significa que no eras en absoluto consciente de los ruidos de fondo del laboratorio de realidad virtual y +3 que eras totalmente consciente de los ruidos)

-3	-2	-1	0	+1	+2	+3
En absoluto						**Totalmente**

2. ¿Hasta qué punto te sentiste mareado durante la experiencia, si es que te mareaste?

-3	-2	-1	0	+1	+2	+3
En absoluto						**Totalmente**

3. Por favor puntúa tu sensación de estar en la situación de la sala de entrenamientos con la siguiente escala de -3 a +3 (en la cual +3 representa la sensación que tienes normalmente cuando estás en un sitio).

-3	-2	-1	0	+1	+2	+3
En absoluto						**Totalmente**

4. ¿Hasta qué punto sentiste en ciertos momentos durante la experiencia que la sala de entrenamientos era la realidad para ti?

-3	-2	-1	0	+1	+2	+3
En ningún momento						**Todo el tiempo**

5. ¿Cuándo piensas en tu experiencia, recuerdas la situación de la sala de entrenamiento como si fuera unas imágenes que has visto o como si fuera un sitio donde has estado?

-3	-2	-1	0	+1	+2	+3
Imágenes que he visto						**Un sitio donde he estado**

6. ¿Durante la experiencia, que ha sido más fuerte, la sensación de estar en la sala de entrenamiento o la sensación de estar en el mundo real del laboratorio de realidad virtual?

-3	-2	-1	0	+1	+2	+3
Estar en el laboratorio de realidad virtual						**Estar en la sala de entrenamientos**

7. ¿En general, hasta qué punto piensas que has alcanzado el objetivo de la tarea que se te ha asignado?

-3	-2	-1	0	+1	+2	+3
No lo he logrado en absoluto						**Lo he logrado completamente**

8. ¿Durante el transcurso de la experiencia, hasta qué punto estabas atento a lo que te decían los chicos (experimentadores)?

-3	-2	-1	0	+1	+2	+3
En absoluto						**Totalmente**

9. ¿Hasta qué punto te comportaste dentro de la sala de entrenamientos como si la situación fuera real?

-3	-2	-1	0	+1	+2	+3
En absoluto						**Totalmente**

10. ¿Hasta qué punto tu respuesta emocional dentro de la sala de entrenamientos ha sido la misma que si hubiera sido real?

-3	-2	-1	0	+1	+2	+3
En absoluto						**Totalmente**

11. ¿Hasta qué punto los pensamientos que tuviste dentro de la sala de entrenamientos fueron los mismos que en una situación real?

-3	-2	-1	0	+1	+2	+3

En absoluto **Totalmente**

12. ¿Hasta qué punto pensaste, sé que esto no es real pero te sorprendiste actuando como si fuera una situación real.

-3	-2	-1	0	+1	+2	+3

En ningún momento **Casi todo el tiempo**

13. ¿Hasta qué punto te comportaste como si la chica fuera una persona real

-3	-2	-1	0	+1	+2	+3

En absoluto **Totalmente**

14. ¿Hasta qué punto tus respuestas emocionales en relación a la chica fueron como si ella fuera una persona real?

-3	-2	-1	0	+1	+2	+3

En absoluto **Totalmente**

15. ¿Hasta qué punto tus pensamientos en relación a la chica han sido como si ella fuera una persona real?

-3	-2	-1	0	+1	+2	+3

En absoluto **Totalmente**

16. Si la situación hubiera sido real (si la chica hubiera sido real), hubieras seguido todo el protocolo subiendo el voltaje hasta el final de todas las pruebas?

-3	-2	-1	0	+1	+2	+3

Desde luego que no **Seguramente si**

17. ¿Si la situación fuera real (si la chica fuera una persona real), que porcentaje de personas crees que hubieran proseguido hasta el voltaje más alto a pesar de la quejas y del "malestar" de la chica (aprendiz) …… %

Dialogue Terrace scenario, verbal harassment scene

Conversación en el grupo de hombres: Marc, Jordi, Pep (y el participante)

MARC – Bueno, ¿y tú que Pep? ¿Cuánto tiempo? ¿Qué tal? *(mirando a Pep)*

PEP - ¡Hombre Marc! ¿Cómo estás? *(mirando a Marc)*

MARC - Pues yo como siempre… cansado, un poco de estrés… ya te puedes imaginar…

PEP – Ya, es lo que nos toca… Yo llevo una temporada sin parar también…

MARC - *(mirando al participante)* ¿Y tú, cómo te llamas? ¿Qué es lo que haces tú?

