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Being There: Understanding the Feeling of Presence in a Synthetic Environment and Its Potential for Clinical Change

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Additional information is available at the end of the chapter

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1. Introduction

Virtual Reality (VR) has been usually described as a collection of technological devices: a computer capable of interactive 3D visualization, a head-mounted display and data gloves equipped with one or more position trackers [1]. The trackers sense the position and orientation of the user and report that information to the computer which updates the images for display in real time.

However, in the behavioral sciences, VR is usually described as [2] “an advanced form of human-computer interface that allows the user to interact with and become immersed in a computer-generated environment in a naturalistic fashion” (p. 82).

This feature transforms VR in an “empowering environment”, a special, sheltered setting where patients can start to explore and act without feeling of being threatened [3]. Nothing the patients fear can “really” happen to them in VR. With such assurance, they can freely explore, experiment, and experience feelings and/or thoughts. VR thus becomes a very useful intermediate step between the therapist’s office and the real world [4; 5]. In other words, the key feature of VR for clinical goals is that it offers an effective support to the activity of the subject by activating the feeling of “presence”, the feeling of being *inside* the virtual world.

But what is presence? In this chapter we will use the following three research outcomes emerging from the recent work of cognitive sciences to build a cognitive theory of presence:

1. *Cognitive processes can be either rational or intuitive*: we will argue that presence is an intuitive feeling that is the outcome of an experience-based metacognitive judgment;
2. *Skills become intuitive when our brain is able to simulate their outcome*: we will show argue that presence monitors intuitively our activity processes using embodied simulations;

3. *Space is perceived in terms of the actions we could take towards them*: we will argue that the feeling of Presence in a real or virtual space is directly correlated to the outcome of the actions the subject can enact in it;

In sum, the feeling of presence can be described as the product of an intuitive experience-based metacognitive judgment related to the enaction of our intentions: We are present in an environment - real and/or synthetic - when we are able, inside it, to intuitively transform our intentions in actions. The consequences of this claim for the development of clinical virtual environments are presented and discussed.

2. Virtual reality: From technology to experience

Since 1986, when Jaron Lamier used the term for the first time, VR has been usually described as a collection of technological devices. In general, a VR system is the combination of the hardware and software that enables developers to create VR applications [6]. The hardware components receive input from user-controlled devices and convey multi-sensory output to create the illusion of a virtual world. The software component of a VR system manages the hardware that makes up VR system. This software is not necessarily responsible for actually creating the virtual world. Instead, a separate piece of software (the VR application) creates the virtual world by making use of the VR software system.

Typically, a VR system is composed by [6]:

- the *output tools* (visual, aural and haptic), that immerse the user in the virtual environment;
- the *input tools* (trackers, gloves or mice) that continually reports the position and movements of the users;
- the *graphic rendering system* that generates the virtual environment;
- the *database construction and virtual object modeling software* for building and maintaining detailed and realistic models of the virtual world. In particular, the software handles the geometry, texture, intelligent behavior, and physical modeling of hardness, inertia, and surface plasticity of any object included in the virtual world.

However, as we have seen in the introduction VR can be described, too, as an advanced form of human-computer interface. Specifically, what distinguishes VR from other media or communication systems is the sense of *presence*. VR can be considered the leading edge of a general evolution of present communication interfaces such as television, computer and telephone whose ultimate goal is the full immersion of the human sensorimotor channels into a vivid and interactive communication experience. But what is presence?

The term “*Presence*” entered the general scientific debate in 1992 when Sheridan and Furness used it in the title of a new journal dedicated to the study of virtual reality systems and teleoperations: *Presence, Teleoperators and Virtual Environments*. In the first issue, Sheridan clearly refers to presence as an experience elicited by technology use [7]: the effect felt when controlling real world objects remotely as well as the effect people feel when they interact with and immerse themselves in virtual environments.

This vision describes presence as “Media Presence”, a function of our experience of a given medium [7-10]. The main outcome of this approach is the “*perceptual illusion of non-mediation*” [10] 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?

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 [11-13]. In this view presence is broad psychological phenomenon, not necessarily linked to the experience of a medium, whose goal is the control of the individual and social activity. In the next paragraphs we will justify this statement using the recent work of cognitive sciences.

3. The first feature of presence: it is an intuitive process

A first problem related to the research about presence is its role in cognitive science: what is its foundation in terms of the cognitive processes involved in it? Stanovich & West, [14] noted that in the last forty years, different authors from different disciplines suggested a two-process theory of reasoning based on Intuitive and Rational processes. Even if the details and specific features of these theories do not always match perfectly, nevertheless they share the following properties:

- Intuitive operations are faster, automatic, effortless, associative, and difficult to control or modify.
- Rational operations, instead, are slower, serial, effortful, and consciously controlled.

One of the theories based on this distinction is the cognitive-experiential self-theory (CEST). As explained by Epstein [15]:

“A fundamental assumption in CEST is that people operate by two cognitive systems: an “experiential system”, which is a nonverbal automatic learning system, and a “rational system,” which is a verbal reasoning system. The experiential system operates in a manner that is preconscious, automatic, nonverbal, imagistic, associative... and its schemas are primarily generalizations from emotionally significant intense or repetitive experience... In contrast to the automatic learning of the experiential system, the rational system is a reasoning system that operates in a manner that is conscious, verbal, abstract, analytical, affect free, effortful, and highly demanding of cognitive resources. It acquires its beliefs by conscious learning from books, lectures and other explicit sources of information, and from logical inference; and it has a very brief evolutionary history.” (pp. 24-25).

The differences between the two systems are described in Table 1. An interesting feature of this approach is that intuition is not only innate. As demonstrated by the research on perceptual-cognitive and motor skills, these skills are automatized through experience and

thus rendered intuitive [16]. In the case of motor skill learning, the process is initially rational and controlled by consciousness, as shown, for example, by the novice driver's rehearsal of the steps involved in parking a car: check the mirrors and blind spots; signal to the side of the space; position the car beside the vehicle I'm parking behind, etc.

	<i>Experiential/Intuitive System</i>	<i>Rational System</i>
Main Features	<ul style="list-style-type: none">• Intuitive: Preconscious, automatic, and intimately associated with affect• Concrete: Encodes reality in images, metaphors, and narratives• Associative: Connections by similarity and contiguity• Rapid processing: Oriented toward immediate action• Resistant to change: Changes with repetitive or intense experience• Differentiated: Broad generalization gradient; categorical thinking• Integrated: Situationally specific; organized in part by cognitive-affective modules• Experienced passively and preconsciously: We are seized by our emotions• Self-evidently valid: “Experiencing is believing”	<ul style="list-style-type: none">• Rational: Conscious, deliberative and affect-free• Abstract: Encodes reality in symbols, words, and numbers• Analytic: Connections by cause-and-effect relations• Slower processing: Capable of long delayed action• Less resistant to change: Can change with speed of thought• More highly differentiated: nuanced thinking• More highly integrated: Organized in part by cross-situational principles• Experienced actively and consciously: We believe we are in control of our thoughts• Not Self-evident: Requires justification via logic and evidence
How it works	<ul style="list-style-type: none">• Operates by hedonic principle (what feels good)• Acquires its schemas by learning from experience• Outcome oriented• Behavior mediated by “vibes” from past experience	<ul style="list-style-type: none">• Operates by reality principle (what is logical and supported by evidence)• Acquires its beliefs by conscious learning and logical inference• More process oriented• Behavior mediated by conscious appraisal of events

Table 1. Differences between the Intuitive and Rational system according to the cognitive-experiential self-theory

However, later the skill becomes intuitive and consciously inaccessible by virtue of practice, as shown, for example, by the difficulty of expert drivers to describe how to perform a complex maneuver to others, and by the fact that conscious attention to it actually interferes with their driving performance.

