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From intention to action: The role of presence

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ABSTRACT

Recent research in neuroscience has tried to understand human action from two different but converging perspectives: the cognitive and the volitional. On one side, cognitive studies analyze how action is planned and controlled in response to environmental conditions. On the other side, volitional studies analyze how action is planned and controlled by a subject's needs, motives and goals. In this paper we suggest that the notion of presence may be the missing link between these two approaches, explaining how can we differentiate between perception, action and concepts.

In particular, a consideration of presence can explain how can we distinguish between a perceived action, a planned or an executed one. We argue that the evolutionary role of presence is the control of agency through the unconscious separation of "internal" and "external" and the enaction/reenaction of intentions.

The model makes sense in terms of evolutionary psychology and is beginning to be supported by evidence of the neural and other physical correlates of action, imitation and self-monitoring. Another strength of this model is that it provides testable predictions about how to improve the experience of presence in media: maximal presence in a mediated experience arises from an optimal combination of form and content, able to support the intentions of the user.

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1. Introduction

In its more general use in relation to experiences mediated by digital information technology, the term presence has referred to a widely reported sensation experienced during the use of virtual reality. However, as commented by Biocca (1997), 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." Rather, as suggested by Loomis (1992), presence may be described as a basic state of consciousness: the attribution of sensation to some distal stimulus, or more broadly to some environment. 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. In general, as underlined by 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 describe the sense of presence as "Media Presence", a function of our experience of a given medium (IJsselsteijn, de Ridder, Freeman, & Avons, 2000; Lombard & Ditton, 1997; Loomis, 1992; Marsh, Wright, & Smith, 2001; Sadowski & Stanney, 2002; Schloerb, 1995; Sheridan, 1992, 1996). The main result of this approach are the definitions of presence such as the "*perceptual illusion of non-mediation*" (Lombard & Ditton, 1997) 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 reason *why* human beings can feel presence when they use media and/or simulation technologies." (p. 496).

To address to these questions, a second group of researchers considers presence as "Inner Presence", 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., 2000; Baños, Botella, & Perpiña, 1999; Lee, 2004a, 2004b; Mantovani & Riva, 1999; Marsh et al., 2001; Moore, Wiederhold, Wiederhold, & Riva, 2002; Riva & Davide, 2001; Riva, Davide, & IJsselsteijn, 2003; Schubert, Friedman, & Regenbrecht, 2001; Spagnolli & Gamberini, 2002; Spagnolli, Gamberini, & Gasparini, 2003; Waterworth & Waterworth, 2001, 2003; Zahoric & Jenison, 1998). In this paper we support this second vision, starting from the following broad statements:

- Presence is an evolved process related to the understanding and management of the causal texture of both the physical and social worlds (Lee, 2004a, 2004b; Waterworth & Waterworth, 2001).
- *The psychology of presence is related to the body and to the embodiment process* (Biocca, 1997; Biocca & Nowak, 2001; Riva, 2006).
- *The psychology of presence is related to human action and its organization in the environment* (Mantovani & Riva, 1999; Marsh, 2003; Riva, Loreti, Lunghi, Vatalaro, & Davide, 2003).

In the paper we will attempt to provide a more elaborate – and probably controversial – account of the fundamental presence enabling mechanisms. Recent research in neuroscience has tried to understand human action from two different but converging perspectives: the cognitive and the volitional. On one side, cognitive studies analyze how action is planned and controlled in response to environmental conditions. On the other side, volitional studies analyze how action is planned and controlled by subject's needs, motives and goals. In this paper we suggest that presence is the missing link between these two approaches.

Specifically, we consider presence as a neuropsychological phenomenon, evolved from the interplay of our biological and cultural inheritance, whose goal is the enaction of volition: presence is *the intuitive perception of successfully transforming intentions into action (enaction)*. Within this vision, we suggest that the ability to feel "present" in a virtual reality system – an artifact – basically does not differ from the ability to feel "present" in our body and the surrounding physical environment in which we are situated.