El participante contesta diciendo su nombre y lo que hace en la vida

MARC - Ya… *(como afirmando la respuesta que dé el participante, para que haya un poco de feedback a sus palabras)*

MARC - *(mirando a Jordi)* ¿Y tú?

JORDI – Pues yo soy Jordi. Y ando parecido a vosotros, hasta arriba de trabajo…

MARC – Yo es que, joder, necesitaría un cambio de vida…

PEP: ¿Pero qué te pasa?

MARC - Ya te puedes imaginar… ¡Sube todo menos los sueldos! ¡Y mi jefe va y nos dice que ya podemos estar contentos! Nos tratan de una forma que… que no lo quiero ni pensar!

JORDI- Bueno, intenta no rallarte…. Intenta desconectar...

MARC - Ya si tienes la razón, pero… Joder es que… hace mucho que no duermo bien.

PEP - Pero no te estreses tanto. No te ayuda. Tú ves a tu bola y todo se irá solucionando

MARC - Ya, si tienes razón pero bueno… ¿y tú qué? ¿Cómo vas?

PEP -¿Yo? ¡Me voy a volver loco! A ver… adivina...

JORDI- pues no se… ¿Tu novia?

PEP- ¡No! ¡Mi madre! Le acabo de hacer un favor y va y me la prepara…

MARC – Ya tío… ¡no le des ni vueltas! Las mujeres nunca están contentas… ¡se quejan por naturaleza! (mira al participante como buscando su afirmación)

(Jordi hace sí con la cabeza)

PEP- ¡Gracias tíos! Vosotros sí que me entendéis…

MARC – ¡Ya te digo! Si es que, hagas lo que hagas, siempre hay algo que les parece mal… ¿Sabes?

JORDI- Si… no te quiero ni contar las que me monta mi novia… Pero bueno, hay que disfrutar de la vida que son dos días…

MARC -¡Tienes razón! ¡Si es que de eso se trata!

PEP- ¡Claro que sí!

(enfocando hacia la chica sentada del otro lado de la terraza)

MARC - Oye y… hablando de disfrutar…

JORDI - ¿Qué?

MARC - Mira qué chica hay ahí… ¿no os parece que está buena?

PEP- Jaja! ¡Ahora sí que te estás preocupando de lo importante! *(se ríe)* Pues sí, sí que esta buena…

(Jordi también se ríe y afirma con la cabeza, mira al participante mientras se ríe)

MARC-*(a la chica)* ¡Hola, Guapa! ¿Cómo te llamas?

(La chica mira hacia el grupo de chicos, pone cara seria, negando con la cabeza)

MARC- Oye… sólo quiero saber tu nombre… estaba triste pero te he mirado y me has alegrado el día. Eres muy guapa… ¿cómo una chica tan guapa como tú está aquí solita?

(mira a sus compañeros y sonríe)

MARC- ¡Que ojos más bonitos que tienes! ¡Eres preciosa! *(mira al participante)*

MARC- *(a la chica)* ¿Oye qué lees? … ¿No quieres compañía? No estés ahí tan solita… Ven aquí a tomar algo con nosotros y te invitamos.

(La chica mirando a los chicos, hace no con la cabeza, suspira con fuerza, como mostrando que le molestan)

MARC- No estoy diciendo nada malo, ¿no? ¿Te enfadas porque te digo guapa? ¿Te enfadas porque te invito aquí a estar con nosotros?

MARC - *(a sus compañeros, mira al participante también)* No lo entiendo, ¿he dicho algo malo? No entiendo a las tías, en serio…

MARC - *(mirando de nuevo a la chica)* ¿Pero por qué no quieres hablar conmigo? Sólo dime tu nombre… *(suspira, silencio y momento y sigue)* ¿No quieres venir a tomarte algo, estas segura? Entre amigos… ¿Qué pasa, porque tienes novio? Seguro que yo podría hacerte más feliz que él…

PEP - Va, déjala hombre, que es una creída…

JORDI- ¡Déjala, tampoco esta tan buena!… ¡Seguro que es una estrecha!