In sum, perceptual-motor skills that are not innate – e.g. driving a car - may become automatic through practice, and their operations thereby rendered intuitive. Using a metaphor derived from computer science, this process can be described as “*knowledge compilation*” [16]: a knowledge given in a general representation format (linguistic-semantic) is translated into a different one, more usable and less computationally demanding (perceptual-motor).

Are presence and telepresence intuitive or rational cognitive processes? On one side, it is evident that presence is the *outcome* of an intuitive cognitive process: no rational effort is required to experience a feeling of presence. On the other side, however, presence is *different* from an acquired motor skill or a behavioral disposition.

A possible path to find a better answer comes from the concept of metacognition. Koriart [17] defines “metacognition” as “the processes by which people self-reflect on their own cognitive and memory processes (monitoring) and how they put their metaknowledge to use in regulating their information processing and behavior (control).” (p. 289). Following the distinction between Intuition and Reasoning, researchers in this area distinguish between *information-based* (or theory-based) and *experience-based* metacognitive judgments [17].

Information-based metacognitive judgments are based on a deliberate use of one’s beliefs and theories to reach an evaluation about one’s competence and cognitions: they are deliberate and largely conscious, and draw on the contents of declarative information in long term memory. By contrast, experience-based metacognitive judgments are subjective feelings that are product of an inferential intuitive process: they operate unconsciously and give rise to a “sheer subjective experience”. An example of these metacognitive judgment are [18]: the “*feeling of knowing*” (knowing that we are able to recognize the correct answer to a question that we cannot currently recall), or the “*feeling of familiarity*” (knowing that we have encountered a given situation before, even if we don’t have an explicit memory of it).

In conclusion, we may describe presence as the sheer subjective experience of being in a given environment (the feeling of “being there”) that is the product of an intuitive experience-based metacognitive judgment.

4. The second feature of presence: it is the outcome of a simulation

A second critical question is “What is intuitively judged by Presence?”. Different authors have suggested a role of presence in the monitoring of action. For example, Zahoric and Jenison [19] underlined that “presence is tantamount to successfully supported action in the environment” (p. 87); Riva and colleagues [13]: suggested that “...the evolutionary role of presence is the control of agency” (p. 24); finally, Slater and colleagues [20] argued that “humans have a propensity to find correlations between their activity and internal state and their sense perceptions of what is going on out there” (p. 208). But, how may this work? And how this process is related to intuition? As suggested by Reber [21]:

"To have an intuitive sense of what is right and proper, to have a vague feeling of the goal of an extended process of thought, to "get the point" without really being able to verbalize what it is that one has gotten, is to have gone through an implicit learning experience and have built up the requisite representative knowledge base to allow for such judgment." (p. 233).

In simpler words, through implicit learning the subject is able to represent complex actions using perceptual-motor data and enact/monitor them intuitively. An empirical proof of this hypothesis 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 [22].

The general framework outlined by the discovery of neuronal resonance processes 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 [23; 24]. As clearly explained by Wilson and Knoblich [25] 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* [26], 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 virtual reality system that is used in both action planning and action understanding. If this is true, how we can distinguish between the virtual action planning and the real action? The answer is easy: using presence. In his book *"Inner Presence"* Revuonso [12] 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 require some form of *"acquaintance"*: a direct awareness (intuition) based on a non

propositional knowledge or nonconceptual content [27]. This view is surprisingly near to the vision of presence as “*perceptual illusion of non-mediation*” [10] introduced before. In both cases, presence is related to a direct experience.

However, if in the Lombard and Ditton definition the mediation is given by the used medium (virtual reality) in the Revuonso view [12], *the mediation is given by the body*: the experience of the body is our first virtual reality system. This vision is shared by many cognitive scientists. For instance Andy Clark [28] 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).

More, 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 [29]: *agency, ownership and location*.

- *Autopagnosia (agency)*: it is a neurological disease characterized by the inability to recognize or to orient any part of one's own body, caused by a parietal lobe lesion [30]: a patient with Autopagnosia is not present in his/her 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 is possible to induce an illusory perception of a fake limb [31] as 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 [31]: 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 [31].

5. The third feature of presence: we use it to monitor our actions

As we have seen before, Lombard and Ditton defined presence as the “*perceptual illusion of non-mediation*” [10] 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. More, recent studies on peripersonal space demonstrated that tool-mediated actions modify the multisensory coding of near peripersonal space [32]: the active use of a tool for physically and effectively interact with objects in the distant space appears to produce a spatial extension of the multisensory peri-hand 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* [33].

These studies confirm that the subject locates himself/herself in an external space according to the action he/she can do in it. As suggested by Zahoric and Jenison [19]: *"presence is tantamount to successfully supported action in the environment"* (p. 87, italics in the original). In sum, the subject is *"present"* in a space if he/she can act in it. More, the subject is *"present"* in the space – real or virtual – where he/she can act in. 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 [34]: I'm more present in a perceptually poor virtual environment (e.g. a textual MUD) where I can act in many different ways than in a real-like virtual environment where I cannot do anything.

Another consequence of this framework is the need to understand more what *"acting successfully"* means. We can start from the definition of *"Agency"*: *"the power to alter at will one's perceptual inputs"* [35]. 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 non mediated (prereflexive) perception of using the body to successfully transforming intentions in action (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 [36].

According to the *Dynamic Theory of Intentions* presented by Pacherie [36; 37] and to the *Activity Theory* introduced by Leont'ev and disseminated by Kaptelinin, & Nardi [38], repairing a computer is driven by an above 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 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 [33; 39].

Specifically, the *Dynamic Theory of Intentions* identifies three different “levels” or “forms” of intentions (Figure 2), characterized by different roles and contents: 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 Figure 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 Figure 1, “preparing the dissertation” is a P-intention.
- *M-intentions (Motor intentions)*. These intentions are responsible for low-level (unconscious and intuitive) 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 Figure 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 [36; 37] in which higher intentions generate lower intentions. In this view the ability to feel “present” in a virtual reality system – a medium - basically does not differ from the ability to feel “present” in our body. When the subject is present during agency – he/she is able to successfully enact his/her intentions – he/she locates him/herself in the physical and cultural space in which the action occurs.

