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ORIGINAL ARTICLE

Is presence a technology issue? Some insights from cognitive sciences

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Abstract 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" (ISPR 2000, The concept of presence: explication statement. http://ispr.info/ Accessed 15 Jan 2009). In this article, we will draw on the recent outcomes of cognitive sciences to offer a broader definition of presence, not related to technology only. Specifically, presence is described here as a core neuropsychological phenomenon whose goal is to produce a sense of agency and control: subjects are "present" if they are able to enact in an external world their intentions. This framework suggests that any environment, virtual or real, does not provide undifferentiated information, ready-made objects equal for everyone. It offers different opportunities and produces presence according to its ability in supporting the users and their intentions. The possible consequences of this approach for the development of presence-inducing virtual environments are also discussed.

Keywords Presence · Cognitive sciences · Cognition · Action · Activity · Intentions · Space

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1 Introduction

The term "*presence*" entered in the wide 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 (Sheridan 1992): 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.

Following this approach, 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" (International Society for Presence Research 2000). In this view, the core of Presence research is the comparison of human perceptions and responses in the context of technology with human perceptions and responses in contexts that do not involve technology (Riva et al. 2003).

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.

Extending this view drawing on the recent outcomes of cognitive sciences, the article presents a conceptual

framework that describes Presence as a core neuropsychological phenomenon whose goal is to produce a sense of agency and control (Riva et al. 2006). For instance, Slater suggested that presence is a selection mechanism that organizes the stream of sensory data into an environmental gestalt or perceptual hypothesis about current environment (Slater 2002).

Within this framework, based on the ecological/ethnographic approach (Gamberini and Spagnolli 2003; Gibson 1979; Mantovani and Riva 1999, 2001; Spagnolli and Gamberini 2005; Spagnolli et al. 2003; Waterworth and Waterworth 2006), any environment, virtual or real, does not provide undifferentiated information, ready-made objects equal for everyone. It offers different opportunities and produces Presence according to its ability in supporting the users and their intentions. The next pages will try to better outline the proposed framework.

2 Are presence and action related?

Over the past ten years, cognitive sciences have shown that the brain acts as an "inference machine" that tries to discover patterns within data by refining a model of how these patterns are generated. In particular, the recent discovery of two functional cluster of premotor neurons—"*canonical neurons*" (F5ab-AIP) and "*mirror neurons*" (F5c-PF)—that are selectively activated by action and perception suggest that the brain dynamically produces contextualized representations (simulations) that support situated action in different situations (Gallese 2000, 2005; Gallese et al. 1996; Rizzolatti and Arbib 1998; Rizzolatti et al. 1996, 1997). This is allowed by a common coding—the motor code—shared by perception, action, and concepts (Knoblich et al. 2005; Prinz 1997; Wilson and Knoblich 2005).

On one side, the vision of an object immediately activates the appropriate hand shape for using it: seeing a red apple activates a precision grip for grasping and turning. On the other side, thinking of an apple produces the simulation of an action related to the apple in a specific context of use.

This common coding also allows the subject for natively recognizing actions done by other beings within the phenomenological contents. Further, the subject predicts the outcome of the identified action using the same simulation mechanism described above: seeing someone grasping an apple produces a contextualized simulation of the full course of the action.

However, this picture has some holes in it: if perception, action, and concepts share the same language how can we differentiate between them. In particular how can we distinguish between a perceived action, a planned or an executed one?

This article suggests that a psychology of Presence is a possible answer to this question. In the proposed vision "Presence" has a simple but critical role in our everyday experience: the control of agency and social interaction through the unconscious separation of both "internal" and "external", and "self" and "other" (Riva 2007). Specifically (Riva 2006, 2008a, b):

- "Presence" is defined as *the non-mediated (prereflexive) perception of successfully transforming intentions in action (enaction) within an external world*;
- "Social Presence" is defined as *the non-mediated perception of an enacting other (I can recognize his/her intentions) within an external world.*

This framework is complex and controversial. In particular, the first critical issue is the relation between presence and action. Do we need action to have presence? For instance, a possible criticism that can be raised against the above definitions is the following: "*What about this thought experiment: paint a 20′ by 20′ by 20′ room completely white, there are no windows, have a person sit in the middle of the room, there is nothing to interact with, is the person not present there? If so, then it would seem (to me) that the ability to act in an environment is unrelated to Presence*".

