

11 **Sense of Presence in Virtual Training: Enhancing Skills Acquisition and Transfer of Knowledge through Learning Experience in Virtual Environments**

Fabrizia MANTOVANI, Gianluca CASTELNUOVO

Abstract. Recent advances in educational and training technology are offering an increasing number of innovative and promising learning environments including three-dimensional and two-dimensional virtual worlds as well as computer simulations. These environments differ a lot as to both their technological sophistication and to the types of skills taught, varying for example from immersive 3D environments of high-fidelity to simulations of complex relational situations, for the learning of “soft skills” of growing strategic interest to enterprises such as leadership, customer service, coaching, selling etc. The learning potential of virtual training relies on the possibility for learners to make a number of significant first-person experiences and to fail in a safe and protected environment. In order to be effective, the experience should seem real and engaging to participants, as “if they were in there”: they should feel (emotionally and cognitively) present in the situation. The goal of this chapter is to investigate the relationships existing among the factors that are crucial to the emergence of a sense of presence in virtual training environments. This exploration aims at outlining a possible model of presence in virtual learning environments, trying to define on the one hand the key factors conveying it in training contexts and on the other hand how the sense of presence contributes to enhance learning efficacy and to support following transfer of knowledge and skills.

Contents

11.1	Introduction.....	168
11.2	Sense of presence and virtual learning experience.....	169
11.3	Towards a model of presence in VR training.....	170
11.4	The relationship between sense of presence and transfer of knowledge and skills.....	176
11.5	Conclusion.....	178
11.6	References.....	179

11.1 Introduction

Recent advances in educational and training technology are offering an increasing number of innovative and promising learning environments [1-3]. These include three-dimensional and two-dimensional virtual worlds as well as computer simulations, which seem likely to offer an opportunity to enhance the training process of different skills through experience in virtual environments.

Virtual Reality (VR) is now used as a means to acquire concepts, procedures, basic and complex skills in many fields, from traditional flight simulators [4] to surgical simulators [5, 6], from training people to action in dangerous environments (e.g. training for space missions or military intervention) to decision-making training [7, 8].

In fact, there are areas and domains whose training presents a number of problems and obstacles to be addressed by training design, such as for example the difficulty or the impossibility to recreate the situation object of training in normal professional contexts, the use of complex, very expensive and delicate instruments or situations where mistakes can have important negative consequences (e.g. when learning to use a dangerous machine).

As indicated by many authors [9-11], VR technology (simulations, 2D and 3D worlds) can offer a number of potential benefits to training which we can synthesize as follows.

First of all, VR can provide *experiential and active learning*, thus encouraging participation and enhancing motivation; it also offers potential for *visualization* and for the management of complex information spaces. VR allows observation and training in *contexts impossible or difficult to experience* in real life: just to make an example, exploring space planets, examining historical scenes, but also facing dangerous fires in emergency situations. Furthermore, virtual environments can be tailored to individual learning and performance style: they are *flexible and programmable*, thus enabling the trainer to present a wide range of controlled *stimuli*. Finally, Virtual Reality can be a useful tool for *evaluation and assessment*, since every training session in the VE can be easily monitored and recorded by trainers.

In synthesis, we could affirm, together with Winn [3], that the main rationale for the use of Virtual Environments (VE) in learning and training contexts relies in the possibility of making significant first person experiences of the knowledge and skills to be trained.

In order to achieve this goal, the learning experience should seem real and engaging to the participants, as “if they were in there”: they should feel (emotionally and cognitively) present in the situation. The sense of presence experienced by learners in Virtual Environments training can be thus considered as a key feature to ensure the efficacy of virtual training and the following transfer of knowledge and skills from the training context to the “real life” ones.

In this sense, hi-tech and immersive VR can be an effective new kind of learning tool, since trainees in virtual environments can have “multi-sensory experience including visual, auditory and to some extent haptic and tactile cues” [8]. According to Romano [8], in theory VR could be used in every learning context because “anything that can be described digitally can be seen, heard, touched, and interacted with in a VE, even if it is an object not in the range of our normal experiences”.

Nevertheless, when talking of VR training tools we refer here to a wider range of very different systems, going from highly immersive 3D tools to simpler text-based simulations.

We use a broad definition of Virtual Reality Training, including low-tech systems such as text-based simulations and 2D desktop simulations, as well as hi-tech and highly immersive solutions such as 3D environments with head-tracking and Head-Mounted Display, or CAVES: the fundamental feature is, in all of these cases, the recreation and the simulation, mediated by some form of technology, of situations and contexts useful to the training of different skills.