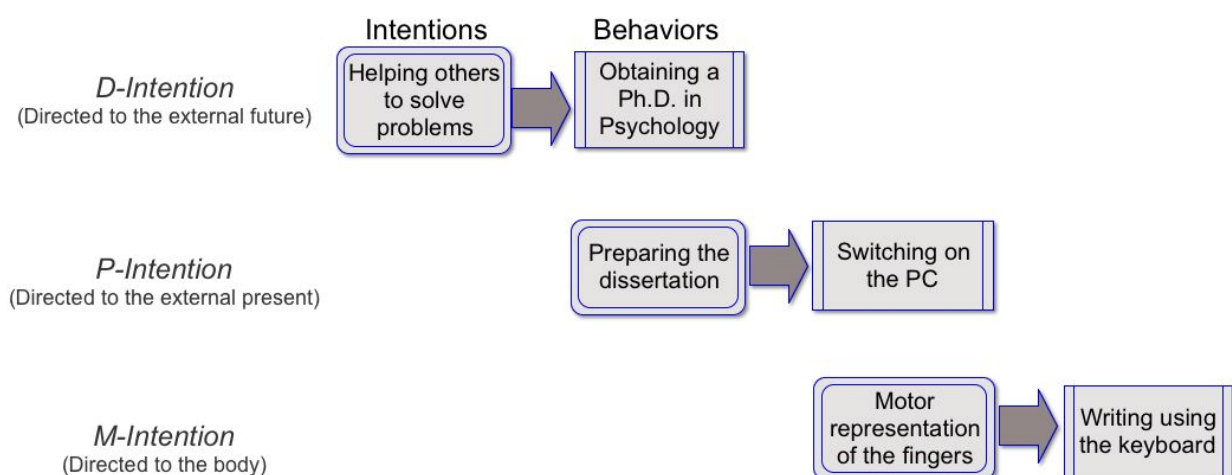


Figure 1. Intentional levels

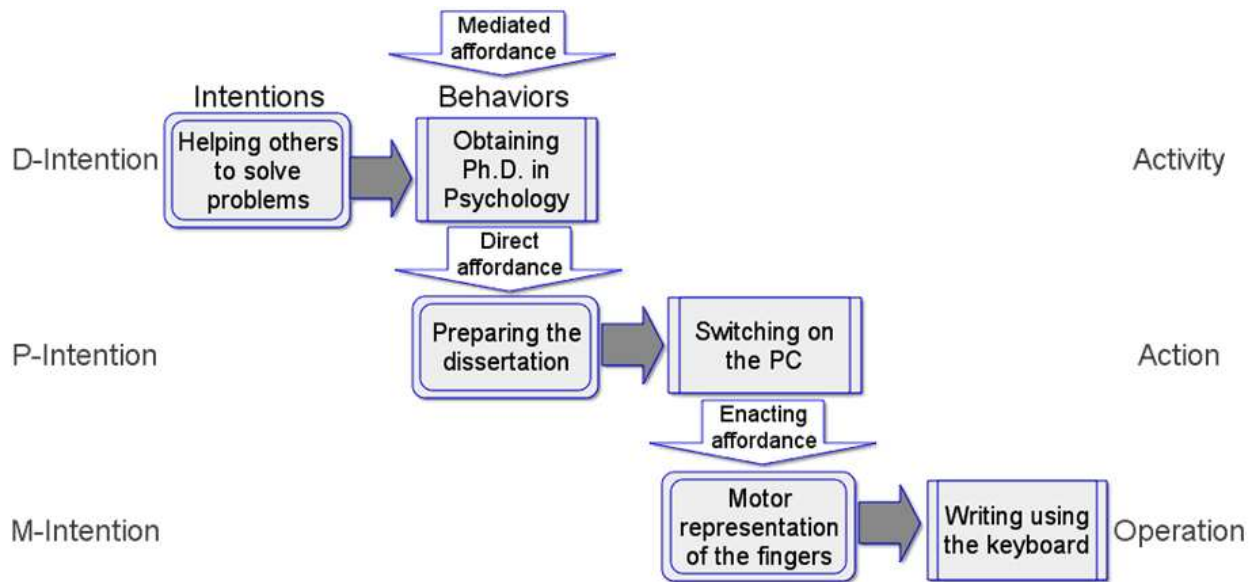


Figure 2. The intentional chain

More, it also suggest 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'm in a restaurant for a formal dinner with some colleagues in a Korean restaurant, but I don't know how to use the chopsticks I have nearby my dish. In this situation I'm 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'm not able to enact my intention (pick up some rice) using the chopsticks, so I don't 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 [40] (Figure 3):

- 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 between the sensory prediction and the sensory consequences of the act (an intuitive process occurring at a sub-personal level) 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* [41], the brain instantiates a sophisticated simulation, based on motor codes, of the outcome of an action and uses this to evaluate its course.

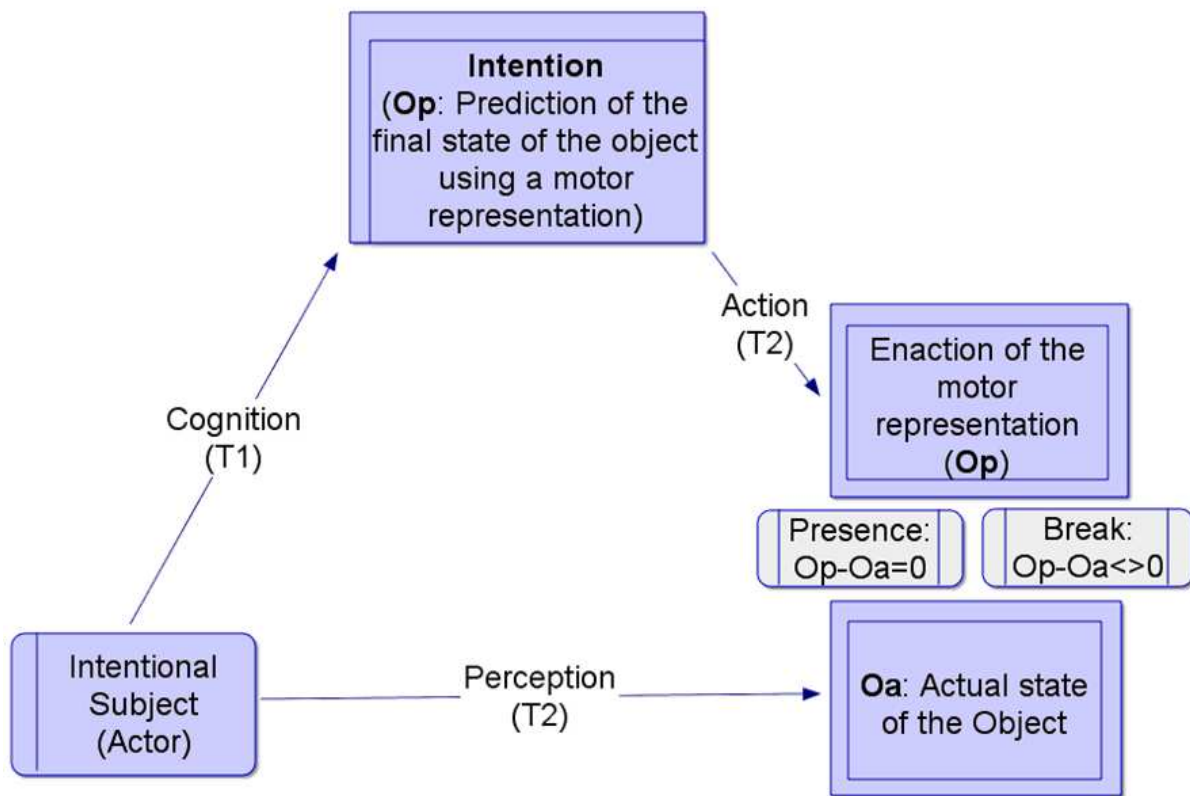


Figure 3. The feeling of presence

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 [42] 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 [19]. In fact, the subject perceives consciously only *significant variations* in the feeling of presence: *breakdowns* and *optimal experiences* [43]. We will discuss more in detail this point in Paragraph 10.