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Varela, Thompson, and Rosch (1991) define "*enaction*" in terms of two intertwined and reciprocal factors: first, the historical transformations which generate emergent regularities in the actor's embodiment and (sensorimotor) experience; second, the influence of an actor's embodiment in determining the trajectory of behaviors. As suggested by Whitaker (Whitaker, 1995) these two aspects reflect two different usages of the English verb "enact". On one side is "to enact" in the sense of "to specify, to legislate, to bring forth something new and determining of the future", as in a government enacting a new law. On the other side is "to enact" in the sense of "to portray, to bring forth something already given and determinant of the present", as in a stage actor enacting a role. In line with these two meanings, presence has a dual role:

- First, presence "locates" the Self in an external physical and/or cultural space: the Self is "present" in a space if he/she can act in it
- Second, *presence provides feedback to the Self about the status of its activity*: the Self perceives the variations in presence and tunes its activity accordingly.

In the following section we will flesh out these claims, before describing our own theoretical stance in detail. In essence, our claim is that presence is a neuropsychological phenomenon, evolved from the interplay of our biological and cultural inheritance, whose goal is the enaction of volition: presence is *the non mediated (intuitive) perception of successfully transforming intentions into action (enaction).*

2. The volitional and the cognitive approaches

Recent research in neuroscience has tried to understand human action from two different but converging perspectives: the cognitive and the volitional. On one side, cognitive studies analyze how action is planned and controlled in response to environmental conditions. On the other side, volitional studies analyze how action is planned and controlled by subject's needs, motives and goals. We outline some aspects and limitation of these two views below, before moving on to suggest a perspective based on presence as the missing link between these two approaches.

2.1. The volitional approach: from goal representation to action

The first psychological attempt to define volition comes from the work of William James. According to James's view (James, 1890), we have volition when there is an idea, a representation, of what is being willed, and any conflicting ideas are absent or stopped.

When this happens, the idea has the power to generate the action. Moreover, the link between the idea and the action is the result of learning: any representation of an event of which the subject has learned that it follows from a given action has the power to call for that action (ideo-motor principle). In this view, goal representations are functional anticipations of action: human actions are initiated by the idea of the sensory consequences that typically result from them.

There is a common criticism of this approach (Hommel, Müsseler, Aschersleben, & Prinz, 2001), which is that any action is not only dependent on internal causes (goals) but on external causes as well. For instance, if we consider an action like "obtaining a Ph.D. in psychology" it is obvious that this action is not only dependent on internal causes (the sensory consequences resulting from it) but on external causes as well. Furthermore, the general goal driving this action does not by itself specify the detail of the actions suited to realize them. How can I pass the General Psychology exam? How can I prepare the Ph.D. dissertation? All of these details need to be specified by taking into account many external factors (stimuli). One of the most interesting attempts to overcome this criticism comes from the work of the Russian psychologist Aleksey Leontjev. According to this author – usually labeled as an *Activity* theorist – the best way to understand volition is to move from the level of action to a higher level: activity (Nardi, 1996).

An activity is defined as a purposeful interaction of a subject (actor) with the world. Any activity is undertaken by a subject, who is oriented towards a specific intention (object), and it is always mediated by physical and social tools (artifacts). Moreover, this author (Leontjev, 1978, 1981) distinguished, within the general agency of the subject, three different levels of analysis.

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Activity is the highest level of agency: the social answer to a specific objective of the subject. The activity of the subject moves toward the object of a specific need (motive) and terminates when it is satisfied. Specifically, an objective is a process characterizing the activity as a whole. For example, in reference to Fig. 1, the activity is to obtain a Ph.D. in Psychology. Any objective – e.g. helping anorectic girls – is closely related to a motive – e.g. the need for self actualization – and both have to be considered in the analysis of an activity.

