

# Chapter 2

## Presence

Giuseppe Riva, Fabrizia Mantovani and Stéphane Bouchard

### 2.1 Introduction

Virtual reality (VR) literature includes many descriptions of users reacting to a virtual environment (VE) in instinctual ways that suggest they believe, at least for a short time, that they were “immersed” and even “present” in the synthetic experience. Following the definitions introduced by Slater et al. (1996): “Presence is a state of consciousness, a state of being [in an environment]...while immersion is related to the quantity and quality of sensory data that is from that environment” (p. 22).

Specifically, immersion is generally understood to be a product of technology that facilitates the production of the multimodal sensory “input” to the user (Burdea et al. 1996) while presence is defined as the psychological perception of being “there,” within a VE (Heeter 1992).

However, as commented by Biocca (1999), and agreed by most researchers in the area, “while the design of virtual reality technology has brought the theoretical issue of presence to the fore, few theorists argue that the experience of presence suddenly emerged with the arrival of virtual reality” (p. 121). So, what is presence? And what is its possible impact in virtual exposure therapy?

For instance, does a strong sense of presence cause patients to better engage and modify emotions and cognitive processes they have already developed in a real environment? Will the skills and the competences acquired in the virtual world transfer to a corresponding real experience? This chapter will try to provide some answers to these questions.

### 2.2 Two Definitions of Presence: Media Presence and Inner Presence

Presence depends on how an individual interprets the VE, or integrates the multimodal information as a function of his/her biological and individual cognitive predisposition (van der Straaten and Shuemie 2000).

In a review, Christine Youngblut (2007) examined 127 research papers related to presence. These papers investigated the relationship between the sense of presence in virtual worlds and over 60 media characteristics. Table 2.1 reports the particular characteristics that have been found to influence the experience of presence. The reported data can provide direction for system developers and may also provide insight into differences that can be expected using different media.

These data clearly underline that visual cues are not the only ones relevant to presence. A large study examined 322 subjects' responses to multisensory cues in a virtual world (Dinh et al. 1999). The results showed that tactile, olfactory, and auditory cues were actually more effective than visual stimuli in increasing the sense of presence. It is important, too, to keep in mind that the content and context of the virtual experience also affect the quality of presence and immersion. In a recent experiment, Gorini and colleagues (2010) analyzed the contribution of media form (i.e., the physical immersion with or without the use of the HMD) and media content (i.e., the presence or absence of a contextualizing narrative) in influencing the users' sense of presence during the exploration of a virtual hospital. Their data clearly show that both media form and media content have a significant impact on the subjects' sense of presence.

In this view, the illusion of presence requires: (1) the processing of multimodal input (i.e., visual, tactile, auditory, kinesthetic, olfactory) from the virtual experience to be combined to form coherent perceptual categories—that is, the virtual experience be recognized as “real”; (2) the integration of this multimodal integration to be processed in an egocentric reference frame—that is, the user feels that he or she is within the environment as opposed to observing it from a third-person perspective; and (3) the ability to give a meaning to the multimodal input—that is, the virtual experience be recognized as “meaningful” and “relevant.”

Due to the complexity of the topic, and the interest in this concept, different attempts to define presence and to explain its role are available in the literature (Waterworth et al. 2012). In general, as underlined by Lombard and Jones (Lombard and Jones 2006): “the first and most basic distinction among definitions of presence concerns the issue of technology” (p. 25).

One group of researchers describes the sense of presence as *media presence*, a function of our experience of a given medium (IJsselstein et al. 2000; Lombard and Ditton 1997; Loomis 1992; Marsh et al. 2001; Sadowski and Stanney 2002; Schloerb 1995; Sheridan 1992, 1996).