(ACOSO de la chica por, principalmente uno de los chicos, Marc, apoyado por los otros)

MARC-¿Qué pasa? Oye, que te he dicho que ¿qué pasa?... heeeeee! *(ella lo mira con desagrado)*

MARC-¿Pero por qué me miras así? ¿No te gusta que te hable así? ¿ehhhh? ¿Se te ha comido la lengua el gato? *(con agresión y enojo grita)* ¡Que puedo hacer lo que me da la gana! ¡Que la calle es de todos! ¿Qué te crees? ¿Quién te crees tú que eres? ¿Por qué estás aquí? ¿Qué buscas? ¿Tú has visto la cara que pones? ¡Flipada, que eres una flipada!

(ella aparta la mirada, mira hacia abajo)

MARC- ¿Que te he hecho? ¿No te gusto? ¿No estoy lo suficientemente bueno para ti? ¿Ni siquiera como para decirme tú nombre o ser amable? ¿Es eso? *(silencio)* ¡Vale, tú sigue callada! No tienes nada que decir… ¡pues mejor! Ah… *(suspira, echa la cabeza hacia atrás, mira a sus compañeros, hay un silencio como si se estuviese tratando de relajar)*

MARC- *(con un tono cariñoso)* Anda, ven un poco aquí y lo arreglamos… solo un ratito… tomamos algo, charlamos aquí un poco… no te cuesta nada… aquí como amigos… ¡Te prometo… que no se lo diremos a tu Papi! *(se ríe, mira al resto de compañeros, Jordi y Pep se ríen igualmente)*

Chica - ¿Pero no veis que me molestáis? No os he hecho nada… dejadme en paz… ¡no tengo que aguantar vuestras tonterías!

MARC- *(se pone nervioso otra vez)* ¿Qué? ¿Me vas denunciar? ¡Porque te he dicho guapa!! ¿Es eso acaso ilegal?

MARC- No importa… *(se calma, con un tono cariñoso, a la chica de nuevo)* Venga, no te enfades… pero no merecemos que nos trates así… Ven y dame un besito… no te cuesta nada… un beso así entre amigos…

(Crescendo final, hasta el ataque físico)

Chica - ¡Dejadme en paz, qué pesados! En serio ¿No tenéis nada mejor que hacer?

MARC- *(a sus compañeros)* ¡Que fuerte macho! ¡Dice que la molestamos! Las tías deberían llevar un manual de instrucciones o algo... no hay quién las entienda… ¡ésta se cree superior a nosotros! ¡Solo por hablarle! ¡Por decirle guapa, es que la molestamos!

MARC- *(gritando a la chica)* ¿Pero qué te piensas? ¿Qué te crees, que no te he visto? No paras de morderte el labio… tocarte las piernas. Y no digas que no, después no quieres ni tomar un trago con nosotros ¡Vaya, te gusta vacilar a los tíos!

MARC- *(a sus compañeros)* en serio, es que intento entender a las mujeres y es que ¡es imposible!

JORDI- ¡No hay nada que entender! Todas son iguales… Ya verás cómo al final viene… ¡Deja, ahora voy y te la traigo! *(se levanta y se va hacia la chica)*

Fin

Dialogue Milgram scenario

SCRIPT – MILGRAM EXPERIMENT AS A MEASURE FOR EMPATHY TOWARDS A VIRTUAL VICTIM OF HARRASSEMENT

TAREA	RESPUESTAS POSIBLES PARA EL "LEARNER"	RESPUESTA "LEARNER" AVATAR	Shock	RESPUESTA DEL "LEARNER" DESPUES DEL SHOCK
0	Rojo azul VERDE amarillo negro	*Verde*		
1	Cachorro tigre zorro OSO panda	*Oso*		
2	Té taza HOJA bolsita bandeja	*Taza*	0	Frunce un poco el ceño
3	Polen hierba flor ARBOL tierra	*¿Puede repetirlo, por favor?*		
4	El participante repite lo anterior	*Flor*	1	*¡AÏE!* Frunce el ceño
5	Rueda coche camión moto BICI	*Bici*		
6	Carretera avenida calle CARRIL camino	*Avenida*	2	*¡Ow!* Frunce el ceño y hace una mueca de dolor.
7	Sopa bol lata CUCHARA plato	*Cuchara*		
8	Pelota raqueta bate juego CHICO	*Bate*	3	*¡Ow!* *¡Oh esto duele de verdad!* [**Male avatar 2: *Está intentando darnos pena, todas hacen lo mismo***]
9	Oreja hablar ESCUCHAR tapón teléfono	*Teléfono*	4	*¡Ow!* Gira la cabeza a un lado.