Each activity is then translated into reality through a specific *action* or a set of *actions*. Each action is a process performed with conscious thought and effort, planned and directed towards achieving a *goal*. With reference to Fig. 1, the activity – obtain a Ph.D. – is translated into a set of actions: going to the library to search for the sources, preparing an index, discussing it with the tutor, etc. Each action can be then split in sub-activities, each related to a sub-goal: searching for the books about anorexia, writing the structure of the first chapter, etc.

Actions and sub-actions are developed through *operations*: if actions are connected to conscious goals, operations are related to behaviors performed automatically. In reference to Fig. 1, the operation of typing when preparing the index of the dissertation is done automatically, without a conscious focus on the movement of the fingers. All the operations, however, are oriented by some *conditions*: unconscious constrains and affordances related to the characteristics of a given tool – such as the position (orienting basis) of the keys on the keyboard – that influence the outcome of the operation.

Conscious awareness of the conditions of a given tool is what distinguishes actions and operations. When we are learning how to use a new tool, its conditions are addressed with deliberate and conscious attention: they require actions. For instance, the first time one types, one has to consciously check the position of the letters on the keyboard. When the activity becomes well practiced and experienced, actions do not need to be planned but are performed without conscious thought or effort: actions become operations. The opposite process is also possible: operations become actions when the original conditions are violated. For instance, if something breaks down – pressing the key does not visualize the given letter on the screen – and/or impedes execution, the subject has to consciously address (goal) the new situation using an action.

All three levels of agency are guided by anticipation. This anticipation is the motive of the activity, the goal of the action and the orienting basis of the operation, respectively. When the activity is performed there is a feedback mechanism, which compares the result of the activity with the prediction, and any incongruence gives rise to a learning situation.

The next step of the analysis offered by *Activity Theory* is related to the link between the user and the tool. Mastering a tool has two effects for the user (Kaptelinin, 1996). First, the tool becomes transparent to the activity of the user: its conditions are handled automatically by the operations. Second, the tool is experienced as a property of the user: it complements or supports the user's abilities improving the efficacy of the activity. Marsh (Marsh, 2003) provides the following example to clarify this point: "For example, a builder uses a saw to cut wood, a hammer fixes nails and joins wood, etc. In normal use, the saw and hammer become an extension of the builder rather than belonging to the external world. Consequently, the builder is able to focus on cutting the wood or driving the nail and not on the operations of (or reflect on) the saw and hammer in use." (p. 88).

The main limitation of the *Activity Theory* is in its descriptive focus. As noted by Nardi (1996): "Activity theory is a powerful and clarifying descriptive tool rather than a strongly predictive theory." (p. 6).

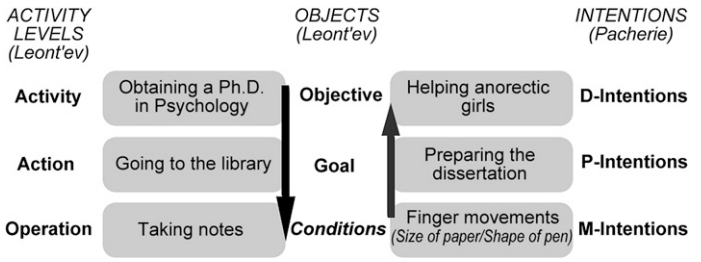

Fig. 1. Activity levels.

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2.2. The cognitive approach: from space to intentions through actions

Recent evidence from normal individuals and human lesion studies supports the view that space perception differs from physical space. For instance, recent neuropsychological research showed that the contents of subject's perception guide action in space and locate the subject in the perceived world (Matelli & Luppino, 2001; Postma, 2005). In other words, as suggested previously by Piaget (1945) with the concept of *assimilation* and Gibson (1979) with the concept of *affordance*, we conceive objects in terms of the actions we could take towards them: the subject has not a separate knowledge of the place's location relative to him/her, what he/she can do in it, and his/her purposes.

Extending this vision, Waskan (2006) suggests that *we represent phenomena by thinking in terms of the mechanisms by which the phenomena may be produced*. An example can help in understanding this point. Retrieving an occluded object – e.g. when we lift a book to retrieve a pencil from under it – is an action taken on the basis of a belief about where the pencil is located relative to the self. In sum (Waskan, 2006), "one cannot see a place as being *there1* rather than *there2* without knowing what it would be to act *there1* rather than *there2*." (p. 170, our italics).

