

# The design of clinical-oriented virtual environments: a communicational approach

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**Abstract.** Understanding how to use immersive virtual reality (VR) to support clinical practice presents a substantial challenge for the designers and users of this emerging technology. Taking this challenge this paper describes VR as a new medium: a communication medium in the case of multi-user VR and a communication interface in single-user VR.

Two are the core characteristics of VR as communication tool: the perceptual illusion of nonmediation and the sense of community. The first characteristic of a satisfying virtual environment is the *disappearance of mediation*, a level of experience where both the VR system and the physical environment disappear from the user's phenomenal awareness. The second characteristic is the *sense of community* developed by interaction. Through interaction made possible by multi-user VR, individuals find or form groups that share interests. So, information exchange becomes the carrier for expressing self-concept and eliciting emotional support.

Within this view, experiencing presence and telepresence do not depend so much on the faithfulness of the reproduction of 'physical' aspects of 'external reality' - which is also a social production, and not a primitive or 'natural' fact - as on the capacity of simulation to produce a context in which social actors may communicate and cooperate.

The consequences of this approach for the design and the development of clinical oriented VR systems are presented, with the methodological and technical implications for the study of advanced human-computer interaction.

# The design of clinical-oriented virtual environments: a communicational approach

## 1. Introduction

Understanding how to use immersive virtual reality (VR) to support clinical practice presents a substantial challenge for the designers and users of this emerging technology. As recently noted by Banos et al. (1) VR has two opposite faces. On one side it can be used by clinicians as a “setting lab where to study anomalous behaviors, emotions and beliefs” (p.284). On the other side, “VR can be also seen as a creator of psychopathology” (p. 288) for its potential of inducing reality judgement and identity problems. Moreover, it is well known that this tool can provoke important side effects such as cybersickness and aftereffects (2), forcing the clinician to a clear planning of his approach to lessen the probability of inducing harmful consequences for the patients.

These opposite faces are resulting from the peculiar characteristics of VR. This tool is not simply a particular collection of technological hardware, but can be considered as a new *medium* defined in terms of its effect on both basic and major psychological processes (3-5). According to Bricken (6) the essence of VR is the inclusive relationship between the participant and the virtual environment, where direct experience of the immersive environment constitutes communication. In this sense, VR can be considered as the leading edge of a general evolution of present communication interfaces like television, computer and telephone (7). Main characteristic of this evolution is the full immersion of the human sensorimotor channels into a vivid and global communication experience (8).

Following this approach, it is also possible to define VR in terms of human experience (9): "a real or simulated environment in which a perceiver experiences telepresence," where telepresence can be described as the "experience of presence in an environment by means of a communication medium" (pp.78-80).

In this definition we can identify three keywords - perceiver, presence and communication - all strictly linked to a key aspect of VR experience. In the next paragraphs we will try to explore these keywords trying to outline a theoretical framework for supporting the development of clinical oriented VR systems.

## 2. The design of a single-user clinical VR system

Biocca & Delaney (8) defined a communication interface as "the interaction of the physical media, codes and information with the sensorimotor channels of the user. The question of the design and representation of this interaction is a basic question in user-interface design, and has attracted much attention since the end of the 1960s.

As noted by Smith (10), one of the essential aspects of the efforts to design adequate user interface has been the introduction of powerful metaphors: "Images are metaphors for concepts. They provide an alternate reality, which is simultaneously concrete in structure and analogic in representation... The visual medium is an extremely useful metaphorical tool not only because it has powerful representational capabilities but also because it has a rich set of topological transformations within its own domain." (pp. 23-24). This is especially true for VR, a medium that has the potential to involve users in sensory worlds that are indistinguishable or nearly indistinguishable from the real world.

However, as noted by Bardini (11), one of the most compelling snares is the use of the term metaphor to describe a correspondence between what the users see on the screen and how they should think about what they are manipulating. According to Kay (12) the correspondence between what the user sees on the screen and what he/she thinks he/she manipulates (between what the user visualizes and his/her internal model of action) is better seen as an *illusion* than as a metaphor. Designing this illusion is designing the user-interface.