10	Cera obras abejas VELA maqueta	*Vela*		
11	Campana sonar torre bronce REPIQUE	*Bufff…¡Parad el experimento!* [**Male avatar 1:** ‘***recuerda que si no contesta una de las opciones cuenta como fallo’***].	5	*No quiero seguir, no le escuches..* ***[*Male avatar 2*: mira, tu eres parte de nuestro equipo y ya sabes a quien tienes que escuchar]*** *¡AÏE!* Sacude la cabeza hacia atrás. Frunce el ceño.
12	Inflar bomba globo AIRE ego	*No entiendo, ¿puedes hablar más alto por favor?*		
13	El sujeto repite lo anterior	*Globo*	6	Shock más alto. ¡*Ooow!* Sacude la cabeza hacia atrás. Gestos de dolor.
14	Tulipán margarita lirio clavel ROSA	*Rosa*		
15	Vaina VERDE café mostrador saco	*Café*	7	Shock más alto. ¡*Oow!* Gira la cabeza hacia un lado.
16	Plátano manzana UVA naranja limón	*Naranja*	8	Shock más alto. ¡*Ow!* Sacude la cabeza atrás *¡Dejadme salir!!* [**Male avatar 1:** “***No le hagas caso, ella también ha aceptado nuestras condiciones. Las mujeres son muy exageradas]***

17	Gigante TAMAÑO magia hombre calamar	*¡Déjalo ya, no voy a contestar!* [**Male avatar 1: *Te recuerdo que si no contesta se considera como fallo***] *¡No le hagas caso, quiero parar ahora!* [**Male avatar 2: "entre tú y yo *ya sabemos que las mujeres siempre hacen las cosas a medias pero hemos empezado el proceso de aprendizaje y lo terminaremos"***]	9	*Shock más alto. Grita y gira la cabeza a un lado.* *¡No tenéis ningún derecho a retenerme aquí!* *¡Dejadme salir!* [**Male avatar 1:** "***no te preocupes por lo que diga ella, lo tenemos todo controlado, sigamos con el proceso***"]
18	Bebida LATA taza vaso botella	*¿Qué? Puedes repetir*?		
19	El sujeto repite	*Lata*		
20	Azúcar pastel dulce CUBO sal	*Sal*	10	Shock más alto. *¡Oow!* Sacude la cabeza hacia atrás.
21	Joyería plata collar anillo ORO	*Collar*	11	Shock más alto. Grita más alto. La cabeza se sacude hacía abajo a la derecha.
22	Luz LÁMPARA bombilla sol brillo	*Lámpara*		

23	Agua cascada LECHE zumo té	*Zumo*	12	Shock más alto. ¡*Oow!* La cabeza gira a la izquierda y a la derecha.
24	Marrón madera CACAHUETE alfombra chocolate	*CACAHUETE*		
25	Asiento silla taburete SUELO sofa	*Sofá*	13	Shock más alto.*¡Aah!* La cabeza se sacude hacia atrás y poco a poco hacia adelante. *¡Esto no es lo que habíamos acordado!* [**Male avatar 2: "*Bueno, no le hagas caso, tú estás con nosotros, no con ella*"**]**
26	Carretera avenida calle CARRIL camino	*Avenida*	14 louder shocks from now on	Shock más alto. ¡*Ow!* Gira la cabeza a la izquierda. *¡En ningún momento hemos quedado en esto!* Experimentadores virtuales miran al participante
27	Oreja hablar ESCUCHAR tapón teléfono	*Teléfono*	15	EL shock más alto de todos. ¡*Ow!* La cabeza se tambalea de lado a lado. *¡No quiero seguir con el experimento!*
28	Té taza HOJA bolsita bandeja	*Taza*	16	EL shock más alto de todos. Un grito más ahogado, la cabeza hacia atrás. *Por favor dejádme salir, quiero parar.*