The main outcome of this approach is the *perceptual illusion of nonmediation* (Lombard and Ditton 1997) definition of presence. Following it, presence is produced by means of the disappearance of the medium from the conscious attention of the subject. The main advantage of this approach is its predictive value: The level of presence is reduced by the experience of mediation during the action. The main limitation of this vision is what is not said. What is presence for? Is it a specific cognitive process? What is its role in our daily experience? It is important to note that these questions are unanswered even for the relationship between presence and media. As underlined by Lee (2004b), “Presence scholars may find it surprising and even disturbing that there have been limited attempts to explain the fundamental

**Table 2.1** Effects of media to presence. (Adapted from Youngblut 2007)

Audio	
Audio cues	♦
Audio sources, nature of	♦
Audio sources, number of	♦
Aural rendering quality	♦
Collision detection, audio	♦
HRTF	♦
Sound rotation, direction	♦
Sound rotation, velocity	♦
Spatialized audio	□
Olfactory	
Olfactory cues	♦
Tactile	
Collision detection, haptic	♦
Collision detection, tactile	♦
Haptic force feedback	♦
Tactile cues	♦
Video	
<i>Visual detail</i>	
Color	♦
Dynamic shadows	♦
Rendering quality	♦
Scene realism	□
Texture mapping, use of	♦
Texture mapping, quality	♦
<i>Visual display</i>	
Latency, visual	♦
Device, CAVE-HMD-monitor	□
Device, HMD-monitor	□
Device, projector-screen-monitor	♦
Device, other	♦
Field of view	♦
Frame rate	♦
Resolution	♦
Stereopsis	♦
Update rate	□
<i>Visual representation</i>	
Behavioral realism	♦
Fidelity of body	♦
Fidelity of hand	♦
Moving between worlds	♦
Navigation method	□

*CAVE* C-automatic virtual environment, *HRTF* head related transfer functions, *HMD* head-mounted display

Key: ♦ single experiment with consistent findings, ♦ different experiments with consistent findings, □ replicated experiments with consistent findings

reason *why* human beings can feel presence when they use media and/or simulation technologies” (p. 496).

To address these questions, a second group of researchers considers presence as *inner presence*—the feeling of being located in a perceived external world around the self (Revonsuo 2006; Riva et al. 2011; Waterworth et al. 2010). In this view, presence is a broad psychological phenomenon, not necessarily linked to the experience of a medium, whose goal is the control of the individual and social activity (Baños et al. 1999, 2000; Lee 2004a, 2004b; Mantovani and Riva 1999; Marsh et al. 2001; Moore et al. 2002; Riva 2009; Riva and Davide 2001; Riva et al. 2003; Schubert et al. 2001; Spagnolli and Gamberini 2002; Spagnolli et al. 2003; Waterworth and Waterworth 2001, 2003; Zahoric and Jenison 1998). In this chapter, we support this second vision, starting from the following broad statements:

- The content of consciousness is the content of a simulated world in our brain (Metzinger 2009; Revonsuo 2006).
- Presence refers to the part of the contents of consciousness that relate to the current time and place in which the body is located (Biocca 1997; Biocca and Nowak 2001; Metzinger 2009; Riva 2006; Waterworth et al. 2010).
- The psychology of presence is related to human action and its organization in the environment (Marsh 2003; Riva 2009; Riva et al. 2003).
- The feeling of presence is not the same in all the situations (virtual or real), but it can be different in relation to the characteristics of the physical, social, and cultural space the subject is in (Mantovani and Riva 1999, 2001; Mantovani and Spagnolli 2000).
- A circular interaction exists between presence and emotions: On the one hand, the feeling of presence is greater in “emotion-inducing” environments; on the other hand, the emotional state is influenced by the level of presence (Bouchard et al. 2008; Riva 2011; Riva et al. 2007).
- Presence alone is not enough to guarantee a positive clinical outcome in VR exposure therapy: The technology behind the virtual stimuli has to be “transparent” enough to enable the activation of the fear structure. Once this threshold is passed, there is no direct effect of the level of presence on the efficacy of desensitization (Côte and Bouchard 2009; Price and Anderson 2007).

### 2.3 Our Brain Is a Simulation: Linking Consciousness and Presence

A series of recent discoveries from cognitive sciences suggests that the mind has to be understood in the context of its relationship to a physical body that interacts with the world. Hence human cognition, rather than being centralized, abstract, and sharply distinct from peripheral input and output modules, has deep roots in sensorimotor processing.