6. The fourth feature of presence: it is divided in three layers

Even if presence is a unitary feeling, on the process side it can be divided into three different layers/subprocesses [44; 45], phylogenetically different, that correspond reasonably well (see Figure 4) to the three levels of intentions identified by Pacherie in her *Dynamic Theory of Intentions* [36]:

- *Proto Presence* (Self vs. non Self – M-Intentions);
- *Core Presence* (Self vs. present external world – P-Intentions);
- *Extended Presence* (Self vs. possible/future external world – D-Intentions).

We define “*Proto Presence*” as the process of internal/external separation *related to the level of perception-action coupling (Self vs. non-Self)*. The more the organism is able correctly to couple perceptions and movements, the more it differentiates itself from the external world, thus

increasing its probability of surviving. Proto presence is based on proprioception and other ways of knowing bodily orientation in the world. In a virtual world this is sometimes known as "spatial presence" and requires the tracking of body parts and appropriate and rapid updating of displays, for example in response to head movements. Proto Presence allows the enaction of M-Intentions only.

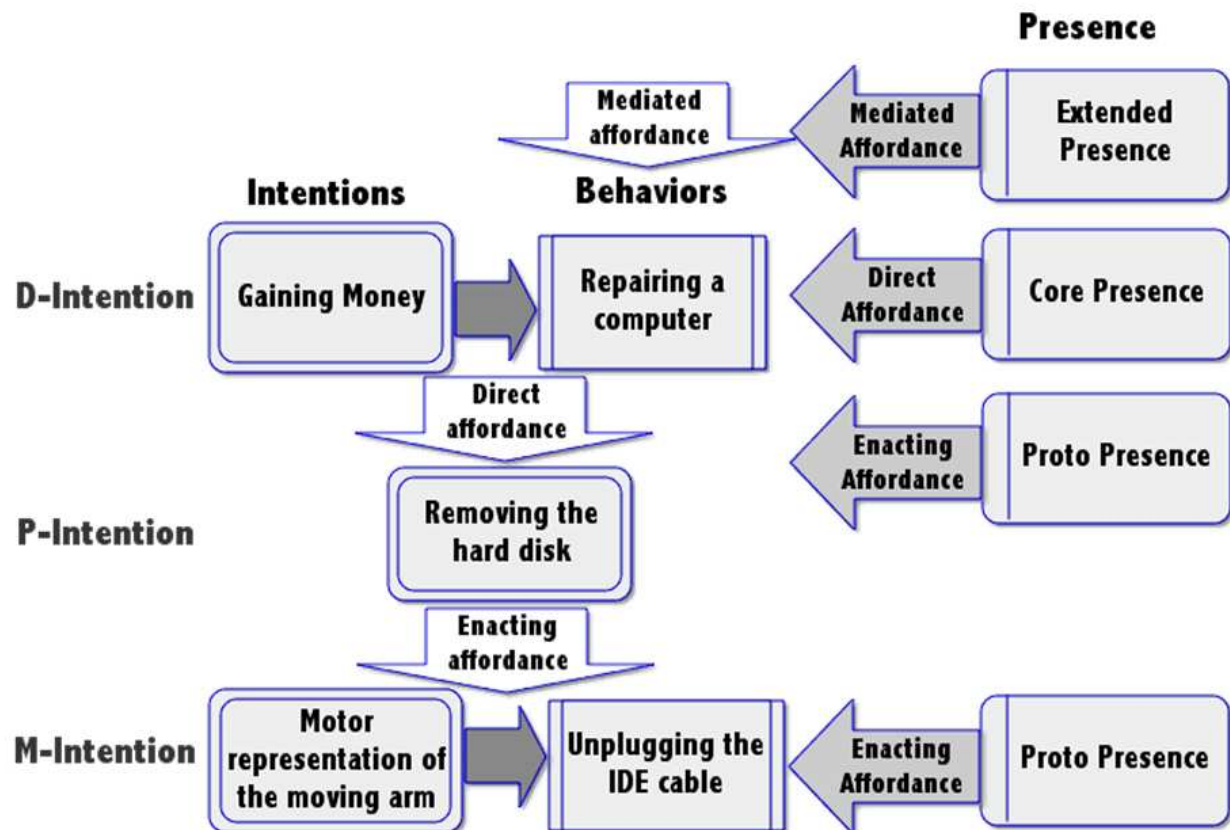


Figure 4. The layers of presence

"Core Presence" can be described as *the activity of selective attention made by the Self on perceptions (Self vs. present external world)*: the more the organism is able to focus on its sensorial experience by leaving in the background the remaining neural processes, the more it is able to identify events of the present moment and the direct affordances offered by the current external world, increasing its probability of surviving. Core Presence allows the enaction of M-Intentions and P-Intentions only. Core presence in media is based largely on vividness of perceptible displays. This is equivalent to "sensory presence" and requires good quality, preferably stereographic, graphics and other displays.

The role of "Extended Presence" is to *verify the relevance to the Self of possible/future events in the external world (Self vs. possible/future external world)*. The more the Self is able to forecast possible/future experiences, the more it will be able to identify relevant ones, increasing the possibility of surviving. Extended presence allows the enaction of M-Intentions, P-Intentions and D-Intentions. Following Sperber and Wilson's approach [46], an input is relevant when its processing yields a positive cognitive effect, a worthwhile difference to the Self's

representation of the world. Extended Presence requires intellectually and/or emotionally significant content. So, reality judgment influences the level of extended presence - a real event is more relevant than a fictitious one.

As underlined by Dillon and colleagues [47], converging lines of evidence from different perspectives and methodologies support this three-layered view of Presence. In their analysis they identify three dimensions common to all the different perspectives, relating to a "spatial" dimension (M-intentions), a dimension relating to how consistent the media experience is with the real world, "naturalness" (P-intentions), and an "engagement" dimension (D-intentions). This view has two main consequences [11; 33].

On one side, the role of the different layers will be related to the complexity of the activity: the more complex is the activity, the more layers will be needed to produce a high level of Presence (Figure 4). At the lower level – motor intention (e.g., grasping a ball) – *proto* Presence is enough to induce a satisfying feeling of Presence. At the higher level – distal intention (e.g., improving stress management) – the media experience has to support all three layers (e.g., allowing movement, *proto presence*; allowing interaction with the environment, *core presence*; giving a sense to the experience, *extended presence*).