As pointed out by Jacobson [12] in fact, also in text-based “virtual realities” it is possible to elicit a strong sense of presence which is important to train skills: but how? Despite the concept of presence was originally strictly tied up with concepts such as technological immersion and perceptual (mainly graphic) realism, it was recently pointed out how it could be better understood as a complex and multidimensional experience [13, 14].

Major goal of this chapter is thus to investigate the relationship between presence and training-oriented VEs in order to elaborate useful indications for designers and researchers in this field. In the first part we will analyze the specific role that presence plays in virtual training. Then, we will explore the elements on which the emergence of a sense of presence in VR depends, and how it could be possible to elicit presence by the means of different levels of technology; a number of theories accounting for different dimensions of presence and different factors at the base of it will be analyzed and used to ground the presented perspective; we will see how different models apply more suitably to different training goals. Finally, we will investigate the relationship between sense of presence and transfer of knowledge and skills in order to enhance VR training efficacy.

11.2 Sense of presence and virtual learning experience

No matter the skill thought or the technology employed, the learning potential of virtual training relies on the possibility for learners to actively and personally experience the training situation. As underlined by educational constructivist models [15], first-person experience, activity and interactivity, together with narrative dimension represent important dimensions to learning.

Roger Schank [16] in his book “Virtual Learning” has clearly pointed out how feeling present, feeling that the consequences of actions played in virtual environments and simulations are real can dramatically improve learning outcome. It is of particular interest the role that mistakes play in this perspective: as the author points out, one learns best from his mistakes, provided that he has the possibility to reflect over them and to receive help and explanations at that very moment he makes them. About this, Virtual Reality has the potential to provide a powerful learning environment, in the middle between reality and fiction: real enough to be relevant and involving for the user/trainee, so to be sure he/she will be able to fix the experience and to recall it in professional context; and at the same time “not real” enough so to allow users to make also severe mistakes in the virtual environment without feeling too depressed or lowered in self-esteem afterwards (so that they are able to reflect over his experience, or ready to look for and receive help). In synthesis, trainees can have a protected environment to experience success and failures, being much more likely to put themselves at stake.

In order to gain a recallable learning experience, it is important to act behaviours, succeed or make mistakes as a consequence to these actions, feeling emotions connected to success or failure and developing and elaborating appropriate thoughts over this experience [17-21].

Keeping this general framework in mind, we should remark that VR applications to training are many and varied, differing according to area (surgery and health-care, military, customer care, management, etc.), technology used, type of skill to train (single versus complex) and specific training goal for the virtual experience.

Furthermore, VR is never the only and single tool for training, so it is very important to understand which part of the training it is most suitable for VR training and effective from a cost/benefit-ratio perspective.

The types of skills which are the specific object of the training in the virtual environments range from very basic and procedural skills (such as repetition of the steps

the put an engine in action) to complex skills, such as managing a health-emergency situation. Skills could be also be divided into physical skills (concrete, graphically representable because they involve physical action over certain elements of the real or virtual environment) and abstract or meta- skills (where it is not the physical environment but rather the more complex situational and relational context which characterizes the environment; e.g. sales training, emergency training). In all these situations the training focus is different and it could be useful, within our analysis, to segment the domain of VR training in different groups according to their main focus:

- *Partial trainers* (focused on the training of single skills): in this case a correct procedure is to be learnt, e.g. learning how a machine works;
- *Trainers for the management of complex situations* (for contextual or relational reasons), e.g. decision making skills: in this case the focus is not as much on learning a procedure as on acquiring meta-skills useful to ensure flexibility and creativity to situation management (since these tasks are characterized by low repetition and high degree of unexpected events);
- *Training environments focused on emotion and stress management*: situations specifically aimed at coping with panic and stress, for example in emergency situations. In this case the specific rationale/objective is diminishing panic, teaching how to cope with it and this goal is achieved by modelling complex situations through manipulation of the characteristics of the different training contexts with the aim of training to a wider range of situations.

As we said before, in all these situations, trainees would learn by doing, that is they could experience the procedure (type I); they could find a number of flexible solutions to manage a complex situation (type II); they could learn to cope with stress and panic in emergency situations (type III). The more they feel *present and involved* in the Virtual Environment, the more real the experience will seem to them: they will experience thoughts, emotions and behaviours similar to those they could experience in a real-life situation, thus allowing the creation of a recallable experience.

11.3 Towards a model of presence in VR training

One of the most critical issue in the field of “presence” is the possibility to define a psychological model in order to explain fruitfully this concept [22, 23]. As recognized by many authors [8, 12, 24, 25], in learning virtual environments presence is the result of a complex web of interrelationships within factors and it does not depend only on graphic or perceptual cues. Moreover the possible applications of VEs are very different (different systems implemented, various skills to train, etc.) and so, at the current state of research, it is not possible to find general rules about presence and relative implementation in learning contexts.