An example of this trend is the recent discovery of neuronal resonance processes activated by the simple observation of others. Rizzolatti and colleagues found that

a functional cluster of premotor neurons (F5c-PF) contains *mirror neurons*, a class of neurons that are activated both during the execution of purposeful, goal-related hand actions, and during the observation of similar actions performed by another individual (Gallese et al. 1996; Rizzolatti et al. 1996).

The general framework outlined by the above results was used by simulation theorists—for example, Lawrence Barsalou, Vittorio Gallese, Alvin Goldman, Jane Heal, Susan Hurley, Marc Jeannerod, Guenter Knoblich, and Margaret Wilson—to support the following view: The mirror system instantiates simulation of transitive actions used to map the goals and purposes of others' actions (Barsalou 2003; Gallese 2005). As clearly explained by Wilson and Knoblich (2005), this is the outcome of an implicit/covert, subpersonal process:

The various brain areas involved in translating perceived human movement into corresponding motor programs collectively act as an emulator, internally simulating the ongoing perceived movement... The present proposal suggests that, in tasks requiring fast action coordination, the emulator derives predictions about the future course of others' actions, which could be integrated with the actions one is currently planning. (pp. 468–469)

According to this approach, action and perception are more closely linked than has traditionally been assumed. Specifically, for the *Common Coding Theory* (Hommel et al. 2001), the cognitive representations for perceived events (perception) and intended or to-be-generated events (action) are formed by a common representational domain: Actions are coded in terms of the perceivable effects they should generate. For this reason, when an effect is intended, the movement that produces this effect as perceptual input is automatically activated, because actions and their effects are stored in a common representational domain.

In simpler words, the brain has its own VR system that is used in both action planning and action understanding. If this is true, how can we distinguish between the virtual action planning and the real action? The answer is easy: using presence. In his book *Inner Presence*, Revuonso (2006) clearly states:

“To be conscious is to have the sense of presence in a world... To have contents of consciousness is to have patterns of phenomenological experience present... In the philosophy of presence, consciousness is an organized whole of transparent surrogates of virtual objects that are immediately present for us in the here-and-now of subjective experience.” (pp. 126–129). In this view, to be directly present right here or for an object to be directly present for me requires some form of “acquaintance”: a direct awareness based on a nonpropositional knowledge or nonconceptual content (Fox 1994).

This view is surprisingly near to the vision of presence as the *perceptual illusion of nonmediation* (Lombard and Ditton 1997) introduced before. In both cases, presence is related to a direct experience.

However, while in the Lombard and Ditton definition the mediation is given by the used medium (VR), in Revuonso's view (2006), *the mediation is given by the body*: The experience of the body is our first VR system. This vision is shared by many cognitive scientists. For instance, Andy Clark (2008) underlines that:

The infant, like the VR-exploring adult, must learn how to use initially unresponsive hands, arms, and legs to obtain its goals.... With time and practice enough bodily fluency is achieved to make the wider world itself directly available as a kind of unmediated arena

for embodied action.... At such moments the body has become “transparent equipment”... that is not the focus of attention in use. (p. 10)

Moreover, different neurological disorders clearly support this view, showing how the direct experience of presence in our body is the result of different and separable subcomponents that can be altered in some way (Metzinger 2009): *agency, ownership, and location*:

- *Autopagnosia (agency)*: It is a neurological disease characterized by the inability to recognize or orient any part of one’s own body, caused by a parietal lobe lesion (Sirigu et al. 1991): A patient with Autopagnosia is not able to use his/her own body.
- *Anarchic Hand (ownership)*: It is a neurological disease in which patients are aware of the actions of their anarchic hand but do not attribute its intentional behavior to themselves (it is not “owned” by them) (Della Sala 2006): The anarchic hand is not present to the patient who owns it.
- *Hemispatial Neglect (location)*: It is a neurological disease characterized by a deficit in attention to and awareness of one side of space. For example, a stroke affecting the right parietal lobe of the brain can lead to neglect for the left side of the visual field, causing a patient with neglect to behave as if the left side of sensory space is nonexistent: A patient with left neglect will not be present in the left part of a room.