The main assumption of this criticism, shared by many presence researchers, is that the core of Presence is "Physical Presence" (Schloerb 1995). According to Schloerb (1995), physical presence is an "objective" feature of things and designates ''the existence of an object in some particular region of space and time. For example, this text (in some form) is physically present in front of you now'' (p. 68).

In this view, virtual reality research should focus on creating a sense of physical presence by simulating as closely as possible the range and intensity of stimuli human senses detect and interpret in perceiving the natural world (Heeter 1992; Sanchez-Vives and Slater 2005).

This vision is based on a philosophical position that is known as "ingenuous realism" (Mantovani 1996; Mantovani and Riva 1999, 2001): reality is a set of objects located outside the mind and has a set of well-defined characteristics. From the viewpoint of ingenuous realism, "physical" presence is "real" because it designates a state of things, the way an object is, the fact that something or someone exists within a certain physical environment.

Unfortunately, the results from one century of neuroscience research undermined the distinction between "physical" and "mental" and the link between presence and the physical body. Here are some examples:

- *Autopagnosia*: 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 (Sirigu et al. 1991). A patient with autopagnosia will not

be present in the 20′ by 20′ by 20′ room described above;

- *Anarchic Hand*: 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 hand of the patient with anarchic hand will not be present in the room described above;
- *Hemispatial Neglect*: 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 the room described above;
- *Isolation tanks*: an isolation tank is a lightless, soundproof thank in which subjects float in salty water at skin temperature (see an example on You Tube at http://www.youtube.com/watch?v=YEjTXX2rHgA). The darkness and silence during the experience have the effect of reducing sensory input from the external environment and within 15/20 min physical presence disappears (Kjellgren et al. 2004). So, if the room described above is an isolation tank, after some time the person's physical presence will disappear.

The challenge of this article is to provide a conceptual framework able to explain both these experiences and technology-mediated experiences. The article will start this attempt from the analysis of the link between action and presence.

3 From action to presence through space

Recent neuropsychological research showed that the contents of subject's perception guide action in space and locate the subject in the perceived world (Matelli and Luppino 2001; Postma 2005). In other words, as suggested previously by Piaget (*assimilation*) and Gibson (*affordance*), *we conceive places in terms of the actions we could take toward 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 pen from under it—is an action taken on the basis of a belief about where the pen 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 pen exists when it is occluded is a matter of knowing what can be done to make the pen visible. Moreover, if I want to grab the pen, 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 demonstrated that tool-mediated actions modify the multisensory coding of near peripersonal space (Farné et al. 2007; Gamberini et al. 2008). the active use of a tool to physically and effectively interact with objects in the distant space appears to produce a spatial extension of the multisensory perihand space corresponding to the whole length of the tool. *In other words, through the successful enaction of his/her intentions using the tool, the subject becomes physically present in the tool.*

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 (1998): ''*presence is tantamount to successfully supported action in the environment*'' (p. 87, italics in the original).

In other words, the subject is "*present*" in a space if he/she can act in it. Moreover, the subject is "*present*" in the space—real or virtual—where he/she can act 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* (Riva 2008a, b): The user is more present in a perceptually poor virtual environment (e.g., a textual MUD) where he/she can act in many different ways than in a real-like virtual environment where he/she cannot do anything.

3.1 Behind action: intentions

Another consequence of the above reflections is the need to understand more about what "acting successfully" means. We can start from the definition of "Agency": "the power to alter at will one's perceptual inputs" (Russell 1996). But how can we define our will?

A simple answer to this question is: through intentions.

For this reason "*Presence" can be defined as the non-mediated (prereflexive) perception of successfully transforming intentions in action (enaction).*

A possible criticism to this definition is the following: "*I may be asked to repair an engine, 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 engine and I are."*

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

According to the *Dynamic Theory of Intentions* presented by Pacherie (2006, 2008) and to the *Activity Theory* introduced by Leont'ev and disseminated by Kaptelinin & Nardi (Kaptelinin and Nardi 2006; Leontjev 1978), repairing an engine is driven by an above objective (e.g., obtaining the money for paying a new house) and is the result of lower-level operations (e.g., removing the spark plugs, cleaning them, etc.,) each driven by specific purposes. So, for an intention that failed (repairing the engine) many others were successful (removing the spark plugs, cleaning them) inducing Presence.