In this conception, the user's quest for the truth of the interaction is directed by the designer of the interface. When a user is trying to touch a spider (task) in the virtual environment using a dataglove, he/she manipulates an iconic representation of both the hand and the spider that are designed to stand for the real objects in his internal model of what he/she is doing. For most users, moving the hand in the virtual environment to touch the spider is a quite straightforward action, analogous to moving the "real" hand on his/her "real" environment. Or so says the metaphorical conception of what is happening: it belongs to the user to realize this analogy. But if, like Kay, you consider this analogy as an illusion, the role of the designer is to make the user believe that what he/she does when he/she moves the hand is an analog to moving the real hand (11).

In order for a virtual environment to work, especially for clinical virtual environments, both clinicians and patients need some idea about what the virtual reality system expects and can handle, and the virtual environment has to incorporate some information about what the person's goals and behaviors are likely to be (11). These two aspects, the user's "mental

model" of the virtual reality system and the virtual environment's "understanding" of the users, are just as much a part of the interface as its physical and sensory manifestations (13-14).

As noted by Vincelli (15-16) VR produces a change with respect to the traditional relationship between client and therapist. The new configuration of this relationship is based on the awareness of being more skilled in the difficult operations of recovery of past experiences, through the memory, and of foreseeing of future experiences, through the imagination. At the same time, the subject undergoing treatment perceives the advantage of being able to re-create and use a real experiential world within the walls of the clinical office of his own therapist. However, this is possible only if the virtual environment can support the relationship between the clinician and the patient. Following the suggestions and feedback of the therapist, the patient is not simply an external observer of pictures or one who passively experiences the reality created by the computer, but on the contrary may actively change the three-dimensional world in which he is acting, in a condition of complete sensorial immersion.

This approach shifts the focus of our attention in creating successfully clinical virtual environments. Faithfulness in reproducing the physical characteristics of the "real" environment is not necessarily the only thing to be borne in mind in simulation: the possibility of interaction which virtual environments allow is also important. More than the richness of available images (17-18), the sensation of presence depends on the level of interaction/interactivity which actors have in both "real" and simulated environments (19-20). Human action needs a certain amount of freedom of movement to adapt itself smoothly to the needs of a changing environment, which is why a good clinical VR system must grant a certain amount of freedom of movement to the patient who move in it. As noted by Ellis (21) the key questions for a VR designer are: "Can the users accomplish the tasks they accept? Can they acquire the necessary information? Do they have the necessary control authority? Can they correctly sequence their subtasks?" (p.258). In fact, the successful implementation of virtual environment simulations will directly depend on the answers to these types of questions.

In this sense, emphasis shifts from quality of image to freedom of movement, from the graphic perfection of the system to the actions of actors in the environment: "Experience of space will depend more on the mode of locomotion than on the visual and acoustic images. The reality of a surface will be in its implications for action (e.g., does it impede locomotion) instead of in its appearance (e.g., does it look like a wall). In this approach, the reality of experience is defined relative to functionality, rather than to appearances" (22).

### 3. The design of a multi-user clinical VR system

Several researchers have defined VR a communication technology or a medium. For instance, Ellis (23) described virtual environments as "communication media", while Biocca & Levy (24) noted that VR "is likely to emerge as the next dominant medium - if not the ultimate medium" (p.9).

It would be misleading, however, to think of single-user VR systems in this way. As noted by Schroeder (25): "The notion of a communication technology normally implies that two or more people are involved and that the emphasis is placed on the messages that pass between them... it follows that the terms 'communication' and 'medium' should only be used in the context of multi-user VR" (p. 143).

Nevertheless, when VR is a communications medium in a multi-user configuration, it can be studied, as Palmer (26) points out, "as a medium of interpersonal communication in the same way all media have been evaluated" (p. 291). Particularly, multi-user VR can be considered as a particular form of computer-mediated-communication (CMC).