Recently, different authors showed that it is possible to induce an illusory perception of a fake limb (Slater et al. 2009; Perez-Marcos et al. 2009) as a part of our own body, by altering the normal association between touch and its visual correlate. It is even possible to generate a body transfer illusion (Slater et al. 2009): Slater and colleagues substituted the experience of male subjects’ own bodies with a life-sized virtual human female body. This was demonstrated subjectively by questionnaire and physiologically through heart-rate deceleration in response to a threat to the virtual body (Slater et al. 2009).

## 2.4 What Is Presence: a Neuro-Psychological Approach

As we have seen before, Lombard and Ditton defined presence as the *perceptual illusion of nonmediation* (Lombard and Ditton 1997), linking it to the experience of a medium:

An illusion of nonmediation occurs when a person fails to perceive or acknowledge the existence of a medium in his/her communication environment and responds as he/she would if the medium were not there.... Presence in this view cannot occur unless a person is using a medium.

However, in the previous paragraph, we suggested that the outcome of many recent neurological studies considers the body as the first medium, through which we articulate ourselves and engage with others. Moreover, recent studies on peripersonal

space demonstrated that tool-mediated actions modify the multisensory coding of near peripersonal space (Farné et al. 2007; Gamberini et al. 2008): The active use of a tool to physically and effectively interact with objects in the distant space appears to produce a spatial extension of the multisensory perihand space corresponding to the whole length of the tool. *In other words, through the successful enaction of the subject's intentions using the tool, he/she becomes physically present in the tool* (Riva 2009).

These studies confirm that the subject locates himself/herself in an external space according to the action he can do in it (Riva and Mantovani 2012). As suggested by Zahoric and Jenison (Zahoric and Jenison 1998): “presence is tantamount to successfully supported action in the environment” (p. 87, italics in the original).

In other words, the subject is “present” in a space if he/she can act in it. Moreover, the subject is “present” in the space—real or virtual—where he/she can act. Interestingly, what we need for presence are both the affordance for action (the possibility of acting) and its enaction (the possibility of successfully acting).

The first suggestion this framework offers to the developers of virtual worlds is that for presence *action is more important than perception* (Riva 2008): I am more present in a perceptually poor VE (e.g., a textual multi user display) where I can act in many different ways than in a lifelike VE where I cannot do anything.

Another consequence of this framework is the need to better understand what “acting successfully” means (Riva et al. 2011). We can start from the definition of *agency*: “the power to alter at will one’s perceptual inputs” (Russell 1996). But how can we define our will? A simple answer to this question is: through intentions. Following this line of reasoning, *presence can be defined as the nonmediated (pre-reflexive) perception of using the body to successfully transforming intentions into actions (enaction)*.

A possible criticism to this definition is the following: “I may be asked to repair a computer, and I may be unable to fix it. This does not mean that I am not present in the environment (real or virtual) where the computer and I are.”

This objection makes sense if we use the folk psychology definition of intention: The intention of an agent performing an action is his/her specific purpose in doing so. However, the latest cognitive studies clearly show that *any behavior is the result of a complex intentional chain that cannot be analyzed at a single level* (Pacherie 2006; Searle 1983).

According to the *dynamic theory of intentions* presented by Pacherie (2006, 2008) and the *activity theory* introduced by Leont’ev and disseminated by Kaptelinin and Nardi (Kaptelinin and Nardi 2006; Leontjev 1978), repairing a computer is driven by a higher objective (e.g., obtaining the money for paying a new car) and is the result of lower-level operations (e.g., removing the hard disk or the central processing unit (CPU), cleaning them, etc.), each driven by specific purposes.

So, for an intention that failed (repairing the computer), many others were successful (removing the hard disk, cleaning it, etc.) inducing presence (Riva 2009, 2010).