More in detail, Pacherie identifies three different "levels" or "forms" of intentions (see Fig. 1), 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 "repairing the car" described in Fig. 1, "gaining money" 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. More in detail, they have to ensure that the imagined actions become current through situational control of their unfolding: in the action "opening the car hood" described in Fig. 1, "checking spark plugs" 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 operation "removing spark plugs" described in Fig. 1, the motor representations required to move the hand are *M*-intentions.

In sum, any intentional level has its own role: *the rational (D-intentions), situational (P-Intention) and motor (M-Intention) guidance and control of action.* More, as suggested by the Activity Theory, they form an intentional cascade (Pacherie 2006, 2008): *higher intentions generate lower intentions.*

3.2 The layers of presence

Recent research by Haggard and Clark (Haggard and Clark 2003; Haggard et al. 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).

In my view, this role is played by presence. More, although presence is a unitary feeling, on the process side it can be divided into three different layers/subprocesses (Riva et al. 2004), phylogenetically different, that correspond reasonably well (see Fig. 2) to the three levels of intentions identified by Pacherie in her *Dynamic Theory of Intentions* (Pacherie 2006):

- Extended Presence (D-Intentions/Activities): The role of "Extended Presence" is to verify the relevance to the Self of possible/future events in the external world (Self

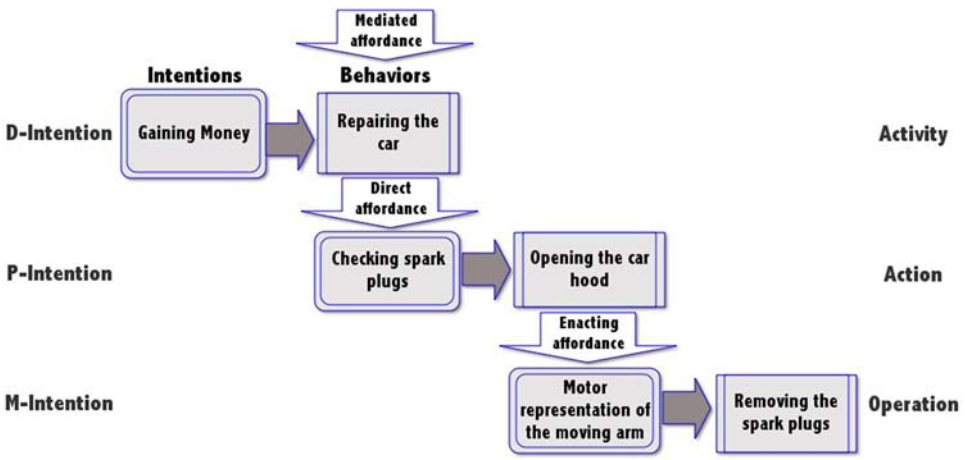

Fig. 1 The intentional chain

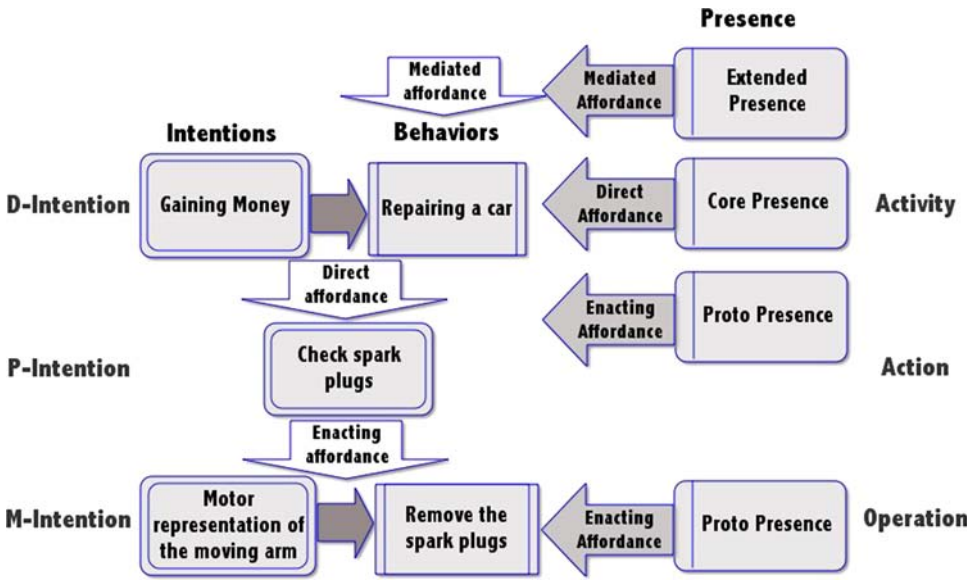

Fig. 2 Activity and Presence

vs. possible/future external world). The more the Self is able to identify and exploit mediated affordances (that cannot be enacted directly) in the external world, the more is the level of extended presence.