Many researchers have tried to find a consensual and unique definition of presence, but now this psychological state is viewed as a complex concept composed by many factors that have to be considered, from technological issues to psychological ones from individual, social and cultural perspectives. As noted by Nowak, “presence is not a unidimensional construct, but instead is a collection of several correlated constructs, each tapping in to small part of the sense of presence” (p.1) [26]. Starting from this relative situation of “suspension” (due to the lack of a general model able to explain this concept) it is important not to find a unique definition of presence but to consider it as a *multi-dimensional concept* [14]. Within this perspective, the psychological state of presence

could be described as a subjective feeling depending on many environmental, contextual and personal characteristics and factors. According to Lombard and Ditton [13], there are at least eight different ways to consider “presence” (*spatial presence, sensory presence, social realism, engagement, social presence, co-presence, social actor within the medium, medium as social actor*).

Each of components considered by Lombard and Ditton can be seen as playing a key (or marginal) role depending on different learning situations (simple *versus* complex skills, motor *versus* cognitive abilities, etc.). In order to obtain a suitable sense of presence tailored to learning contexts, it is necessary to recognize the correlation between different and multiple factors without reducing the approach to a “techno-immersion” model. To avoid this “*technological reduction*”, it is important to underline a first distinction found in literature [27] between *immersion* and *presence* in VEs: the first concept is more connected with technological aspects (such as the level of inclusion and extension of a visual display), whereas presence is more a “state of consciousness” that depends on many factors [28, 29]. However the different importance that immersion and presence can play may depend on the nature of the skill or ability involved in the training. As far as basic cognitive skills are concerned, such as memory of objects, visual discrimination, spatial abilities, etc., a high level of graphic realism is a key factor in making a virtual training efficient. On the other side, in the case of complex cognitive abilities such as problem solving, coping skills, etc., it is more relevant the psychological state of presence than the technological aspects connected with a graphic realism. In both situations realism is a goal, but in two different meanings: in the first case VEs have to recreate a high level of “reality” in objects, colours, images, textures whereas in the second case realism is more connected with the possibility of creating interactions between persons, complex problems till reaching an “ecologically valid” [24] reconstruction of the social and cultural context where people usually live and act. This last condition is more *graphic-realism free* even if a minimum level is required.

According to Baños et al. [25], it is also necessary to consider the concept of *reality judgment*: “when we are speaking about reality judgement, we do not mean the sensorial or pictorial realism. We are not talking of realism but of reality”: what is relevant is the perception of the situation as a real context where to live real experiences till reaching a state of “willing suspension of disbelief” (p. 328) [25]. To achieve this “suspension” features such as interaction or perception of being involved in a real social and cultural context are more important than reconstruction with high level of visual fidelity. Within this perspective, another key concept determining a sense of presence is the *plausibility* of VEs: if virtual scenarios are realistic, the transaction between real and virtual is not characterized by interruptions; so the plausibility could be defined as the capacity to feel a strong sense of presence during the “switch” from real to virtual.

We could hypothesize different strategies to reach sense of presence, focusing on one or the other of Lombard and Ditton’s dimensions. It is possible to reach different forms of “presence” using different types of virtual environments in each situation: enhancing the degree of graphic realism or using an audio story are two very different approaches in the development of a VE, but both can create a functional sense of presence in educational applications.

There are a lot of conditions (such as attention, motivation, interaction, etc.) [30] VEs’ designers have to consider in order to ensure a sense of presence in virtual environments.

We tried to consider presence-related factors already investigated in existing literature within the perspective of training and learning. Factors connected with presence in learning environments could be included in four areas: *perceptual features, individual factors, content characteristics* and *interpersonal, social and cultural context*.

11.3.1 Perceptual features

11.3.1.1 Perceptual realism: graphic vividness of VEs and other “technological” features

There has been a stronger emphasis in the presence research about graphic realism.

Designers and researchers look for ways technology can more closely approximate human sensory experience, and then examine the impact of those technologies on presence.

As reported in Heeter [31], “examples of research along these lines from the PRESENCE 2001 workshop include comparisons of sense of physical presence in mono, stereo, and 5.1 speaker audio mix (...); stereoscopic versus monoscopic views (...); passive haptic feedback versus no haptic feedback (...); impacts of immersion and pictorial realism (...); and comparisons of narrow and wide field of view” (p. 1) [31]. Also Jacobson notes that “most research on presence has focused on technologies that use a variety of sensory inputs (e.g., visual, auditory, haptic) to create a simulacrum of a real environment, a virtual reality (VR) that mimics perceptions in the physical world (...)” (p. 653) [12].

