A Situated Cognition Perspective on Presence

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Abstract

During interaction with computer-based 3-D simulations like virtual reality, users may experience a sense of involvement called *presence*. Presence is commonly defined as the subjective feeling of "being there". We discuss the state of the art in this innovative research area and introduce a situated cognition perspective on presence. We argue that presence depends on the proper integration of aspects relevant to an agent's movement and perception, to her actions, and to her conception of the overall situation in which she finds herself, as well as on how these aspects mesh with the possibilities for action afforded in the interaction with the artifact. We also aim at showing that studies of presence offer a test-bed for different theories of situated cognition.

Keywords: Situated cognition; presence; virtual reality; affordance; action; artifacts

Introduction

The development and the diffusion of computer-based interactive simulations, like 3-D videogames or virtual reality, has been accompanied by an increasing perception of the importance of the sense of presence and involvement that users may experience while interacting with them.

Presence is commonly defined as the subjective feeling of "being there" (Riva, Davide & IJsselsteijn, 2003; Slater, Usoh & Steed, 1995; Witmer & Singer, 1998). Several authors have considered this feeling as mainly deriving from the immersion in a virtual environment (Schubert, Friedmann & Regenbrecht, 1999a; Schubert, Friedmann & Regenbrecht, 1999b; Slater & Wilbur, 1997). In their view, presence results from subjective involvement in this kind of highly interactive virtual environment. Presence would be strong inasmuch as the virtual system enables an inclusive, extensive, surrounding and vivid illusion: the immersive quality of a virtual reality system would be enhanced by the perceptive features and the proprioceptive feedback provided by the system.

Within this perspective, different authors have developed different conceptions of presence. Sheridan (1992) and Zeltzer (1992), for example, have described presence as the sense of being placed somewhere different from the actual physical location. Sheridan, in particular, has defined virtual presence as the subjective feeling or mental state in which a subject has the belief of being "physically present with visual, auditory, or force displays generated by a computer". Heeter (1992) has defined an environmental presence which is yielded by the perception that an environment exists that seems to consider you as present and modifies depending on what you do. Witmer and Singer (1998) also have taken presence to be due to immersion, but have linked it to the tendency to direct attention toward selected information that be meaningful to the individual. Presence would then be similar to selective attention, and the sense of presence would be yielded by the allocation of attentional resources. According to these authors, both involvement and immersion are needed to experience presence. Their approach, while focusing on immersive properties, also emphasizes the role that attention-directing role of activity within complex interactive situations.

The specific role that interaction with technology plays in creating presence has been firstly considered by Lombard and Ditton (1997), who have defined presence as the "perceptual illusion of non-mediation". In particular, according to Lombard (2000), presence should be divided into those aspects which involve the perception of a physical environment (where the sensory features correspond to those of the physical world), those which involve the perception of social interaction (where the social features correspond to those of the physical world), and those which involve both.

In this perspective, presence is taken to occur when a person misperceives an experience mediated by technology as if it were a direct (that is, non-mediated) one. Presence, then, would not be intrinsic to technology, but would vary depending on how much the user acknowledges the role of technology. It could therefore be yielded by different kind of technologies.

The importance of activity in the support and the enhancement of presence in virtual reality has been investigated by Flach and Holden (1998), who have emphasized the necessity that interaction with objects be

introduced in virtual environments. On a similar vein, Zahorik and Jenison (1998) have focused on the role of plausibility in perception/action behaviors; the latter are dealt with in terms of affordances.

Thus, while studies in the area began within a purely technological, artifact-centered perspective, the need for a more psychological, human-centered framework has been felt with increasing strength.

In an attempt to combine immersion-based theories with activity-based ones, Sheridan (1999) has built his Estimation Theory on the assumption that we can never have true knowledge of objective reality; instead, we are continuously making and refining a mental model which estimates reality. This process is made possible by our sensing reality and interacting with it. Immersion in virtual reality is a source of stimuli, starting from which users would create a mental model of the virtual environment and of how they relate to it. It would be the structure of this mental model that determines whether or not users experience a sense of presence. Thus, even when the users are uncertain about the reality of their perceptions in the virtual environment, such perceptions would anyway be close relatives of those they have in the "real" physical world.

Mantovani and Riva (1999) have been the first to emphasize the importance of the freedom that users may have in their interaction with the virtual environment, as well as the need that the social and cultural dimensions of action in both the physical and the simulated world be thoroughly considered. According to them, every action — and especially those performed in a simulated world — takes place within a framework of meanings that are grounded in the user's cultural background. It is based on the information found in this cultural framework that each specific user develops her sense of presence in interaction. Culture shapes the individual minds and organizes their ways of knowing and acting in their social and physical environment (Mantovani & Riva, 2001). When the information provided by the environment is ambiguous to the individual, as may happen with virtual reality, the ambiguity can be resolved or reduced with the aid of culturally based information that helps the user to reinterpret and understand the overall interaction.