- Core Presence (P-Intentions/Actions): It can be described as the activity of selective attention made by the Self on perceptions (Self vs. present external world). The more the Self is able to identify and exploit direct affordances (that can be enacted directly with a movement of the body) in the external world, the more is the level of core presence.
- Proto Presence (M-Intentions/Operations): It is the process of internal/external separation related to the level of perception-action coupling (Self vs. non-Self). The more the Self is able to use the body for enacting direct affordances in the external world, the more is the level of proto presence.

Given its link with action and intentions, Presence is not separated by the experience of the subject but *it is directly related to it*. It corresponds to what Heidegger (1959) defined "the interrupted moment of our habitual standard, comfortable *being-in-the-world*". In fact, a higher-level of Presence is experienced by the Self as a better quality of action and experience (Zahoric and Jenison 1998). More, the agent perceives directly only *the variations* in the level of Presence: *breakdowns* and *optimal experiences* (Riva 2006).

From a computational viewpoint, the experience of Presence is achieved through a forward-inverse model (Fig. 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.

This model, that is supported by the Bayes' theorem, suggests that our experiences are dependent on one's knowledge of it (expressed in terms of its predictability): each experience is affected by the intention related to it. Furthermore, the extent to which one updates his/her intention is affected by how that experience adds to it (Fletcher and Frith 2009). In sum, *Presence provides to the agent a feedback about the status of its activity*: the agent perceives the variations in Presence and tunes its activity accordingly. Specifically, the agent tries to overcome any breakdown in its activity and searches for engaging and rewarding activities (optimal experiences).

From a practical viewpoint, these reflections suggest that:

(a) *Subjects with different intentions will not experience the same level of Presence, even when immersed in the same virtual environment*: this means that understanding and supporting the intentions of the user will improve his/her Presence in the virtual world.
(b) *The more the task is complex, the more are the intentional levels that have to be supported by the virtual environment to induce a high-level of presence*: it is easier to induce presence during simple tasks (operations) as removing the spark plugs than in

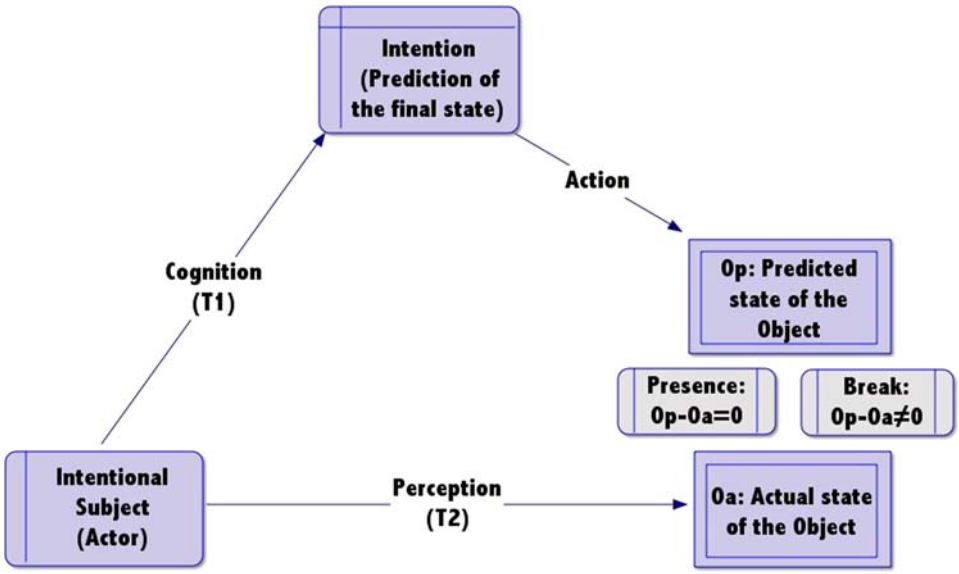

Fig. 3 Presence and break in presence

complex tasks (activities) as repairing the car (see Fig. 2).