On the other side, subjects with different intentions will not experience the same level of Presence, even when immersed in the same virtual environment [13]: this means that understanding and supporting the intentions of the user will improve his/her Presence in a virtual world. More, maximal Presence is achieved when the environment is able to support the full intentional chain of the user.

7. Presence and clinical change

The use of virtual reality (VR) in clinical psychology has become more widespread [48]. The key characteristics of virtual environments for most clinical applications are the high level of control of the interaction with the tool, and the enriched experience provided to the patient [2]. Typically, in VR the patient learns to cope with problematic situations related to his/her problem. For this reason, the most common application of VR in this area is the treatment of anxiety disorders, i.e., fear of heights, fear of flying, and fear of public speaking [49; 50]. Indeed, VR exposure therapy (VRE) has been proposed as a new medium for exposure therapy [48] that is safer, less embarrassing, and less costly than reproducing the real world situations. The rationale is simple: in VR the patient is intentionally confronted with the feared stimuli while allowing the anxiety to attenuate. Avoiding a dreaded situation reinforces a phobia, and each successive exposure to it reduces the anxiety through the processes of habituation and extinction.

However, it seems likely that VR can be more than a tool to provide exposure and desensitisation [48]. As noted by Glantz and colleagues [51]: "*VR technology may create enough capabilities to profoundly influence the shape of therapy.*" (p.92). Emerging applications of VR in psychotherapy include eating disorders and obesity (see Figure 5) [52-54], posttraumatic stress disorder [55], addictions [56], sexual disorders [57], and pain management [58]. But what is the potential role of presence in these treatments?



Figure 5. The use of VR in the treatment of Obesity: A phase of the therapy (*left*) and a screen-shot of the virtual environment (*right*)

To answer this question let's start from another question: How is it possible to achieve the desired change in a patient? This question has many possible answers according to the specific psychotherapeutic approach; however, in general, change occurs through an intense focus on a particular instance or experience [59]. By exploring this experience as thoroughly as possible, the patient can relive all of the significant elements associated with it (i.e., conceptual, emotional, motivational, and behavioral) and make them available for reorganization. Within this general model there exist many specific methods, including the insight-based approach of psychoanalysis, the schema-reorganization goals of cognitive therapy, the functional analysis of behavioral activation, the interpersonal relationship focus of interpersonal therapy, and the enhancement of experience awareness in experiential therapies.

What are the differences between them? According to Safran and Greenberg [60], behind the specific therapeutic approach there are two different models of change: bottom-up and top-down. Bottom-up processing begins with a specific emotional experience and leads eventually to change at the behavioral and conceptual level; top-down change usually involves exploring and challenging tacit rules and beliefs that guide the processing of emotional experience and behavioral planning. These two models of change are focused on the two different cognitive systems – intuition and reasoning – we discussed in Paragraph 4

Even if many therapeutic approaches are based on just one of the two change models, a therapist usually requires both [59]. Some patients seem to operate primarily by means of top-down information processing, which may then lead the way to corrective emotional experiences. For others, the appropriate access point is the intensification of their emotional experience and their awareness of both it and its related behaviors. Finally, different patients who initially engage the therapeutic work through top-down processing only may be able to make use of bottom-up emotional processing later in the therapy.

In this situation, the sense of presence provided by advanced technologies, VR in particular, offers a critical advantage [61]: used appropriately, it is possible to target a specific cognitive system without any significant change in the therapeutic approach. For instance, behavioral therapists may use a virtual environment for activating the fear structure in a phobic patient through confrontation with the feared stimuli; a cognitive therapist may use VR situations to assess situational memories or disrupt habitual patterns of selective attention; experiential therapists may use VR to isolate the patient from the external world and help him/her in practicing the right actions; psychodynamic therapists may use VEs as complex symbolic systems for evoking and releasing effects.

In fact, VR can be described as an *advanced imaginal system*: an experiential form of imagery that is as effective as reality in inducing emotional responses [62]. As underlined by Baños, Botella & Perpiña [63], the VR experience can help the course of therapy for “its capability of reducing the distinction between the computer’s reality and the conventional reality.” In fact, “VR can be used for experiencing different identities and... even other forms of self, as well” (p. 289). The possibility of structuring a large amount of realistic or imaginary controlled stimuli and, simultaneously, of monitoring the possible responses generated by the user of the technology offers a considerable increase in the likelihood of therapeutic effectiveness, as compared to traditional procedures [64].

More, As noted by Glantz and colleagues [51]:

“One reason it is so difficult to get people to update their assumptions is that change often requires a prior step – recognizing the distinction between an assumption and a perception. Until revealed to be fallacious, assumptions constitute the world; they seem like perceptions, and as long as they do, they are resistant to change.” (p. 96).

Using the sense of presence induced by VR, it is easier for the therapist to develop realistic experiences demonstrating to the patient that what looks like a perception – e.g., the body image distortion – in fact is a result of his/her mind. Once this has been understood, individual maladaptive assumptions can then be challenged more easily.

However, as noted by Price and Anderson [65] presence is not enough to produce a clinical change. The two authors explored the relation between presence, anxiety, and treatment outcome in a clinical study that used a virtual airplane to treat individuals with fear of flying. The results support presence as a conduit that enabled phobic anxiety to be expressed during exposure to a virtual environment. Nevertheless, presence was not supported as contributing to treatment outcome: feeling present during exposure may be necessary but not sufficient to achieve benefit from VR therapy. These results echoed findings from Krinj and colleagues [66], who compared the efficacy of a highly immersive CAVE-like system and the less immersive but more affordable HMD technology. They reported more presence and more anxiety in the CAVE system, but no difference in treatment outcome.

To better understand the possible link between presence and clinical change in the next two paragraphs we will explore the connections between presence, emotions, optimal experiences and therapy.

8. Presence for clinical change: The role of emotions

One of the most important effects of presence for clinical practice is that a virtual experience may evoke the same reactions and emotions as a real experience. For instance, Slater and colleagues [67] used VR to reproduce the Stanley Milgram's 1960s experimental approach: the participants were invited to administer a series of word association memory tests to a female virtual human (avatar) representing the stranger; when the avatar gave an incorrect answer, the participants were instructed to administer an "electric shock" to her, increasing the voltage each time; the avatar then responded with increasing discomfort and protests, eventually demanding termination of the experiment.

Their results show that in spite of the fact that all participants knew for sure that neither the avatar nor the shocks were real, the participants who saw and heard the female virtual human tended to respond to the situation at the subjective, behavioral and physiological levels as if it was real. As noted by the researchers [67]:

"In the debriefing interviews many said that they were surprised by their own responses, and all said that it had produced negative feelings – for some this was a direct feeling, in others it was mediated through a 'what if it were real?' feeling. Others said that they continually had to reassure themselves that nothing was really happening, and it was only on that basis that they could continue giving the shocks."