It follows that to know that the pencil exists when it is occluded is a matter of knowing what can be done to make the pencil visible. Moreover, if I want to grab the pencil, its spatial position will be represented in terms of the movements needed to reach for it. Further, its shape and size will be represented in terms of the type of handgrip it affords.

More, recent studies on peripersonal space (the space surrounding our bodies, which can be reached by our limbs) demonstrated that tool-mediated actions modify the multisensory coding of near peripersonal space (Farné, Serino, & Làdavas, 2007; Gamberini, Seraglia, & Priftis, 2008): the active use of a tool to physically and effectively interact with objects in more distant space appears to produce a spatial extension of the multisensory peri-hand space corresponding to the whole length of the tool. Interestingly, a relatively prolonged, but passive experience with a tool is not sufficient to induce such a dynamic remapping of peripersonal space (Farnè, Bonifazi, & Làdavas, 2005).

This suggests that the representation of plastic modifications of peripersonal space are tightly linked to the active, purposeful use of a tool as physical extension of the body (Legrand, 2007): it is only through the successful enaction of his/her intentions using the tool that the subject becomes physically "present" in the tool (the tool is incorporated in the peripersonal space). In summary, and connecting the domain of presence with the one of agency, neuropsychological evidence suggests that the subject is "*present*" in a space if he/she can act in it; and, the subject is "*present*" in a tool if he/she can use it to act.

A classical definition of "agency" is the one suggested by James Russell: "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. According to folk psychology, 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 action is the result of a complex intentional chain that cannot be analyzed at a single level (Pacherie, 2006, 2008; Searle, 1983).

Pacherie identifies three different "levels" or "forms" of intentions, 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 Fig. 1, "helping anorectic girls" 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. 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. 1, the motor representations required to move the pen are M-intentions.

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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*.

To make the picture even more complex, cognitive scientists (Haggard & Clark, 2003) underline how the understanding of agency requires three different – but connected – levels of analysis: source of action, body movement, and authorship. In brief, agency requires:

- The concept of an action goal, or state of affairs in the external world, that the action aims to produce (intentional chain);
- The somatosensory and proprioceptive experience of movement of the part of the body in accordance with the goal of the action (comparison between intention and perception);
- The attribution of this experience to the actor.

3. Our theoretical stance

If we compare our short description of the volitional and cognitive approaches, we can find some interesting similarities. Both analyze agency through a three-level chain of objects/intentions in which higher levels generate lower ones. Both evaluate an action as successful through the comparison of the objects/intentions driving the action with its outcome. And both consider the mastering of a tool as the way to make it transparent (directly present) to the subject. Nevertheless, neither of them identifies a specific cognitive process addressing the complex task of comparing in real time and unconsciously the objects/intentions driving the action with its outcomes. To overcome this limitation we specify the concept of presence in a particular way. As indicated earlier, we consider presence as a neuropsychological phenomenon, evolved from the interplay of our biological and cultural inheritance, whose goal is the enaction of volition: presence is *the intuitive perception* (Kahneman, 2002) *of successfully transforming intentions into action (enaction)*.

Recent research by Haggard and Clark (Haggard & Clark, 2003; Haggard, Clark, & Kalogeras, 2002), on voluntary and involuntary movements, provides direct support for the existence of a specific cognitive process binding intentions with actions. In their words (Haggard et al., 2002): "Taken as a whole, these results suggest that the brain contains a specific cognitive module that binds intentional actions to their effects to construct a coherent conscious experience of our own agency." (p. 385).

We suggest that the ability to feel "present" in a virtual reality system – an artifact – basically does not differ from the ability to feel "present" in our body (Riva, 2009a, 2009b). 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. Furthermore, if the subject is present during a mediated action (involving tools), he/she incorporates the tool in his/her peripersonal space, extending the action potential of the body into virtual space (Clark, 2003).