Specifically, the *dynamic theory of intentions* identifies three different “levels” or “forms” of intentions (Fig. 2.1), characterized by different roles and contents:



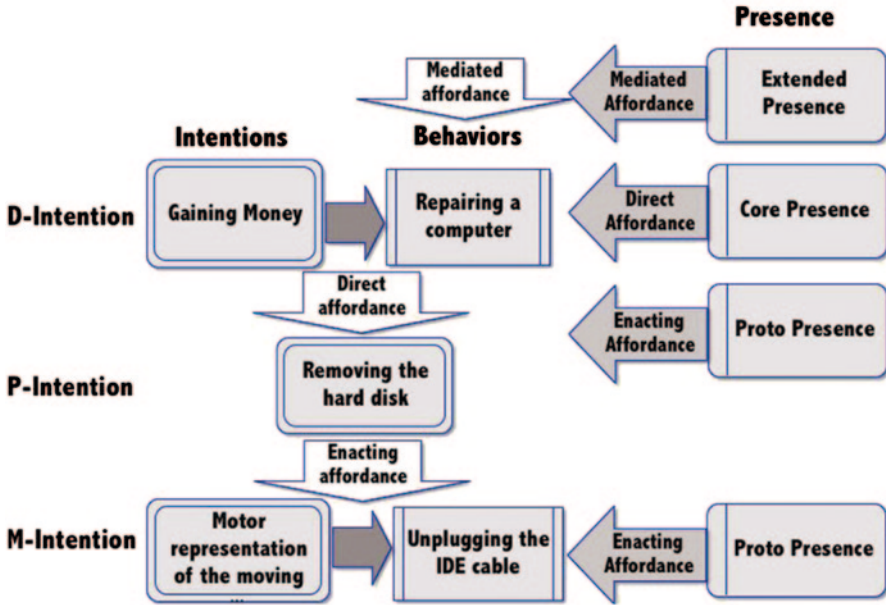


Fig. 2.1 The intentional chain

distal intentions (D-intentions), proximal intentions (P-intentions), and motor intentions (M-intentions):

- *D-intentions (future-directed intentions)*: These high-level intentions act both as intra- and interpersonal coordinators, and as prompters of practical reasoning about means and plans: In the activity, “obtaining a Ph.D. in psychology” described in Fig. 2.2, “helping others to solve problems” is a D-intention, the object that drives the activity of the subject.
- *P-intentions (present-directed intentions)*: These intentions are responsible for high-level (conscious) forms of guidance and monitoring. They have to ensure that the imagined actions become current through situational control of their unfolding: In the activity described in Fig. 2.1, “preparing the dissertation” is a P-intention.
- *M-intentions (motor intentions)*: These intentions are responsible for low-level (unconscious) forms of guidance and monitoring: We may not be aware of them and have only partial access to their content. Further, their contents are not propositional: In the activity described in Fig. 2.2, the motor representations required to write using the keyboard are M-intentions.

Any intentional level has its own role: the rational (D-intentions), situational (P-intention), and motor (M-intention) guidance and control of action. They form an intentional cascade (Pacherie 2006, 2008) in which higher intentions generate lower intentions.



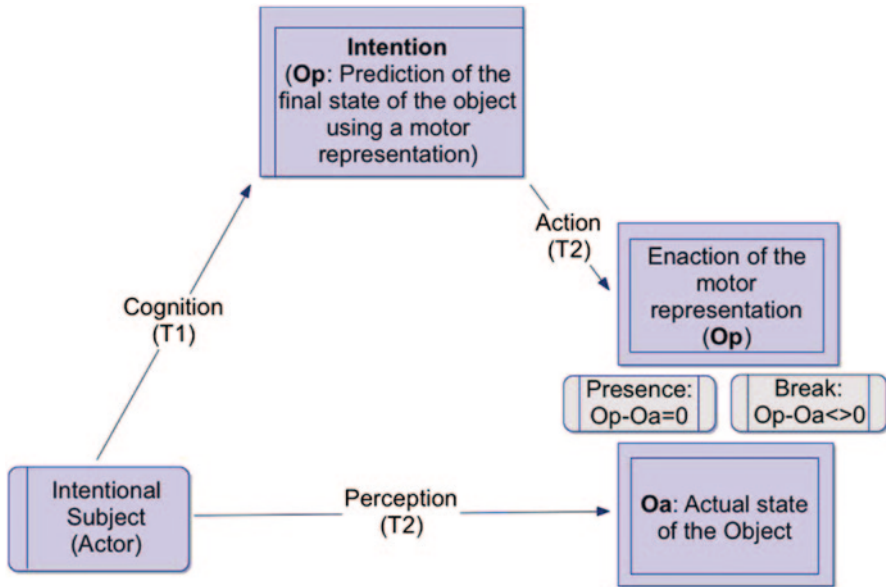


Fig. 2.2 The feeling of presence

This view suggests that the ability to feel “present” in a VR system—a medium—basically does not differ from the ability to feel “present” in our body. When the subject is present during agency—i.e., he/she is able to successfully enact his/her intentions—he/she locates himself/herself in the physical and cultural space in which the action occurs.