Riva, Waterworth and Waterworth (2004) have pointed out that a culture-based view of interaction supports a perspective on presence as " the referencing of our perception to an external space beyond the limits of the sensory organs themselves". According to this perspective, it is the capacity of distal attribution — that is, the capacity that humans have of distinguishing between their own body and the external world — that allows for the sense of presence in simulated as well as in non simulated worlds. Even if the experience of presence is a unitary feeling, it can be conceptually divided in three different layers, phylogenetically different and closely related to the three levels of self discussed by Damasio (1999). Riva, Waterworth and Waterworth (2004) thus distinguish

between proto presence (that is, the distinction between self and not-self), core presence (that is, the distinction between the self and the present external world), and extended presence (that is, the distinction of self with respect to the present external world). These authors stress that the sense of presence is a direct function of these three layers (the more they are integrated, the more we feel present) and that, in the experience of optimal presence, biologically and culturally determined cognitive processes work in harmony to focus all the levels of the self on a significant situation in the external world, be it real or virtual.

Finally, Biocca (2001) has claimed that the issue of presence may be most fruitfully approached via philosophy of mind. Specifically, he has suggested that the issue of presence opens the door to related problems in the science of human consciousness, notably the mind-body problem. The problem of presence bridges the philosophy of mind and the philosophy of technology on the issue of mediated embodiment, that is, on the fuzzy boundaries between the body and its technological extensions.

We agree that a proper treatment of the issue of presence in virtual reality should begin with the acknowledgment that presence is a major feature of human consciousness, and the hub of any interaction with natural as well as artificial environments.

The environments in which human beings live are endowed with a huge component of artificiality: virtual reality, as it has been developed in the last two decades, is a recent and particularly sophisticated expression of our basic biological disposition to create artifacts as supports for intrapersonal and interpersonal activities.

Human beings interact with and through artifacts — and, in more general terms, with their world or worlds — in ways that depend on the representations that they entertain about them. We take representations to be conscious mental states (Searle 1992). Representations are essentially about spaces of possible actions (*affordances*) and are thus colored with different degrees of desirability and emotion (Tirassa, in press; Tirassa, Carassa & Geminiani 2000). They originate in the interaction between an individual, who is endowed with her personal history as well as with the biological history of our species, and a perceived, desired, remembered or imagined environment.

Our basic tenet is that the mind should not be conceived of as an ideal, abstractly defined cognitive system (possibly a computational or information-processing one) which is "implemented" in a separate and interchangeable material structure that physically realizes its activities. We think instead that the mind is a biological property of the body, with which it is in a relation of coevolution and codetermination.

Affordances as Representations

The human mind/body has evolved for generating an adaptive interaction with the world, and in particular for planning actions which be able to modify the environment in order to fulfill individual aims and desires. It is thus

reasonable to accept the suggestion, originally advanced from within ecological psychology (Gibson, 1979), that an individual perceives the world not in terms of objective, abstract features, but directly in terms of spaces of possible actions, that is, of *affordances*. An affordance is not defined univocally based on the agent's features or of the world's features alone. It is instead a relational notion: possibilities for action depend on the encounter of the characteristics of the two poles of the interaction, and are shaped by the overarching activity in which the agent is involved (Carassa, Morganti & Tirassa 2004).

In our reading of Gibson's work, what the world puts in the agent/environment interaction is the resources and the constraints to which the animal's control systems must conform, such as the invariants of the optical flow (which is also part of the reason why Gibson talks of "direct perception"). What the animal puts in the interaction is its own nature, which makes a certain configuration of surfaces, a certain texture of the layout, and so on, take the mental shape of a certain affordance.

If the animal's nature includes a mind like ours, the traditional concept of affordance has to be reconsidered in the light of what we actually know about human cognition. The dimension of interaction which have been more thoroughly discussed in recent research is perceptual-motor coordination. In investigating how affordances develop cognitively and behaviorally, particularly in the first years of life, the focus is thus on activities like crawling or reaching for and grasping objects; and the problems typically addressed concern the locomotory control, based on information contained in the optical flux, or the adaptive control of action through the integration of proprio- and estero-ceptive information.

Research has been less concerned with the cognitive dimensions of interaction. However, these dimensions are identified as the crucial ones for treating the issue of presence in the literature on virtual reality. It has been claimed, for example, that "it is necessary to add layers of meaning to perceptual objects" (Biocca, 2001), and that it is necessary to study "the interplay of bodily and cognitive processes" (Schubert, Friedman & Regenbrecht, 1999b) and the mental models that people entertain when interacting with virtual environments (Biocca, 1997; IJsselstein, 2002; Riva, Waterworth & Waterworth, 2004).