3.1. Presence as monitoring of action

The presence process can be described as a sophisticated but unconscious form of monitoring of action and experience, transparent to the self but critical for its existence. The main experiential outcome of this process is the sense of agency: we feel that we are both the author and the owner of our own actions. For this reason, the feeling of presence is not separated by the experience of the subject but it is related to the quality of agency. A higher level of presence is experienced as a better quality of action and experience: the more the subject is able to enact his/her intentions in a successful action, the more he/she feels present. As suggested by Bickhard (2006): "There is much to be addressed about such systems of action selection, but the crucial point for now is that any triggering of an interaction, or any indication of the current appropriateness of an interaction, presupposes that that interaction is in fact appropriate for the current conditions." (online: http://www.interdisciplines.org/adaptation/papers/2).

We suggest that it is the *feeling of presence that provides to the self key feedback about the status of its activity*. The self perceives the variations in the feeling of presence and tunes its activity accordingly.

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This tuning is achieved through a simulative forward model (Blackemore & Decety, 2001): during self-produced actions a sensory prediction of the outcome of the action is produced along with the actual motor command. The results of the comparison (which occurs at a sub-personal 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 *Covert Imitation Theory* (Knoblich, Thornton, Grosjean, & Shiffrar, 2005; Wilson & 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 intuitive perception* (Kahneman, 2002) *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 (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 & Jenison, 1998). The agent perceives directly only *significant variations* in the feeling of presence: *breakdowns* and *optimal experiences* (Riva, 2006).

Why do we consciously track presence variations? Our hypothesis is that they are a sophisticated evolutionary tool used to control the quality of behaviour. 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 successful action. According to Csikszentmihalyi (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. 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). A corollary of the proposed vision is important for our goals: it is possible to design mediated situations that elicit a state of flow by activating a high level of presence (maximal presence) (Morganti & Riva, 2004; Riva, 2004; Waterworth et al., 2003).

3.2. The layers of presence

Even if presence is a unitary feeling, on the process side, it can be divided into three different layers or subprocesses (for a broader and more in-depth description see (Riva, Waterworth, & Waterworth, 2004)), described below, phylogenetically different, and strictly related to the evolution of self (Damasio, 1999):

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

We also note that both *Activity Theory* (Leontjev, 1978, 1981) and the *Dynamic Theory of Intentions* (Pacherie, 2006, 2008) organize intentions into a comparable three-level structure (see Table 1).

We define *"Proto Presence"* more precisely 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" (Baumgartner, Valko, Esslen, & Jäncke, 2006) 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/Operations only (Riva, 2009a).

"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

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Table 1
The layers of presence.

Layers	Relation with the self	Consciousness	Intentions	Activity	Media
Proto presence	Self vs. non self (Other)	Mostly unconscious (breakdowns)	Motor intentions (conditions)	Operation	Proprioceptive
Core presence	Self vs. present external world	Conscious of here and now	Present intentions (goal)	Action	Perceptual
Extended presence	Self relative to present external world	Conscious of self in relation of the world	Future intentions (objects)	Activity	Conceptual

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/Operations and P-Intentions/Actions only (Riva, 2009a). Core presence in media is based largely on vividness of perceptible displays (Schuemie, van der Straaten, Krijn, & van der Mast, 2001). 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. Following Sperber and Wilson's approach (Sperber & Wilson, 1995), 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.

3.3. Presence: internalization and externalization

A final assumption of our model is a strict link between intentions, Self and presence: *presence evolves in time, and its evolution is closely related to the evolution of the Self*. Specifically, following the three-stage model of the ontogenesis of Self (Proto-Self, Core Self, Autobiographical Self, see Fig. 2) proposed by Damasio (1999), presence evolves in time to allow higher levels of intentional granularity (Riva, 2006, 2008).