Moreover, it also suggests that even in the real world the feeling of presence will be different according to the ability of the subject to enact his/her intentions within an external environment. For instance, I am in a restaurant for a formal dinner with some colleagues in a Korean restaurant, but I do not know how to use the chopsticks I have near my dish. In this situation, I am physically there, but the lack of knowledge puts me outside, at least partially, from the social and cultural space of the “formal Korean dinner.” The result is a reduced presence and a limitation in my agency: I am not able to enact my intention (pick up some rice) using the chopsticks, so I do not use them to avoid mistakes.

Finally, in this view, presence can be described as a sophisticated but unconscious form of monitoring of action and experience: The self perceives the variations in the feeling of presence and tunes its activity accordingly. From a computational viewpoint, the experience of presence is achieved through a forward-inverse model (Blackemore and Decety 2001) (Fig. 2.2):

- First, the agent produces the motor command for achieving a desired state given the current state of the system and the current state of the environment.

- Second, an efference copy of the motor command is fed to a forward dynamic model that generates a prediction of the consequences of performing this motor command.
- Third, the predicted state is compared with the actual sensory feedback. Errors derived from the difference between the desired state and the actual state can be used to update the model and improve performance.

The results of the comparison (which occurs at a subpersonal level) between the sensory prediction and the sensory consequences of the act can then be utilized to determine both the agent of the action and to track any possible variation in its course. If no variations are perceived, the self is able to concentrate on the action and not on its monitoring. As suggested by *the simulation theorists* (Knoblich et al. 2005; Wilson and Knoblich 2005), the brain instantiates a sophisticated simulation, based on motor codes, of the outcome of an action and uses this to evaluate its course.

For this reason, the feeling of presence—*the prereflexive perception that the agent's intentions are successfully enacted*—is not separated by the experience of the subject, but *is directly related to it*. It corresponds to what Heidegger (Heidegger 1959) defined as “the interrupted moment of our habitual standard, comfortable *being-in-the-world*.” A higher feeling of presence is experienced by the self as a better quality of action and experience (Zahoric and Jenison 1998). In fact, the subject perceives consciously only *significant variations* in the feeling of presence: *breakdowns* and *optimal experiences* (Riva 2006).

Why do we consciously track presence variations? Riva and colleagues suggest that it is a sophisticated evolutionary tool used to control the quality of behavior. Specifically, the subject tries to overcome any breakdown in its activity and searches for engaging and rewarding activities (optimal experiences). It provides both the motivation and the guiding principle for successful action. According to Csikszentmihalyi (1975, 1990), individuals preferentially engage in opportunities for action associated with a positive, complex, and rewarding state of consciousness, defined by him as “optimal experience” or “flow.” There are exceptional situations in which the activity of the subject is characterized by a higher level of presence than in most others. In these situations the subject experiences a full sense of control and experiential immersion (Morganti and Riva 2004; Riva 2004; Waterworth et al. 2003).

When this experience is associated with a positive emotional state, it constitutes a flow state. An example of flow is the case where a professional athlete is playing exceptionally well (positive emotion) and achieves a state of mind where nothing else is attended to but the game (high level of presence).

### 2.4.1 *The Layers of Presence*

Even if presence is a unitary feeling, on the process side it can be divided into three different layers/subprocesses (Riva et al. 2004), phylogenetically different, that correspond reasonably well (see Fig. 2.3) to the three levels of intentions identified by Pacherie in her dynamic theory of intentions (Pacherie 2006):

Advances in Virtual Reality and Anxiety Disorders

Wiederhold, B.K.; Bouchard, S.

2014, VII, 287 p. 87 illus., Hardcover

ISBN: 978-1-4899-8022-9