In this vein, we will discuss the cognitive nature of affordances as representations situated in an unfolding interaction. We will use as an example the case of an agent engaged in cooking, an activity that necessarily requires the use of artifacts.

Cooking is pervasive in everyday life; it is grounded in a history-long cultural tradition and embued with values and social meanings. In our culture, the art of cooking is particularly appreciated and can be performed with a rich repertoire of practices and specialized tools. Each tool has been designed for a specific function, tailored to a class of activities like chopping, cutting, smashing and so on. While, at first glance, the use of such artifacts may be viewed as primarily based on perceptual-motor integration, a deeper analysis reveals that a much wider array of cognitive capacities is involved.

Think of a person who is going to prepare a cake, and imagine that he choose to use a whisk to prepare part of the dough.

The whisk, a small object made of curved pieces of wire with a handle, affords a variety of movements that depend on how our physical (manual in this case) capacities mesh with features of the object like its shape, dimensions, structure, and rigidity. The point is that the very object immediately affords one particular movement to someone who possess a specific expertise. This peculiar affordance does not depend on perceptual-motor abilities alone: it requires the capacity to recognize what the specific function of the artifact is within the practices aimed at preparing certain specific recipes. An experts is "invited" by the whisk to perform a quite technical movement: to handle it in an oblique position so to be able to execute a quick light sweeping movement.

The management of such movement depends on the creation, the maintenance, and the moment-by-moment reactivation of sensorimotor schemes that "tell" the agent how to appropriately program his movements in the specific situation in which he finds himself, what sorts of feedback to expect from the world, and so on. That way, his mind/body will "know" what muscular power to exert in order to achieve that particular movement; and, if he exercises such power correctly, his mind/body will "take it for granted" that the world will respond in agreement with certain invariant rules of the physical world. Actually, it is also on the grounds of such feedback that he will be able to know how he is executing his movement, which point in a particular sequence of movements he has reached, and so on.

The whisk, like any artifact, is an embodied project whose functions only exist in the minds of the designer and of the user (Tomasello, 1999; Mantovani, 1996; Norman, 1988).

Let us consider again how a potential user may be able to grasp what function the whisk incorporates. He will be able to infer the designer's intentions in the light of a rich background of knowledge. For example, if he knows that certain types of cakes contain a soft and creamy component, he will be able to imagine the possible make-up of a specific tool designed to obtain this effect, as well as to recognize an object which has been designed for that purpose.

Circularly, the whisk designer will ground her work on the knowledge that she thinks she can safely attribute to a (anonymous, but decently expert) user, and will probably try to make the affordances that the tool incorporates as evident as possible.

Thus, an affordance does not result from a perceptual act alone, nor from a simulation of perceptual-motor abilities alone. It is instead a representation in which different aspects are meshed: cultural aspects (culinary culture), representation of function (a tool-to-whip-a-cream), and somatic/functional aspects (the human hand's articular

mobility and grasp). Moreover, for an individual engaged in an unfolding interaction, the landscape of affordances is shaped by his motives, interests, values and long-term goals and desires. All these elements give meaning to what is perceived and done moment by moment.

Meaning does not arise only from the sensibility to appreciate what is currently happening and from the ability to react in a fluid and savvy way: it depends on our conceptualizations of ourselves as immersed in a global situation, which is in turn embedded in our personal history. In this sense, our feeling of presence is not determined by the physical place to which we are immediately tied by perception, be it natural, artificial, or virtual; instead, it is grounded in a meaningful situation that stretches in the past and faces future. The meaning of the situation, which is conceptual in its nature (Clancey, 1997), creates a bundle of affordances that become relevant within a specific interaction.

In an individual's subjective perspective, each action that he performs plays a role within a narrative that he tells himself concerning what is happening, what he is doing there and why, with what future perspectives, and so on. More precisely, each action that he performs plays a role within a complex weave of such narratives, that end up giving a meaning to his being there, in that place, in that very moment, choosing to perform a certain action, as well as to the specific body movement which ultimately shapes the material counterpart of his mental state. Each such narrative may be viewed as a choreography (Clancey, 1997) in which the agent features as the protagonist; each has an intrinsically autobiographical and social nature, and the overall weave thus results from the whole previous history of that individual (which includes, of course, his current and past hopes and plans for the possible futures).

Situated Presence

Our view is different from the mainstream view of "embodied cognition" that has led Schubert, Friedmann and Regenbrecht (1999b) to talk of "embodied presence" in the following terms: "Presence develops from the representation of navigation (movement) of the own body (or body parts) as a possible action in the virtual world. Presence is the outcome of media perception. In the process of developing presence a mental model of the virtual three-dimensional space is constructed, consisting of the possible actions in this space. The possible actions of the body are central in this model. Stimuli from the real environment must be suppressed for presence to emerge. The more the mediated stimuli follow embodied constraints (e.g., coupling with body movement), the easier is the construction. Because the environment is perceived in terms of embodied action (affordances in our terms), a feeling equivalent to the feel of memory mentioned above develops. This is what we call the sense of presence."