Stasser (27) defined interpersonal communication as *a process by which a group of social actors in a given situation negotiate the meaning of the various situations, which arise between them*. This definition has two important implications, which have a strong influence on multi-user VR, too. If interpersonal communication is a process of negotiation:

- the only way to understand it is by analyzing the subjects involved in it in the environment in which they operate, meaning that the social context in which the VR experience occurs plays a crucial role;
- new processes and activities will develop during interactions, which challenge and modify the initial relationship between subject and context.

These points are particularly true for VR, given its status of medium. As noted by Banos et al. (1) VR can affect cognitive development for "its capability of reducing the distinction between the computer's reality and the conventional reality." Moreover "VR can be used for experiencing different identities and... even other forms of self, as well" (p. 289). As Mantovani (28) notes, "Virtual reality is a communication environment in which the interlocutor is increasingly convincing in terms of physical appearance, yet increasingly less tangible and plausible in terms of personal identity. This paradox results from juxtaposing a convincing simulation of the physical presence of the other, and the disappearance of the interlocutor's face behind a mask of false identities" (p.197). It is surely no accident that members of electronic communities very often adopt false 'nickname' identities, and openly

accept them in others. Within the same community, a person (29) may "construct and project mask-like identities which function as delegated puppets-agents" (p. 105). Gender switches are also commonly made, often for rather specific reasons - to get to know people of the opposite sex to meeting them; to explore the emotions of people of the opposite sex - although the fun of simply 'dressing up' and pretending to be someone else is also a factor.

But, how can we define some guidelines for the development of multi-user clinical virtual environments? In the pages that follow we shall explore the Situated Action Theory and the Positioning Theory, two new socio-cognitive approaches which seem us to explain some of the issues just raised (30).

*Situated Action Theory* - SAT - developed within the field of socio-cognitive research known as "cognition in practice". Though based on traditional cognitivist analyses of information processing and symbolization, SAT introduces a change of perspective in that it sees action not as the execution of a ready-conceived plan, but as adaptation to context (31). As Suchman notes, "instead of separating action from the circumstances in which it occurs as the execution of a carefully thought out plan ... SAT tries to study how people use circumstances to develop an intelligent course of action" (p.167).

Thus, SAT implies a basic redefinition of the meaning of communication. Context may be co-constructed by social actors, but they use communication to exchange meanings, not pieces of information. More precisely, the content of communication is interpretations of the situations which actors are involved in. In this sense, the most effective way of explaining the meaning of messages is to connect them to a shared context of meaning. However, this is more difficult in VR than in other computer-based activities. As noted by Oravec (32), VR forces individuals "to deal with such issues of image manipulation and distortion on an immediate and personal basis, as participant immersed in fast-moving interaction" (p. 51). This adds layers of complexity to an already-overwhelming set of social constructs.

To overcome this problem, VR designers usually use some tricks. For instance, more of the effort of the design of multi-user VR is focused toward developing tools for the creation of faces. This choice reflects the considerable societal attention on the face as medium for expression and information display. Particularly, facial expressions exceed verbal reports to enhance context comprehension. Generally, development of multi-user VR systems calls for conceptual mechanisms with which groups can be constructed and vehicles through which groups can express themselves (32).

But, how VR users connect themselves to the virtual groups created by multi-user VR systems? Largely VR users view themselves in the VR experience in terms of how they

manage the other users which they are associated, particularly by relating to such cultural objects such as "consistency", "integration" or "balance". Studies of Positioning Theory (PT) have served to reinforce this view. As recently formulated by Rom Harré (33-34), PT replaces the traditional idea of role with the concept of positioning. The main difference between the two is that a role is a stable and clearly defined category, while positioning is a dynamic process generated by communication. As Davies and Harré (35) point out, subjects' selves during interaction "participate in an observable and subjectively coherent way in the joint production of story lines" (p. 48). In this phase subjects see themselves as "contradictors" (35) and use the positioning process to build "a variety of selves" (p. 47) closely linked to the result of interaction.