Experimental manipulations of emotions and presence have been conducted. Bouchard and colleagues [68] immersed adults suffering from snake phobia to a virtual environment where anxiety was experimentally induced, or not, by manipulating the apprehension of the participants and keeping the content of the immersions identical. Using a single-item measure of presence, the results showed that presence was significantly higher when participants were anxious during the immersion than in the baseline or the non-anxious immersion.

Baños, Botella, Guerrero, Liaño. Alcañiz, & Rey [69] compared the sense of presence between virtual and imaginary environments. Participants were randomly assigned to one of the two conditions (imagined versus virtual spaces) and the subjective sense of presence was measured in three moments (beginning, middle, and end). Results shown that the participants in "imagery" spaces indicated a decrease of their sense of presence, whereas the opposite occurs in participants in "virtual" spaces.

Michaud et al. [70] experimentally manipulated presence in a sample of heights phobics who had to take an elevator and perform tasks on a scaffold outside of a 15-story building. When the immersion in the virtual environment was conducted in a high-presence setting, the level of anxiety was significantly higher than when the immersion was conducted in a low-presence setting.

Riva and colleagues [71] also analyzed the possible use of VR as an affective medium focusing on the relationship between presence and emotions. Their data showed a circular interaction between presence and emotions: on one side, the feeling of presence was greater in the "emotional" environments; on the other side, the emotional state was influenced by

the level of presence. Taken together these results, in agreement with the model presented before, underline the existence of a bi-directional relationship between presence and emotions.

First, the higher the presence, the higher intensity of emotions the user experiences. Therefore, if the focus is on designing applications capable of eliciting emotions with the goal of reducing or modifying them (as in psychological therapy), the environments must be able to induce a high feeling of presence through a full support to the intentions of the user.

However, the opposite could also be claimed: the higher the intensity of the emotions and feelings, the higher the presence and reality judgment. From this point of view, the focus for psychological treatment would lie on designing relevant environments, providing intellectually and/or emotionally significant content for the specific sample involved in the treatment. For instance, a recent study by Gorini and colleagues [72] comparing a sample of 20 Mexican participants - 8 living in El Tepeyac, a small rural and isolated Mexican village characterized by a very primitive culture, and 12 high civilized inhabitants of Mexico City - clearly showed that VR exposure to a relaxing environment has different physiological and psychological effects according to the cultural and technological background of the users.

A study by Bouchard et al. [73] studied presence using a virtual environment designed to treat specific phobias (musophobia) with VR. Participants in both conditions were immersed in the same VE containing a rodent, yet in one condition they were deceived and led to believe that they were actually being immersed in real time in the physical room with the rodent. The deception used a blend of mixed videoconference-VR technologies, display of high-tech hardware relaying the videoconference and the VR computers, and false instructions stating that they were “currently live in the real room” or that they were “seeing a fake 3D copy of a room”. Presence was significantly higher when participants were told they were seeing the “real” room that was being projected in the head-mounted display in real time [73]. This study confirms the possibility of manipulating presence without changing any objective properties of the VE.

9. Presence for clinical change: The role of optimal experiences

In Paragraph 6 we discussed a critical feature of presence: it *provides the self with a feedback about the status of its activity*. Specifically, the self perceives the variations in the feeling of presence (*breakdowns* and *optimal experience*) and tunes its activity accordingly [43].

Winograd and Flores [74] refer to presence disruptions as *breakdowns*: a *breakdown* occurs when, during our activity, an aspect of our environment that we usually take for granted becomes part of our consciousness. If this happens, we shift our attention from action to the object or environment to cope with it. To illustrate, imagine sitting outdoors engrossed in reading a book on a pleasant evening. As the sun sets and the light diminishes one continues reading, engrossed in the story until one becomes aware that the light is no longer

suitable for reading. In such conditions, before any overt change in behavior, what we experience is a breakdown in reading and a shift of attention from the book to the light illuminating the book.

It is interesting to consider why we experience these breakdowns. Our hypothesis is that breakdowns are a sophisticated evolutionary tool used to control the quality of experience that ultimately enhances our chances of survival [13; 44]. As a breakdown occurs we experience a lower level of presence. This reduces the quality of experience, and leads us to confront environmental difficulties through an attentive shift.

On the other side we have optimal experiences. According to Csikszentmihalyi [75], individuals preferentially engage in opportunities for action associated with a positive, complex and rewarding state of consciousness, defined as “optimal experience”, or “flow.” There are some exceptional situations in real life in which the activity of the subject is characterized by a higher level of presence. In these situations the subject experiences a full sense of control and immersion. When this experience is associated to a positive emotional state, it can create 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 matters but the game (high level of presence). For Ghani and Deshpande [76] the two main characteristics of flow are (a) the total concentration in an activity and (b) the enjoyment which one derives from the activity. Moreover, these authors identified two other factors affecting the experience of flow: a sense of control over one's environment and the level of challenge relative to a certain skill level.

Following this vision, it is possible to design mediated situations that elicit optimal experiences by activating a high level of presence [77]. Optimal experiences promote individual development. As underlined by Massimini and Delle Fave, [78]:

“To replicate it, a person will search for increasingly complex challenges in the associated activities and will improve his or her skill, accordingly. This process has been defined as cultivation; it fosters the growth of complexity not only in the performance of flow activities but in individual behavior as a whole.” (p. 28).

According to this vision, existing VR treatments should include positive peak experiences because they serve as triggers for a broader process of motivation and empowerment. Within this context, the *transformation of flow* can be defined as a person's ability to draw upon an optimal experience and use it to marshal new and unexpected psychological resources and sources of involvement. We hypothesize that it is possible to use VR to activate a transformation of flow to be used for clinical purposes [77]. The proposed approach is the following: first, identify an enriched environment that contains *functional* real-world demands; second, using the technology to enhance the level of presence of the subject in the environment and to induce an optimal experience; third, allowing cultivation, by linking this optimal experience to the actual experience of the subject.

To verify the link between advanced technologies and optimal experiences, the “V-STORE Project” investigated the quality of experience and the feeling of presence in a group of 10 patients with Frontal Lobe Syndrome involved in VR-based cognitive rehabilitation [79].

On one side, the project used the Experience Sampling Method for repeated on-line assessments of the external situation and the emotional, cognitive and motivational components of daily experience during one-week of these patients, including traditional cognitive rehabilitation and sessions of exposure to V-STORE VR environment.

On the other side, after the VR experience they used the ITC-Sense of Presence Inventory to evaluate the feeling of presence induced by the VR sessions. Findings highlighted the association of VR sessions with both positive affect and a high level of presence. In particular, during the VR sessions, the “spatial presence,” the first scale of the ITC-Sense of Presence Inventory, was significantly correlated with the positive psychological feelings of “being free” ($r = 0.81$, $p < 0.01$) and “being relaxed” ($r = 0.67$, $p < 0.05$).

The transformation of flow may also exploit the plasticity of the brain producing some form of functional reorganization [80]. Recent experimental results from the work of Hunter Hoffman and his group in the treatment of chronic pain [81] also might be considered to foster this vision. Few experiences are more intense than the pain associated with severe burn injuries. In particular, daily wound care - the cleaning and removal of dead tissue to prevent infection - can be so painful that even the aggressive use of opioids (morphine-related analgesics) cannot control the pain.