(c) *Maximal Presence is achieved when the environment is able to support the full intentional chain of the user*: this can explain (i) the success of the Nintendo Wii over competing consoles (it is the only one to fully support M-intentions); (ii) the need of a long-term goal to induce a high-level of Presence after many experiences of the same virtual environment.

4 Intentions: the link between presence and social presence

The previous section connected action and intentions to Presence. Recent studies suggest that a similar link exists in Social Presence, the ability of recognizing others in an external environment (Biocca et al. 2003). Specifically, is through the recognition of the Other's intentions that he/she becomes present to us.

4.1 Social presence: understanding the intentions of the other

There is a large body of evidence underlying that infants, even in the first months of life, show a special sensitivity to communication and participate in emotional sharing with their caregivers (Legerstee 2005). Trevarthen (Trevarthen 2001; Trevarthen and Aitken 2001) argues that an infant is conscious, from birth, of others' subjectivity: he/she is conscious of other's mental states and reacts in communicative, emotional ways so to link each other's subjectivity. Meltzoff goes further (Meltzoff 1999; Meltzoff and Decety 2003; Meltzoff and Moore 1977; Meltzoff et al. 2002) proposing the existence of a *biological mechanism allowing infants to perceive others "like them" at birth.*

This ability can be defined as *"Social Presence": the non-mediated (prereflexive) perception of an enacting other within an external world.*

It is important to note, however, that this ability evolves in time and it is related to the intentional skills of the subject: a subject can recognize only the intentions that he/she is able to enact. As underlined by Meltzoff and Brook (2001): "Evidently, infants construe human acts in goal-directed ways. But when does it start? We favor the hypothesis that it begins at birth … The hypothesis is not that neonates represent goal directedness in the same way as adults do. In fact, neonates probably begin by coding the goals of pure body acts and only later enrich the notion of goals to encompass object directed acts" (p. 188).

In fact, newborns are able to detect *intentionality* (there is an other)—they recognize that a M-intention is being enacted by another self—but neither to detect higher-level intentions—they do not recognize D-intentions and P-intentions—nor to identify the *motives* of motor behaviors—they do not recognize why the specific M-intention is being enacted. However, this simple ability has a critical role for the newborn: the more he/she is able to identify other selves, the more it is the possibility of starting an interaction, thus increasing his/her probability of surviving.

The next step in the development of Social Presence skills is the identification of communicative intentions in other selves (the intention of the other is toward the self). The more the infant is able to identify a communicative intention in other selves, the more it is the possibility of starting an interaction, thus increasing its probability of

surviving. This skill requires the ability of enacting P-intentions and usually appears after 4–9 months from birth.

The highest level of Social Presence is the identification of intentional congruence and attunement in other selves (the self and the other share the same intention). The more the self is able to identify intentional attunement in other selves, the more it is the possibility of conducting an interaction, thus increasing its probability of surviving. This skill requires the ability of enacting high level D-intentions (motives) and usually appears only at the age of 11.

From a practical viewpoint, these reflections lead to new suggestions for the developers of a virtual world:

(a) *Action and its intentions are more important than perception also for Social Presence*: In this view text, if it is able to convey the intention of the writer, can induce more Social Presence than a static 3D photo of the same writer.
(b) *Social Presence in children is different from Social Presence in adults*: their different ability of enacting intentions also influences their ability of recognizing intentions. So networked virtual environments for children have to be simpler.

4.2 Social presence: the cognitive process

How does a subject learn to recognize and explain the full intentional chain of the other? Following Csibra and Gergely (2006), this processes can be considered a *predictive* one: it emulates the action needed to achieve a hypothesized goal. From the computational viewpoint, it follows the same bayesian approach used by Presence (Fig. 4):

- First, the agent recognizes a motor intention, and identify the actor as another intentional self (other);
- 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 (goal);
- Third, the predicted state is compared with the actual sensory feedback. Errors derived from the difference between the predicted state and the actual state (break) can be used to update the model and improve performance.

Supporting this vision, Oztop et al. (2005) showed that the motor modules of the observer can be used in a "predictive mode" to infer the mental state of the actor. According to their model, mirror neurons (Rizzolatti et al.1998, 2000) can be involved in the sensory forward prediction of goal-directed movements, which are activated *both* for mental simulation during action observation and for feedback-delay compensation during movement.