In psychology, these ideas have carried over into the work of Gergen (36) and Bruner (37), too. Gergen specifically has looked in detail at the construction of self, in studies of how an individual's self-esteem and idea of self vary in a set of different situations. These studies show that the concept of self varies both in relation to the type of people the subject frequents, and in response to the positive and negative comments they make. Altogether, then, the self may be seen as a product of the situation in which the subject acts. For his part, Bruner, though accepting the subject's autonomy, speaks of "creatures of history" whose selves are both "a guarantee of stability and a barometer reflecting changes in the cultural climate" (p. 108).

Many developers of multi-user VR systems are aware of this and are conscious of the need to "create community" in the context of their efforts (32). Even if many traditional means for creating community are not available, a great effort is given to the creation of virtual town squares or meeting rooms. According to Coate (38) the work of maintaining virtual communities is similar to the one of an innkeeper: facilitating interaction and keeping order among patrons. In fact, if multi-user VR has to serve as community for its users, it has to embody, or replace with adequate substitutes, some functions of community life that parallel those commonly provided by "traditional" communities. This is even truer for the development of clinical oriented multi-user VR systems, where the sense of community could be an important boost of therapy.

According to Cultler (39), in the socially constructed space of Cyberspace, where interaction produces culture, information is the only real medium of exchange an individual has with which to build a presence. Information exchange becomes the carrier for expressing self-concept and eliciting emotional support. Affiliations, which form around general and special

interests, are limited only by the ability of individuals to process all the interactions that flow through the network to the desktop.

#### 4. Conclusions

In conclusion, we can describe VR as a communication tool: a communication interface in the case of single-user VR and a communication medium in multi-user VR. In this sense, VR can be considered as the leading edge of a general evolution of present communication interfaces, whose main characteristic is the full immersion of the human sensorimotor channels into a vivid and global communication experience (8-40). Two are the core characteristics of this experience: the perceptual illusion of nonmediation and the sense of community. The first characteristic of a satisfying virtual environment is the *disappearance of mediation*, a level of experience where both the VR system and the physical environment disappear from the user's phenomenal awareness. When this happens, the user is not simply an external observer of pictures or one who passively experiences the reality created by the computer, but on the contrary may actively change the three-dimensional world in which he is acting, in a condition of complete sensorial immersion. In this way the subject undergoing treatment perceives the advantage of being able to re-create and use a real experiential world within the walls of the clinical office of his own therapist.

The second characteristic is the *sense of community* developed by interaction. Through interaction made possible by multi-user VR, individuals find or form groups that share interests. So, information exchange becomes the carrier for expressing self-concept and eliciting emotional support.

At the end we can propose a new definition of *presence* (20) that (a) recognizes the mediated character of every possible experience of presence; (b) always conceives experience as immersed in a social context; (c) stresses the component of ambiguity inherent in everyday situations; (d) highlights the function of confirmation which culture (artifacts and principles) plays. Breaking down this idea into formulas, we may say that (20):

- presence is always mediated by both physical and conceptual tools which belong to a given culture: “physical” presence in an environment is no more “real” or more true than telepresence or immersion in a simulated virtual environment;

- the criterion of the validity of presence does not consist of simply reproducing the conditions of physical presence but in constructing environments in which actors may function in an ecologically valid way: we accept the emphasis of ecological approach on the primacy of action on mere perception;
- action is not undertaken by isolated individuals but by members of a community who face ambiguous situations in a relatively coordinated way: to be able to speak of an actor's presence in a given situation, his freedom of movement must be guaranteed, both in the physical environment (locomotion) and in the social environment, composed of other actors involved in the same situation, in whatever way and for whatever reason.

The main consequence of this approach for the design and the development of clinical oriented VR systems is that a patient's presence in an environment exists if and only if that patient can use the VR for cooperating with the therapist and/or other patients, and even for entering into conflict with them. In fact, than the richness of available images (17-18), the sensation of presence depends on the level of interaction/interactivity which actors have in both "real" and simulated environments (19). In this sense, emphasis shifts from quality of image to freedom of movement, from the graphic perfection of the system to the actions of actors in the environment.

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