The processes of internalization and externalization provide a possible explanation for this evolution. Vygotsky (Vygotsky, 1965, 1978) states that internalization and externalization are the dialectical mechanisms that allow an individual to construct higher psychological structures. On one side external activity transforms internal cognitive processes (*internalization*). On the other side, knowledge structures and moments of internal activity organize and regulate external social processes (*externalization*). Internalization is social by its very nature: it is not just copying but rather a transformation or reorganization of social information and mental structures based on the individual's action and interaction, usually mediated by social and physical tools. The opposite process of internalization is externalization.

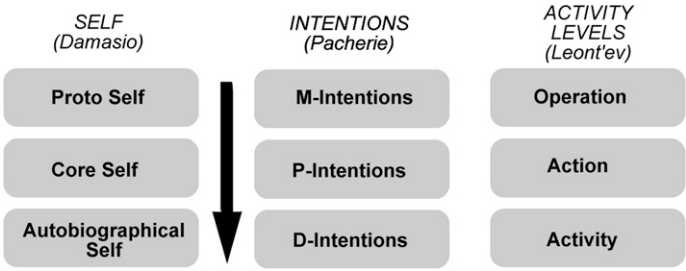

Fig. 2. Self, intentions and activity.

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Mental processes manifest themselves in external actions performed by a person, so they can be verified and corrected, if necessary. This dialectical process also leads to the production of new artifacts used to facilitate mental processes and action.

Here we suggest that the processes of internalization and externalization are influenced by the experienced presence during agency (Morganti, Carassa, & Riva, 2008):

- The more presence experienced during a mediated action, the greater the possibility that the used tool (physical or social) will be internalized;
- The more presence experienced during an action, the greater the possibility that the content of the activity will be externalized.

4. Mediated presence in virtual realities

As Sanchez-Vives and Slater (2005) suggest, "[mediated] presence is a phenomenon worthy of study by neuroscientists and may help towards the study of consciousness, since it may be regarded as consciousness within a restricted domain". In a fully-immersive virtual reality many aspects affecting the experience can be controlle, maipulated and replicated precisely, and because of this virtual realities (and to a lesser extent, other interactive media) provide a powerful paradigm for experimentation, with presence measures serving as dependent variables. The ability to design specific interactive environments with predictable effects on the sense of presence follows from this.

4.1. Designing and measuring mediated presence

Often, an interaction designer's aim is to design for as much presence as possible. In previous work, we have identified three practical ways of approaching the design of maximal mediated presence, derived from our theoretical position (Riva et al., 2004): digital participation, mediated flow, and embodied immersion. In these situations, the organism responds as if what happens in a mediated environment is real, and of immediate significance.

Digital participation arises if we design a role for the participant as a performer in an interactive drama (Nath, 2001) seen from a first person perspective. If the performer becomes emotionally and intellectually engaged by the events in an appropriately immersive environment, extremely high levels of presence can be achieved (Waterworth, Waterworth, & Westling, 2002). A feature of this state of participation is a corresponding loss of self-consciousness. In this respect, digital participation resembles the flow state. According to Trevino and Webster (Trevino & Webster, 1992) *mediated flow* corresponds to the extent to which (a) the user perceives a sense of control over the computer interaction, (b) the user perceives that his or her attention is focused on the interaction, (c) the user's curiosity is aroused during the interaction, and (d) the user finds the interaction intrinsically interesting. As with digital participation, events are experienced from a first person perspective.

Embodied immersion is our term for a style of interaction that uses bodily movements not only for consciously-monitored control over the environment, as in standard computer interactions, but also for more direct, automated inputs from the body. The pioneering work in this area was carried out by Char Davies in the mid-nineties (Davies, 2003). In Osmose, for example, breath and balance are used to control navigation, while in Ephémère visually dwelling on a portrayed "organic" form causes it to age before the eyes. As with the examples digital participation and mediated flow, this style of first person mediated experience results in a loss of self-consciousness and we also see this as an approach to eliciting maximal levels of presence.