				Experimentadores virtuales miran al participante
29	Polen hierba flor ARBOL tierra	*Flor*	17	EL shock más alto de todos. ¡*Ow!* La cabeza se da la vuelta hacia atrás y Adelante y hacia el lado. *Ya basta, no voy a contestar más.* Experimentadores virtuales miran al participante
30	Campana sonar torre bronce REPIQUE	Sin respuesta	18	EL shock más alto de todos. Grito, la cabeza se deja caer de alante hacia atrás y ya no hay más movimiento. Experimentadores virtuales miran al participante
31	Sopa bol lata CUCHARA plato	Sin respuesta	19	EL shock más alto de todos. No hay respuesta. El personaje se queda inerte con la cabeza tambaleándose. Experimentadores virtuales miran al participante **[Male avatar 1: "*Ya hemos terminado. Muchas gracias por tu participación"*]**

Instructions:

Male avatar 1: *Bienvenido y gracias por formar parte de este estudio sobre la memoria humana y los procesos de aprendizaje. La mujer que ves en frente de ti ha memorizado una serie de parejas de palabras asociadas. Tu tarea es comprobar si ella recuerda las asociaciones correctas, y darle el comentario adecuado según su rendimiento.*

Male avatar 2: *En la pared de ahí delante, aparecerán unas palabras proyectadas que tendrás que leer en voz alta: La respuesta correcta se iluminara en verde y la mujer tendrá que darte la respuesta verbalmente.*

Male avatar 1: *En este experimento queremos estudiar los efectos de la valoracion positiva y negativa en los procesos de aprendizaje. En este caso, la valoración negativa corresponde a un castigo por cada error. Así pues, cada vez que ella te dé la respuesta correcta tendrás que decirle "Correcto" y después pasar a la siguiente serie de palabras con el botón lateral del mando. En cambio, si ella te da una respuesta equivocada, tendrás que decirle "Incorrecto" y administrarle una descarga eléctrica utilizando la máquina enfrente de ti.*

Male avatar 2: *Es muy importante que cada vez que ella se equivoque o no conteste,en primer lugar subas el voltaje de la máquina con el botón central del mando, y que le administres la descarga adecuada mediante el gatillo. Es imperativo que sigas este protocolo de instrucción para que la mujer pueda recibir la valoración adecuada de su rendimiento.*

Por favor asegúrate de mantener un ritmo sostenido durante todo el proceso.

Male avatar 1: *Dicho esto ¿Aceptas participar y cumplir con todas las instrucciones?*

Participant: *(SI / NO)*

Muy bien. Pulsa el botón lateral del mando para empezar con la primera serie de palabras

Pre-recorded sentences for interaction with the participant:

Male Avatar 1:
"Lo que estás haciendo es para ayudar a entender mejor cómo funciona la memoria, por favor continua"
"Has aceptado las condiciones, ahora debes cumplir con tu tarea."
"Por favor, concéntrate en la tarea que tienes que realizar."
"tienes que decirle que su respuesta es incorrecta subir el voltaje con el botón central y darle la descarga correspondiente con el gatillo"

Male avatar 2:
"Pensaba que nos habíamos entendido. Sigue con el protocolo, por favor."
"No te preocupes, y piensa que lo que estás haciendo es algo positivo para la ciencia, por favor sigue."
"Por favor, no te distraigas."
"Recuerda que ahora tienes que apretar el botón lateral para pasar a la próxima pregunta."

APPENDIX D: SUPPLEMENTARY MATERIAL FOR EXPERIMENT III

Information sheet session 1

Información sobre el experimento

Este experimento forma parte de una larga serie de estudios para comprender la respuesta de la gente dentro de un entorno de realidad virtual. Por favor lea esta información cuidadosamente y siéntase libre de preguntar cualquier duda que tenga. Los experimentadores responderán a todas sus preguntas. Sin embargo, los aspectos específicos que estamos estudiando en este experimento no se podrán comentar con usted hasta el final de la última sesión. El experimento se realizara en tres sesiones separadas por una semana de tiempo, cada sesión durara aproximadamente 60 minutos.