However it is well known that distraction - for example, by having the patient listen to music - can help to reduce pain for some people. Hoffman and colleagues conducted a controlled study of the efficacy of VR as an advanced distraction by comparing it with a popular Nintendo video game. The results showed dramatic reductions in pain ratings during VR compared to the video game [82].

Further, using a functional magnetic resonance imaging scanner they measured pain-related brain activity for each participant during conditions of virtual reality and without virtual reality in an order randomized study [81]. The team studied five regions of the brain that are known to be associated with pain processing, the anterior cingulate cortex, primary and secondary somatosensory cortex, insula, and thalamus. They found that during VR the activity in all the regions showed significant reductions. In particular, they found direct modulation of pain responses within the brain during VR distraction. The degree of reduction in pain-related brain activity ranged from 50 percent to 97 percent.

10. Presence for clinical change: The neuroVR software

Although it is undisputable the potential of VR – as presence inducing technology - for clinical and research applications, the majority of existing clinical virtual environments are

still in the laboratory or investigation stage. In a review, Riva [48] identified four major issues that limit the use of VR in clinical practice:

- the lack of standardization in VR hardware and software, and the limited possibility of tailoring the virtual environments (VEs) to the specific requirements of the clinical or the experimental setting;
- the low availability of standardized protocols that can be shared by the community of researchers;
- the high costs (up to 200,000 US\$) required for designing and testing a clinical VR application;
- most VEs in use today are not user-friendly; expensive technical support or continual maintenance are often required.

To help researchers to overcome these issues and to develop VR applications able to exploit the clinical potential of presence, Riva and colleagues presented at the Medicine Meets Virtual Reality conference in 2007 a free virtual reality platform based on open-source software [83]: NeuroVR (<http://www.neurovr.org>). This software allows non-expert users to adapt the content of different pre-designed virtual environments to the specific needs of the clinical or experimental setting. Following the feedbacks of the thousands of users who downloaded the first version, they developed in late 2011 a new version – NeuroVR 2 – that improves the possibility for the therapist to enhance the patient's feeling of familiarity and intimacy with the virtual scene, by using external sounds, photos or videos [84].

In NeuroVR 2, the user can choose the appropriate psychological stimuli/stressors from a database of objects (both 2D and 3D) and videos, and easily place them into the virtual environment. The edited scene can then be visualized in the Player using either immersive or non-immersive displays. Currently, the NeuroVR library includes 18 different virtual scenes (apartment, office, square, supermarket, park, classroom, etc.), covering some of the most studied clinical applications of VR: specific phobias, cognitive rehabilitation, panic disorders and eating disorders.

The VR suite leverages two major open-source projects in the VR field: Delta3D (<http://www.delta3d.org>) and OpenSceneGraph (<http://www.openscenegraph.org>). Both are building components that integrates with ad-hoc code to handle the editing and the simulation. The NeuroVR2 Editor's GUI (see Figure 6) is now based on the QT cross-platform application and UI framework from Nokia (<http://qt.nokia.com/>) that grants a higher level of editing and customization over the editor functionalities, while the graphical rendering is done using OpenSceneGraph, an open source high performance 3D graphics toolkit (<http://www.openscenegraph.org/projects/osg>).

The new features include advanced action triggering based both on user behavior (proximity and collision) and on therapist choice (keyboard), realistic walk-style motion, advanced lighting techniques for enhanced image quality, and streaming of videos using alpha channel for transparency.



Figure 6. The NeuroVR 2 Editor

The NeuroVR 2 Player too has been largely rewritten to grant a more efficient workflow for the scenes playback and has a brand new startup interface written in QT. The whole suite is developed in C++ language, targeted for the Microsoft Windows platform but fully portable to other systems if needed.

11. Presence for clinical change: The interreality paradigm

Even if virtual reality is a very good presence-inducing technology, there is still room for improvement. Apparently, the main limitation of its actual use in clinical applications is the distance from reality [85]: the virtual experience is a distinct realm, separate from the emotions and behaviors experienced by the patient in the real world. In other words, the behavior of the patient in VR has no direct effects on the real life experience. More, the emotions and problems experienced by the patient in the real world are not directly addressed in the VR exposure [85].

To address this issue recently Fidopiastis and colleagues suggested the use of mixed reality (MR) [86]. The use of MR in clinical psychology is not new. Cristina Botella and her team used it for the treatment of small animal phobias [87]. The main advantage of this approach is that in MR virtual object are integrated into the real world: during the therapy the patient is seeing a real-world scene, and a series of computer-generated objects that, at that same moment, are super-imposed on the real physical environment. As noted by Botella and colleagues [87], this approach offers other advantages, too: it facilitates the experience of presence (the feeling of being there), and reality judgment (the fact of judging the experience as real) since the environment the patient is seeing is, in fact the "reality".

In this chapter we suggest that a further advancement might be offered by a new technological paradigm, Interreality: an hybrid, closed-loop empowering experience bridging physical and virtual worlds [88]. Specifically, the Interreality approach provides a twofold feedback activity:

- *behavior in the physical world influences the experience in the virtual world:*
 - For example, if the emotional regulation during the day was poor, some new experiences in the virtual world will be unlocked to address this issue.
 - For example, if the emotional regulation was okay, the virtual experience will focus on a different issue.
- *behavior in the virtual world influences the experience in the real world:*
 - For example, if I participate in the virtual support group I can send text messages during the day to the other participants.
 - For example, if my coping skills in the virtual world were poor, the decision support system will increase the chance of possible warnings in real life and will provide additional homework assignments.

On one side, the patient is continuously assessed in the virtual and real worlds by tracking the behavioral and emotional status in the context of challenging tasks (*customization of the therapy according to the characteristics of the patient*). On the other side, feedback is continuously provided to improve both the appraisal and the coping skills of the patient through a conditioned association between effective performance state and task execution behaviors (*improvement of self efficacy*).

Our claim is that bridging virtual experiences – fully controlled by the therapist, used to learn coping skills and emotional regulation - with real experiences – that allow both the identification of any critical problem and the assessment of what has been learned – using advanced technologies (virtual worlds, advanced sensors and PDA/mobile phones) is a feasible way to address the above limitations. This approach may offer the following innovations to current VR and/or MR protocols:

- *objective and quantitative assessment of symptoms using biosensors and behavioral analysis:* monitoring of the patient behavior and of his general and psychological status, early detection of symptoms of critical evolutions and timely activation of feedback in a closed-loop approach;
- *decision support for treatment planning through data fusion and detection algorithms:* monitoring of the response of the patient to the treatment, management of the treatment and support to the clinicians in their therapeutic decisions.
- *provision of warnings and motivating feedback to improve compliance and long-term outcome:* the sense of “presence” allowed by this approach affords the opportunity to deliver behavioral, emotional and physiological self-regulation training in an entertaining and motivating fashion.

For example, in the standard VR protocol used in the treatment of post-traumatic stress disorders [89] “*imagination and/or exposure evoke emotions and the meaning of the associated*

feelings can be changed through reflection and relaxation". We would suggest as an alternative that "controlled experience evokes emotions that result in meaningful new feelings which can be reflected upon and eventually changed through reflection and relaxation".