In our view, instead, presence depends on the proper integration of aspects relevant to an agent's movement and perception, to her actions, and to her conception of the overall situation in which she finds herself, as well as on how these aspects mesh with the possibilities for action afforded in the interaction with the virtual environment.

We have distinguished three levels in the interaction of an agent with her world, be it real or virtual: that of the situation, that of the action, and that of body movement and perception (Carassa, Morganti & Tirassa 2004). These levels are not reducible to one another; instead, each of them "contains" and gives meaning to the subsequent one, which in turn realizes it, in a circular relationship of codetermination.

Normally, an agent will not think of her movement in terms of a motor sequence (unless, of course, she has any reason to do so, like when learning a physical exercise, in which case the motor sequence may be the very action or situation). Instead, she will choose and perform actions whose goals are part of a broader situation, which she represents as the activity, or the weave of activities, in which she is participating at each moment.

These activities are, in their turn, supported by goals, values, knowledge, and roles that give them meaning, boundaries, histories, and possible directions of development.

Therefore, an individual will represent herself not as a monad with no history who "behaves" in an objectively given world, but as an agent who carries on a narrative about herself in the world. What is of interest to her is to follow complex flows of meaning relevant to the different choreographies in which she finds herself. Her representations and actions create her participation in such choreographies from moment to moment.

How does this conception of mind and agency, a constructivist and interaction-based one (Tirassa, in press) affect our conception of experience and presence in virtual reality?

When the interaction is such that a good feeling of presence is generated and maintained, several other things will become possible. Firstly, the mind may compensate with its own capacities, at least to a certain extent, for the "low fidelity" of the simulated world. As we have said above, what makes the difference is not the technological perfection of the virtual environment, but the type of interaction that it affords.

Secondly, just as action support presence, so does presence support action. The feeling of presence is satisfactory when the user manages to make an overall sense of her interaction with the environment. When this happens, she will also be able to make such interaction useful and interesting for her future narratives: in simple terms, she will be able to learn something.

Thus, in experiencing a virtual reality environment, the user will bring with herself everything that she has been up to that moment. By the same token, her experience with the media will add to her "cognitive history". This may mean that she will have acquired knowledge (e.g., concerning the Qumran scrolls, or how to fly an airplane), or that she will have spent a few hours shooting nasty green aliens that want

to invade the Earth, or, in the worst case, that she will have suffered from cybersickness — even this is an experience, however unpleasing, that will affect her possible futures.

What the designer does is to create an envelope within which the interaction with the virtual environment may belong to a weave of narrative meanings. The goal of such enterprise is not intrinsic to the virtual environment, but is born out of the structural coupling between the user and the environment — or, as happens, between the user, the environment, and a supervisor or a tutor who guides the interaction.

The kernel of our position is that the environment, even a virtual one, has a subjective, rather than objective, nature. The classic dichotomy between an external world, which is objectively given, and an internal world, which mirrors it faithfully (any discrepancy being a misrepresentation), does not capture the interactional nature of human agency. The meaning of the entities in the world lies in the affordances that they grant to the agent, and such affordances are not an intrinsic property of the entities alone, but a property of the interaction between the agent and the entities themselves (Tirassa, Carassa & Geminiani, 2000). Of course, in the case of the human species, many affordances are not relevant to physical movements only, but to mental activities like reasoning or daydreaming, or to social activities like communicating.

The availability of the affordances depend on the activities in which the agent is participating at each moment. Such activities result from the agent's previous history, which goes to constitute both her memory and the processes of recognition and reconceptualization that make such history immediately useful in the current interaction (Edelman, 1992; Glenberg 1997).

Thus, what happens on entering a virtual environment is not that we leave behind and forget about a real world whose role is then, at most, that of an external disturbance which decreases or hampers presence in the virtual environment. Instead, we bring our experience inside the virtual world, and, in turn, we integrate the virtual world in our experience, which will go to sediment in our overall future history and projects.

The possibility of first-person action in the world, that is, the possibility of contributing to the generation and maintenance of world dynamics, and of receiving in turn the possibility (and the need) to generate and maintain our cognitive dynamics, is another crucial factor of presence, that is, of our capability to feel that we are participating in the world in which we find ourselves.

On the basis of these considerations, Varela (1990) has claimed that virtual reality environments, cognitive systems, and the world co-define themselves. According to Varela, the sensory and motor levels provide the ground on which reality is constructed, in that they provide the ontological foundations of knowledge.

We claim that these basic levels have to integrated with cognitive dimensions that we consider as much important to characterize human agency.

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