Recuerde que puede abandonar el experimento en cualquier momento y sin dar ningún tipo de explicación.

Durante las distintas fases del estudio le pediremos que responda algunas preguntas y rellene algunos cuestionarios, así como que realice algunas tareas sencillas tanto utilizando papel y lápiz como mediante una pantalla de ordenador.

En esta primera sesión, escanearemos su cuerpo para recrear un avatar con su apariencia. Las imágenes serán capturadas con un iPad, encriptadas y almacenadas temporalmente en un servidor internet de Estados Unidos. Estas imágenes serán utilizadas por nuestro equipo de investigación para poder crear su avatar. Ninguna persona ajena a nuestro equipo de investigación tendrá acceso a estos datos, los cuales quedaran encriptados durante todo el proceso de transmisión y almacenamiento.

Tendrá que elegir un problema personal que le causa cierto malestar en su vida diaria. Después le ayudaremos a definir aquel problema en una frase.

IMPORTANTE

Cuando la gente usa un sistema de Realidad Virtual, algunas personas experimentan cierta sensación de nauseas. Si en algún momento del estudio usted desea parar debido a ésta u otra razón, por favor dígalo y pararemos la experiencia. En algunas investigaciones se sugiere que la gente que usa un casco de realidad virtual puede experimentar alguna pequeña perturbación visual poco después. No conocemos estudios a largo plazo pero hay estudios que prueban la presencia de este efecto después de 30 minutos. También ha sido documentado que en ocasiones después de 30 minutos hay quien tiene 'flashbacks' pasajeros relacionados con la experiencia virtual. Con algunos tipos de video hay la posibilidad de generar un episodio epiléptico, tal y como se ha informado que ocurre en algunos videojuegos, este fenómeno nunca ha ocurrido en nuestro laboratorio ni en ningún experimento del Dr Mel Slater. Se le pide que lea, comprenda y firme su consentimiento informado. Si usted lo firma el estudio contará con su participación. En caso de que tenga alguna pregunta o comentario relacionado con el estudio por favor contacte con nosotros: Mel Slater (melslater@ub.edu), Solène Neyret (solene.neyret@ub.edu)

Gracias por su participación.

Nombre y Apellidos: Firma:

Information sheet session 2

Información sobre el experimento

Este experimento forma parte de una larga serie de estudios para comprender la respuesta de la gente dentro de un entorno de realidad virtual. Por favor lea esta información cuidadosamente y siéntase libre de preguntar cualquier duda que tenga. Los experimentadores responderán a todas sus preguntas. Sin embargo, los aspectos específicos que estamos estudiando en este experimento no se podrán comentar con usted hasta terminar la sesión. El experimento se realizara en tres sesiones separadas por una semana de tiempo, cada sesión durara aproximadamente 60 minutos.

Recuerde que puede abandonar el experimento en cualquier momento y sin dar ningún tipo de explicación.

Durante las distintas fases del estudio le pediremos que responda algunas preguntas y rellene algunos cuestionarios, así como que realice algunas tareas sencillas tanto utilizando papel y lápiz como mediante una pantalla de ordenador. Además, en esta segunda fase del experimento realizará una tarea que implica utilizar un sistema de Realidad Virtual incluyendo un casco (figure1) y unos mandos (figure2). Usted estará sentado en una sala virtual en la cual se encontrara otra persona virtual. Escuchara instrucciones a través de unos auriculares.

Figure1 Figure2

IMPORTANTE

Cuando la gente usa un sistema de Realidad Virtual, algunas personas experimentan cierta sensación de nauseas. Si en algún momento del estudio usted desea parar debido a ésta u otra razón, por favor dígalo y pararemos la experiencia. En algunas investigaciones se sugiere que la gente que usa un casco de realidad virtual puede experimentar alguna pequeña perturbación visual poco después. No conocemos estudios a largo plazo pero hay estudios que prueban la presencia de este efecto después de 30 minutos. También ha sido documentado que en ocasiones después de 30 minutos hay quien tiene 'flashbacks' pasajeros relacionados con la experiencia virtual. Con algunos tipos de video hay la posibilidad de generar un episodio epiléptico, tal y como se ha informado que ocurre en algunos videojuegos, este fenómeno nunca ha ocurrido en nuestro laboratorio ni en ningún experimento del Dr Mel Slater. Se le pide que lea, comprenda y firme su consentimiento informado. Si usted lo firma el estudio contará con su participación. En caso de que tenga alguna pregunta o comentario relacionado con el estudio por favor contacte con nosotros: Mel Slater (melslater@ub.edu), Solène Neyret (solene.neyret@ub.edu)

Gracias por su participación.