More, if the typical VR exposure protocol focuses on directly modifying the content of dysfunctional thoughts through a rational and deliberate process, Interreality focuses on modifying the patient's relationship with his or her thinking through more contextualized experiential processes.

In conclusion we argue that the potential advantages offered to VR treatments by the Interreality approach are:

- *a real-time feedback between physical and virtual worlds:* Interreality uses bio and activity sensors and devices (PDAs, mobile phones, etc) both to track in real time the behavior and the health status of the user and to provide targeted suggestions and guidelines.
- *an extended sense of community:* Interreality uses hybrid social interaction and dynamics of group sessions to provide each users with targeted – but also anonymous, if required – social support in both physical and virtual world.
- *an extended sense of presence:* Interreality uses advanced simulations (virtual experiences) to transform health guidelines and provisions in experience. In Interreality the patients do not receive abstract info but live meaningful experiences.

12. Conclusions

As explained previously, the feeling of presence induced by VR has helped this medium to find a significant space in clinical treatment. In particular, VR is playing an important role as a presence-enhanced supportive technique. Through presence, VR helps the patient to confront his/her problems in a meaningful yet controlled and safe setting. Furthermore, it opens the possibility of experiencing his/her life in a more satisfying way. In fact, VR therapists are using presence to provide meaningful experiences capable of inducing deep and permanent change in their patients. But what is presence? And how it can be used to improve the process of clinical change?

The International Society of Presence Research, defines "Presence" (a shortened version of the term "telepresence") as a "psychological state in which even though part or all of an individual's current experience is generated by and/or filtered through human-made technology, part or all of the individual's perception fails to accurately acknowledge the role of the technology in the experience". This approach describes the sense of presence as "Media Presence", a function of our experience of a given medium. The main outcome of this approach is the "*perceptual illusion of non-mediation*" [10] 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?

To address these questions a second group of researchers, including the authors of this chapter, considers presence as “Inner Presence”, the feeling of being located in a perceived external world around the self [11-13]. In this view presence is broad psychological phenomenon, not necessarily linked to the experience of a medium, whose goal is the control of the individual and social activity.

In the chapter we used the following three research outcomes emerging from the recent work of cognitive sciences to build a cognitive theory of presence:

1. *Cognitive processes can be either rational or intuitive*: we showed that presence is an intuitive feeling produced by an experience-based metacognitive judgment;
2. *Skills become intuitive when our brain is able to simulate their outcome*: we suggested that presence monitors intuitively our activity processes using embodied simulations;
3. *Space is perceived in terms of the actions we could take towards them*: we argued that the feeling of presence in a real or virtual space is directly correlated to the outcome of the actions the subject can enact in it.

In sum, the feeling of presence can be described as the product of an intuitive experience-based metacognitive judgment related to the enaction of our intentions: We are present in an environment - real and/or synthetic - when we are able, inside it, to intuitively transform our intentions in actions.

From a clinical viewpoint presence transforms VR in an “empowering environment”, a special, sheltered setting where patients can start to explore and act without feeling threatened [3]. Nothing the patient fears can “really” happen to them in VR. With such assurance, they can freely explore, experiment, feel, live, and experience feelings and/or thoughts. VR thus becomes a very useful intermediate step between the therapist’s office and the real world. In other words, the key feature of VR for clinical goals is that it offers an effective support to the activity of the subject by activating a high sense of “presence”, the feeling of being *inside* the virtual world.

However, as noted by Price and Anderson [65] presence is not enough to produce a clinical change: feeling present during VR exposure is necessary but not sufficient to achieve benefit from VR therapy. For this reason, in the last two paragraphs we explored the links between presence, emotions and optimal experiences.

First, the higher the presence, the higher is the intensity of emotions experienced by the user. Therefore, if the focus is on designing applications capable of eliciting emotions with the goal of reducing or modifying them (as in psychological therapy), the environments must be able to induce a high feeling of presence through a full support to the intentions of the user. However, the opposite could also be claimed: the higher the intensity of the emotions and feelings, the higher the presence and reality judgment. From this point of

view, the focus for psychological treatment would lie on designing relevant environments, providing intellectually and/or emotionally significant content for the specific sample involved in the treatment.

Second, the higher the presence, the optimal is the experience for the user. Following this vision, it is possible to design mediated situations that elicit optimal experiences by activating a high level of presence. More, given the link between optimal experiences and individual development, VR treatments should promote positive peak experiences because they serve as triggers for a broader process of motivation and empowerment. The proposed approach is the following: first, develop a VR environment that contains *functional* real-world demands; second, use the technology to enhance the level of presence of the subject in the environment and to induce an optimal experience; third, allow cultivation, by linking this optimal experience to the actual experience of the subject.

To help therapists and researchers to test these ideas we provided two further suggestions.

On one side we introduced NeuroVR (<http://www.neurovr.org>). This software, that reached version 2, allows non-expert users to adapt the content different pre-designed virtual environments to the specific needs of the clinical or experimental setting. Using the software the user can choose the appropriate psychological stimuli/stressors from a database of objects (both 2D and 3D) and videos, and easily place them into the virtual environment. The edited scene can then be visualized in the Player using either immersive or non-immersive displays. Currently, the NeuroVR library includes 18 different virtual scenes (apartment, office, square, supermarket, park, classroom, etc.), covering some of the most studied clinical applications of VR: specific phobias, cognitive rehabilitation, panic disorders and eating disorders.

On the other side, even if virtual reality is a very good presence-inducing technology, there is still room for improvement. Apparently, the main limitation of its actual use in clinical applications is the distance from reality: the virtual experience is a distinct realm, separate from the emotions and behaviors experienced by the patient in the real world. In other words, the behavior of the patient in VR has no direct effects on the real life experience. More, the emotions and problems experienced by the patient in the real world are not directly addressed in the VR exposure. To overcome the above limitations, here we suggested a new paradigm for e-health – “*Interreality*” – that integrates assessment and treatment within a hybrid environment, bridging physical and virtual world.

The clinical use of Interreality is based on a closed-loop concept that involves the use of technology for assessing, adjusting and/or modulating the emotional regulation of the patient, his/her coping skills and appraisal of the environment (both virtual, under the control of a clinicians, and real, facing actual stimuli) based upon a comparison of that patient’s behavioural and physiological responses with a training or performance criterion:

- the assessment is conducted continuously throughout the virtual and real experiences;

- the information is constantly used to improve both the emotional management and the coping skills of the patient.

In conclusion, we suggest that the feeling of presence, here described as an intuitive metacognitive judgment related to the enaction of our intentions - we are present in a real or virtual environment we are able, inside it, to intuitively transform our intentions in actions – is potentially very useful for improving the clinical practice. Our hope is that the present chapter and the ideas presented in it will stimulate a discussion within the clinical and research VR community about the potential, the advantages and the possible limitations that the use of presence inducing technologies – such as virtual reality, mixed reality and Interreality – may offer to clinical change.

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