Petranker (Petranker, 2003) distinguishes between "narratives", which are usually expressed in the third person and which we tell or are told to us, and "stories", which we inhabit from a first person perspective. For us, maximal presence arises when we fully "inhabit" the "story" of what is happening to us right now. Narrative, by its nature, is a distancing from the present. To design for maximal mediated presence is to create stories we can inhabit as fully as possible. These stories are located in immersive environments and elicit embodied, unselfconscious and engaged participation from all three layers of the self.

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Measurement of mediated presence has sometimes been a contentious issue, but reliable methods do exist. Questionnaires are the most established, some designed and validated specifically for virtual reality contexts (Schubert et al., 2001), others with more general applicability to a range of digital media (Lessiter, Freeman, Keogh, & Davidoff, 2001), the latter having larger scale validation than the former. Other widely used approaches include measurement of physiological (Meehan, Insko, Whitton, & Brooks, 2002) and postural changes (Freeman, Avons, Meddis, Pearson, & IJsselsteijn, 2000) which are interpreted in terms of events occurring in the mediated environment. A more recent approach measures changes in electrical brain activity during interaction (Mikropoulos, Tzimas, & Dimou, 2004). Each of these approaches have familiar strengths and weaknesses, and a consensus is emerging that we need triangulations of introspective, behavioural and neuropsychological data to increase the validity of presence measurement.

4.2. Specific predictions from the theory

Our theoretical position suggests that a typical, unexceptional level of presence arises from a split of attentional resources between layers with differing content, with some attention being directed to the current external situation and some to a different internal concern. Minimal presence results from an almost complete lack of integration of the three layers discussed above, such as is the case when attention is mostly directed towards contents of extended consciousness that are unrelated to the present external environment. By the same reasoning, maximal presence arises when proto consciousness, core consciousness and extended consciousness are focused on the same external situation or activity. Maximal presence thus results from the combination of all three layers with an abnormally tight focus on the same content. This will arise in a mediated experience from an optimal combination of form and content, able to support the activity of the user. This perspective provides several predictions, derivable from our model, about when maximal presence will be elicited through mediated experiences.

The first two predictions relate to recognition of, and support for, a user's purposes and activities.

1) To induce maximal presence, a mediated experience has to include recognition of the specific purpose of the user. If the developer is not able to identify the specific objective of the user it will fail in supporting his/her action, reducing the level of presence.
2) To induce maximal presence, a mediated experience has to identify and support the specific tools that mediate the activity of the user. Most of the activity of the user is mediated by physical and social artifacts. The developer has to identify and embed in the virtual reality system features to support the action of the user effectively.

Proto presence will be determined only by variations in the form of a medium, core presence by both form and content, and extended presence only by content. Media form must provide the means for a convincing perceptual illusion, but the content should be integrated with (and so attract attention to) that form for the presence illusion to happen convincingly. Further, both have to support the activity of the user in reaching his/her specific objective.

The role of the different layers will be related to the complexity of the activity carried out in the mediated experience: the more complex the activity, the more layers will be needed to produce a high level of presence. At the lower level – operations – proto presence is enough to induce a satisfying feeling of presence. At the higher level – activity – the media experience has to support all three layers. As suggested by Juarrero (1999) high level intentions (Future Intentions/Objects) channel future deliberation by narrowing the scope of alternatives to be subsequently considered (cognitive reparsing). In practice, once the subject forms an intention, not every logical or physically possible alternative remains open, and those that do are encountered differently: once I decide to do A, non-A is no longer a viable alternative and should it happen, I will consider non-A as a breakdown (Bratman, 1992).

These considerations suggest two additional predictions for the mediated conditions that will generate maximal presence:

3) To induce maximal presence, a mediated experience will decompose the activity of the user into its different components. The virtual reality system has to identify the start and the end of each level

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and sublevel of the activity of the subject to support them. Further, each level and sublevel has its specific motive. The developer has to identify all the driving motives to effectively support the activity of the subject. For example, if I want to develop a VR surgical simulator, I have to identify all the levels and sublevels of activity used by the surgeons in their standard practice and verify that the developed environment is able to effectively support them.