From an evolutive viewpoint this approach has two strengths. First, it can be seen as the brain's attempt to minimize the free energy induced by a stimulus by encoding its most likely cause (Kilner et al. 2007). More, the recognition of others' intentions using a forward model allows interpretation without prior experience since, as long as an intentional movement or behavior is in the repertoire of the Self, it will be interpretable without any training.

If Social Presence is the result of predicting Other's intentions through an internal simulation, it is not separated by the experience of the subject but it is related to the quality of his/her social interactions. In fact the subject experiences reflexively the feeling of Social Presence

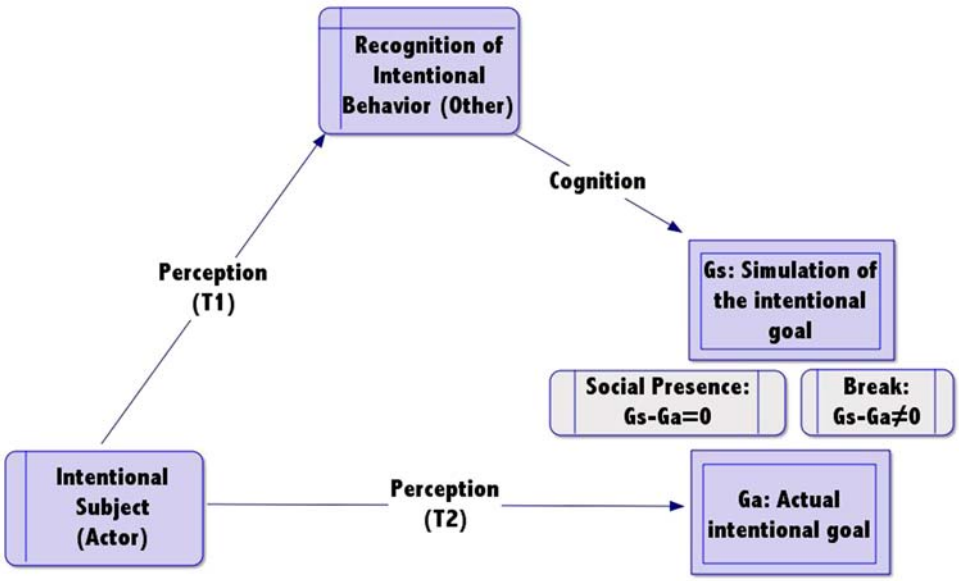

Fig. 4 Social Presence

only when the quality of his experience is modified during a social interaction: according to the level of Social Presence experienced by the subjects, they will experience *intentional opacity* on one side (break in Social Presence), and *communicative attuning and synchrony* (optimal social experiences) on the other side (Anolli et al. 2002).

Possible remarks related to the above definitions are the following: *"If I misinterpret the other's intentions does that mean that he is not socially present? Furthermore, if I believe my interpretation of the other's intentions are correct, does that mean that he is socially present to me irrespective of the veracity of my interpretation?"*

Cognitive studies underline that both points are at least in part true. First, recent research (Iacoboni 2008) suggests that, we have an innate ability of recognizing others. On one side, most subjects are able to identify without any conscious involvement (through the work of mirror neurons) M-intentions and P-intentions. More specifically, the functional properties of these neurons suggest that they may implement a simple, non-inferential mechanism of action recognition based on neural identity. On the other side, an impairment of these neurons limits the social presence experienced by the subject. For instance autistic children, who have a dysfunctional mirror neuron system, also have deficits in social and communicative skills (Oberman et al. 2005; Williams 2008). In other words, others are not socially present to them.

The second remarks, too, is substantially true. For instance, Reeves and Nass (1996) underlied how people respond to mediated or simulated objects (computer, robots, etc.,) as if they were intentional ("The media equation") and attribute to them social presence. In other words, computer and robots are often considered socially present because people attribute to them intentional behaviors.

In conclusion, new suggestions for the developers of a virtual world are:

(a) *We have the highest level of Social Presence when the environment is able to support the full intentional chain of the other*: if the other is not able to express and enact fully his/her intentions through the medium the level of Social Presence will be low.
(b) *The more the communicative task is complex, the more are the intentional levels that have to be supported by the virtual environment to induce a high-level of presence*: it is difficult to induce social presence during complex cooperative tasks.
(c) *The best avatars are those whom can express fully the intentions of the user*: it is not critical to have a human-like avatar. Is more important to have the possibility to express intentions through them. According to communication and cognitive psychology nonverbal cues (facial expressions and body movements) are critical to provide intentional cues.