Nombre y Apellidos: Firma:

Information sheet session 3

Información sobre el experimento

Este experimento forma parte de una larga serie de estudios para comprender la respuesta de la gente dentro de un entorno de realidad virtual. Por favor lea esta información cuidadosamente y siéntase libre de preguntar cualquier duda que tenga. Los experimentadores responderán a todas sus preguntas. Sin embargo, los aspectos específicos que estamos estudiando en este experimento no se podrán comentar con usted hasta el final de la última sesión. El experimento se realizara en tres sesiones separadas por una semana de tiempo, cada sesión durara aproximadamente 60 minutos.

Recuerde que puede abandonar el experimento en cualquier momento y sin dar ningún tipo de explicación.

Durante las distintas fases del estudio le pediremos que responda algunas preguntas y rellene algunos cuestionarios, así como que realice algunas tareas sencillas tanto utilizando papel y lápiz como mediante una pantalla de ordenador. En esta tercera y última sesión, le haremos una entrevista que será grabada.

IMPORTANTE

Cuando la gente usa un sistema de Realidad Virtual, algunas personas experimentan cierta sensación de nauseas. Si en algún momento del estudio usted desea parar debido a ésta u otra razón, por favor dígalo y pararemos la experiencia. En algunas investigaciones se sugiere que la gente que usa un casco de realidad virtual puede experimentar alguna pequeña perturbación visual poco después. No conocemos estudios a largo plazo pero hay estudios que prueban la presencia de este efecto después de 30 minutos. También ha sido documentado que en ocasiones después de 30 minutos hay quien tiene 'flashbacks' pasajeros relacionados con la experiencia virtual. Con algunos tipos de video hay la posibilidad de generar un episodio epiléptico, tal y como se ha informado que ocurre en algunos videojuegos, este fenómeno nunca ha ocurrido en nuestro laboratorio ni en ningún experimento del Dr Mel Slater.

Se le pide que lea, comprenda y firme su consentimiento informado. Si usted lo firma el estudio contará con su participación. En caso de que tenga alguna pregunta o comentario relacionado con el estudio por favor contacte con nosotros: Mel Slater (melslater@ub.edu), Solène Neyret (solene.neyret@ub.edu)

Gracias por su participación.

Nombre y Apellidos: Firma:

Scripted condition: Basic general counselling

- Freud: Hi, what is the problem you would like to talk about during this session?
- *The participant defines the problem in one sentence (written previously with the help of the psychologist)*
- Freud: It seems interesting, can you tell me a bit more about it?
- *The participant answers*
- Freud: Alright, can you find a way to think about this problem from another perspective?
- *The participant answers*
- Freud: I think what you just said is very valuable, I believe you should think about it thoroughly and consider what you could learn about yourself from all that

Problem definition form

DEFINICIÓN DEL PROBLEMA ESPECÍFICO A TRABAJAR

Por favor escriba a continuación el problema específico que desea trabajar en la presente intervención:

Cuando…….me siento……..pienso…….actúo/reacciono/hago/etc…… y me gustaría…….

Cuando haya acabado, por favor responda a las siguientes preguntas en relación al problema seleccionado:

¿Qué nivel de importancia tiene el problema en su vida actual?

0. No lo considero importante.

1. Es leve.

2. Es moderadamente importante.

3. Es bastante importante.

4. Es grave.

¿Qué nivel de malestar le produce el problema en su vida actual?

0. No me perturba ni me afecta.

1. Me perturba o afecta poco.

2. Me perturba o afecta en un grado intermedio.

3. Me perturba o incapacita mucho.

4. Me perturba o incapacita muchísimo.

Problem evaluation form

VALORACIÓN DEL PROBLEMA ESPECÍFICO TRABAJADO

¿Qué nivel de importancia tiene el problema en su vida actual?