4) *The lower the level of activity, the easier it is to induce maximal presence*. The object of an activity is wider and less targeted than the goal of an action. So, its identification and support is more difficult for the designer of a VR system. Further, the easiest level to support is the operation. In fact, its conditions are more "objective" and predictable, being related to the characteristics (constrains and affordances) of the artifact used: it is easier to automatically open a door in a virtual environment than to help the user in finding the right path for the exit. At the lower level – operations – proto presence is enough to induce a satisfying feeling of presence. At the higher level – activity – the media experience has to support all the three levels.

At the higher levels of activity, maximal presence arises when the contents of extended consciousness are aligned with the other layers of the self, and attention is directed to a currently present external world. However, this is a difficult task to achieve for a VR developer. He/She has to provide as much immersion as possible, integrating proto (spatial) and core (sensory) presence. To integrate extended presence, the events and entities experienced in the virtual environment must have significance for the participant. The form must provide the means for a convincing bodily and perceptual illusion, but the content should be integrated with (and so attract attention to) the form for the illusion of mediated presence to happen convincingly.

If our model can predict the conditions for maximal presence, it should also predict when and why mediated presence may be experienced at a relatively low level. This can be the case in many, indeed most, interactive situations, reflecting that the different layers of presence are less than perfectly integrated. For example, if a virtual reality is experienced without an accurate and responsive body tracking system, there might be a high level of core presence (vividness), a high level of extended presence (engagement), but this will not be integrated with proto presence. Similarly, when engaged in reading a compelling book whilst sitting comfortably in a safe place, extended consciousness may be occupied by the medium, but the other layers of presence will not be involved. Even if placed in a highly immersive VR, a participant may be pre-occupied with other concerns, perhaps because the mediated content is not very engaging. In this case, proto and core presence may have been invoked by the medium, but not extended presence.

We foresee a programme of research to test these and other predictions from our model. A particular focus for the interpretation of results would be significant improvements in presence levels in response to manipulations of the situational conditions of activity.

5. Conclusions

We have presented the sense of presence as a neuropsychological phenomenon, evolved from the interplay of our biological and cultural inheritance, whose goal is the enaction of the volition of the subject: presence is the intuitive perception (Kahneman, 2002) of successful intentions in action. Although presence is a unitary feeling, on the process side it can be divided into three different layers/subprocesses, phylogenetically different, and strictly related to the evolution of self. These three levels of presence also correspond reasonably well both to the three levels of intentions identified by Pacherie in her *Dynamic Theory of Intentions* (Pacherie, 2006) and to the different levels of activity identified by *Activity Theory* (Leontjev, 1981).

Presence mediated by information technology is the feeling of being in an external world, in the realization of which that technology plays a direct role. To arise and persist, it requires adequate form to be directly perceived, conscious attention to that form, and content that will sustain such attention. When we experience strong mediated presence, our experience is that the technology has become part of the self, and the mediated reality to which we are attending has become an integrated part of the other. When this happens, there is no additional conscious *effort of access* to information, nor *effort of action* to overt responses in the mediated environment. We perceive and act directly, as if unmediated.

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The extent to which we experience presence through a medium thus provides a measure of the extent to which that technology has become an integrated part of the self. Maximal presence in a mediated experience arises from an optimal combination of form and content, able to support the intentions of the user.

In this paper we have attempted to provide an account of the fundamental presence enabling mechanisms as based on the interaction between intentions and actions. Recent research in neuroscience has tried to understand human action from two different but converging perspectives: the cognitive and the volitional. On one side, cognitive studies analyze how action is planned and controlled in response to environmental conditions. On the other side, volitional studies analyze how action is planned and controlled by subject's needs, motives and goals. In this paper we have suggested that presence is the missing link between these two approaches. We believe that our model makes sense in terms of evolutionary psychology and is beginning to be supported by evidence of the neural and other physical correlates of action, imitation and self-monitoring. It also provides testable predictions about how to improve the experience of presence in interactive media.

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