5 Inner presence versus media presence

How does this vision of presence refer to the classical one (Coelho et al. 2006) that describes the sense of presence as a function of the experience of a given medium (*Media Presence*)?

Lombard and Ditton define the sense of presence as the *perceptual illusion of non-mediation* (Lombard and Ditton 1997), produced by means of the disappearance of the medium from the conscious attention of the subject. We defined the sense of presence as the "non-mediated (prereflexive) perception that an intention is being enacted successfully". Where is the difference?

Apparently the main difference is in what is "non-mediated" by presence. In this article, we clearly indicated *successful intentions* as the non-mediated content. Lombard and Ditton suggest that a person is present when his/her response to the medium is not mediated (Lombard and Ditton 1997):

"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."

Are these positions so different? According to Searle and Pacherie (Pacherie 2006; Searle 1983) the answer maybe no. As we have seen before, any complex behavior (repairing a car) is the result of an intentional chain that cannot be analyzed at a single level. Within this chain, any single action is composed of two parts: an intention, and a movement.

When the action is premeditated, it is caused by a "prior intention": an intention to act formed in advance of the action (P-Intentions and D-Intentions). However, many body movements are caused by an "intention-in-action" (M-Intentions), which drives the movement prereflexively, without the need of a prior intention.

What is the link between them? Any higher-level intention (P-Intentions and D-Intentions) is enacted through chains of M-intentions that are not under the direct control of the subject.

This is the typical case of synchronous mediated communication when the user masters the medium: the fingers of an expert chatter or the hands of a Doom III cooperative player are prereflexively driven by M-intentions. Following Heidegger (1962), when this happens the medium is "ready-to-hand", can be used unconsciously. Only when

there is a breakdown, a problem—the keyboard is no more responsive or the screen disappears—the user needs to plan a new action (P-intention or D-Intention according to the context) to solve the problem.

For Lombard and Ditton the Doom cooperative players are present in the game "if this does not draw attention to itself reminding them that they are having a mediated experience". For the position presented in this article, the players are present in the virtual environment if they are able to drive successfully and prereflexively their interaction. If I substitute in the proposed definition of presence the word "intention" with the one "intention-in-action" there is an almost perfect match with the Lombard and Ditton's position: *the non-mediated (prereflexive) perception of successful intentions in action* (see Fig. 3). The main difference is that this definition works for experiences not related to media, too.

To make this concept clearer some examples may help. A stroke patient with a left hemiplegia is no more "present" in the left part of his body: using his left hand he is not able to translate an intention-in-action in a purposeful behavior.

An anarchic hand patient is no more present in his/her hand because he/she is not able to use the hand to enact his/her intentions.

But it is not only the body to be not "present"—or not "ready-to-hand"—to the self. I'm in a restaurant for a formal dinner with my boss and some colleagues, but I don't know how to directly use the many different strange forks I have around 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 dinner". The result is a reduced presence and a limitation in my agency: I don't use the forks to avoid mistakes. These examples show clearly how both physical boundaries (body, wall, obstacles, etc.,) and social and cultural boundaries have a strong influence on the possibility of action and the experienced presence of the subject.

In this context, *a breakdown* occurs when, during our activity, we are forced to stop our intentional chain. To illustrate, imagine sitting in a balcony 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. At that stage, we are not present anymore in the reading and we have to reflexively plan an action to switch on the light on the balcony.

6 Conclusions

This article tried to show that the concepts of "Presence"—*the non-mediated (prereflexive) perception of successfully transforming intentions in action (enaction) within an external world*—and "Social Presence"—*the non-mediated perception of an enacting Other within an external world*—can offer a conceptual framework for understanding the link between the enaction and the recognition of intentions. Through Presence, the agent *prereflexively* controls his/her action through a forward-inverse model: the prediction of the action is compared with perceptual inputs to verify its enaction. Through Social Presence, the agent *prereflexively* recognizes and evaluates the action of others using the same forward-inverse model: the prediction of the action is compared with perceptual inputs to verify its enaction.

This model makes sense in terms of cognitive psychology and is beginning to be supported by evidence of the neural and other physical correlates of action, imitation, and self-monitoring. From a more practical viewpoint, the model suggests that any environment, virtual or real, does not provide undifferentiated information, ready-made objects equal for everyone. It offers different opportunities and produces Presence according to its ability in supporting the users and their intentions.

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