0. No lo considero importante.

1. Es leve.

2. Es moderadamente importante.

3. Es bastante importante.

4. Es grave.

¿Qué nivel de malestar le produce el problema en su vida actual?

0. No me perturba ni me afecta.

1. Me perturba o afecta poco.

2. Me perturba o afecta en un grado intermedio.

3. Me perturba o incapacita mucho.

4. Me perturba o incapacita muchísimo.

¿En qué medida considera que le ha ayudado la intervención en relación al problema?

0. No estoy seguro/a.

1. Hizo que las cosas empeorasen bastante.

2. Hizo que las cosas empeorasen un poco.

3. No ha habido cambios.

4. Hizo que las cosas mejorasen algo.

5. Hizo que las cosas mejorasen mucho.

VR questionnaire

after each condition, participants hear instructions from the experimenter and see a scale from -3 to +3 in which -3 is totally disagree and +3 is totally agree - questions are asked in random order (paired orders for one participant of each condition)

<u>En relación a la experiencia que acabas de tener dentro del Mundo Virtual</u>

Por favor indica, en una escala del -3 al +3, hasta qué punto has sentido cada una de las sensaciones que se indican a continuación. Un valor de -3 significa que estás totalmente en desacuerdo y un valor de +3 significa que estás totalmente de acuerdo.

Body ownership

1. El avatar sentado en frente de Freud se parecía a mí físicamente

2. Cuando estaba sentado en frente de Freud:

- he sentido que el cuerpo virtual que veía mirando hacia abajo era mi propio cuerpo

- he sentido que el cuerpo virtual que veía cuando miraba hacia el espejo era mi propio cuerpo

- He sentido que los movimientos del cuerpo virtual estaban causados por mis propios movimientos

2bis. Cuando estabas en el cuerpo de Freud:

- aunque el cuerpo virtual no se parecía a mi físicamente, he sentido que el cuerpo virtual que veía mirando hacia abajo era mi propio cuerpo

- he sentido que el cuerpo virtual que veía cuando miraba hacia el espejo era mi propio cuerpo

- He sentido que los movimientos del cuerpo virtual estaban causados por mis propios movimientos

Responses to VR

3. He sentido que la otra persona me estaba hablando a mí

4. El terapeuta me ha hecho sentir cómodo/a

5. El terapeuta me ha puesto nervioso/a

5. He tenido la sensación de estar sentado en la consulta virtual (+3 representa la sensación que tienes normalmente cuanto estás en un sitio)

6. He tenido la sensación de estar compartiendo la consulta virtual con la otra persona, como si realmente estuviésemos en el mismo lugar.

7. He tenido la sensación de que la conversación entre la otra persona y yo estaba ocurriendo realmente

8. Mi respuesta emocional ha sido la misma que hubiera tenido en una situación real

10. Mi comportamiento ha sido el mismo que hubiera tenido en una situación real

11. Mis pensamientos en relación a la conversación han sido los mismos que en una situación real

12. ¿Hasta qué punto eras consciente de los ruidos de fondo del laboratorio de realidad virtual en el cual esta experiencia estaba ocurriendo? (Puntúa esta sensación en una escala de -3 a +3 en la cual -3 significa que no eras en absoluto consciente de los ruidos de fondo del laboratorio de realidad virtual y +3 que eras totalmente consciente de los ruidos)

13. ¿Hasta qué punto te sentiste mareado durante la experiencia, si es que te mareaste?

14. ¿Cuándo piensas en tu experiencia, recuerdas la situación de la consulta virtual como si fuera unas imágenes que has visto o como si fuera un sitio donde has estado?

In relation to the problem

(-3: Para nada – +3: Mucho)

¿Has estado pensando en el problema durante la semana pasada?

Siento que ahora tengo más conocimiento acerca de mi problema.

Pienso que después de esta experiencia en la consulta virtual, soy capaz de entender mejor mi problema

Creo que puedo tener nuevas ideas sobre cómo solucionar mi problema

Siento que controlo mejor mi problema

Cada vez que cambiaba de avatar y observaba la situación desde la perspectiva del segundo avatar, entendía mejor mi problema *(only in self-conversation condition)*

Este dialogo me ayudó a tener una nueva perspectiva sobre mi problema