Heeter underlines the limits of considering only this factor in determining presence: “sensorial realism is certainly an important influence on presence, but there is more to the story. Presence is a subjective experience. Even perfect mediated sensory perception would not by itself automatically induce a strong sense of presence because reality does not automatically induce a strong sense of presence” (p. 1) [31].

Furthermore, even if the realism of VEs is growing due to the technological development, a sensory parity between virtual and real has not been reached again. Many years of research are necessary to ensure a high level of complete multi-sensory involvement of users in VEs. According to Heeter [31], although these technological aspects will ensure a higher level of fidelity in the virtual reconstruction of reality, they are not sufficient to recreate a functional sense of presence.

In learning virtual environments graphic realism is important in applications where the visual channel is critical: in high-defined scenarios used for flight or drive simulations for example, the sense of presence could “break down” in case of not high graphic realism. On the other hand, in the cognitive and affective domains of learning [32] high visual fidelity is not always required, such as situations where the focus of training is more on attitudes or values.

11.3.1.2 Interactivity and control

Constructivist and experiential approach to learning have underlined the key importance of acting over the environment to learn [33, 34], so one of the key issue in the presence factor of perceptual features is represented by the possibility to interact with the learning environment controlling all the steps of the training. Bringing an object, moving it from one to other side, constructing other objects and seeing the effects of personal actions are only some of many advantages VEs allow. To control means also the possibility to receive of receiving to receive feedback, modify behaviors, analyze actions and re-view different steps of the learning *iter*. All these actions enhance a sense of presence and allow a transfer of knowledge from the virtual context to the real one.

In learning contexts these issues are critical where training is based on the exchange of information, *stimuli*, movements, words, etc. between different subjects or between a subject and an object represented in VEs: the feedback from a virtual body in surgical simulations or the answer from a group of persons in multi-users environments during a role playing are only two examples of the importance of receiving feedback in some learning situations. In other contexts, such a VE developed for spatial (positioning) abilities, interaction could be absent or moved to another step of the training once finished the virtual experience.

11.3.2 Individual factors

11.3.2.1 Imagination and suspension of disbelief

In some contexts, such as text-based virtual environments, a functional transfer of knowledge between “real” and “virtual” about learning experiences can be reached not providing all the details and information typical of a high fidelity reconstruction, but leaving users in a particular “suspended position”: they only receive few details about the virtual context and starting from this incomplete level of information, they can “complete” the lack of definition in VEs constructing the scenario. In this process of knowledge construction, imagination plays a major role. According to Jacobson, “although detailed description is critical in fostering a sense of presence in imagined and imaginary worlds, novelists, literary theorists, and other scholars agree that details must be selective and that depth of detail should not undermine the “glory of imagined description” (p. 655) [12].

Also Reed notes that “readers want only a few external details to confine their imaginations; they will take what the writer has given and supply the rest” [35]. Other researchers have underlined the role of imagination in experiencing presence [36, 37]. So imagination can fill in the gaps of information facilitating and reinforcing the involvement and engagement also in textual materials [12].

In training situations this issue is important in applications where virtual environments could only provide a starting stimulus or cue for the subject: a great part of the learning process is represented by the work of reconstruction subjects make following the guidelines provided by VEs. This is the case of the most abstract abilities, such as leadership, managing or complex cognitive ones. In this applications a too structured situation, without undefined spaces, could not allow persons to adapt and modify it towards their real needs: subjects do not reach the fixed goal of acquiring a new skill because situations provided during the training are too forced by VR designers.

The state of “suspension of disbelief” is the sense of non mediation subjects could perceive using technological tools: the ideal condition is represented by “forgetting the medium”. The technological *hyper-mediation* new tools allow could lead to a sense of *immediacy* and *transparency* called *remediation* [38].

But not only a high-level of technology allows a high sense of “suspension of disbelief”: According to Jacobson [12], one critical question could be whether virtual worlds combining graphics and sounds foster more or less “suspension of disbelief” than simple text-based ones. Schroeder [39] remarks that the participants feel more involved in graphic worlds than in text-based virtual environments, but there are no data to support this idea. On the other side, Schiano and White [40] note that people could prefer text-based environments (and not audio and video ones) in order to represent themselves. Further research is necessary to evaluate experiences of individuals exploring different types of virtual environments [12]. However, according to Schiano and White’s opinion, imagination is critical and for this reason Gerrig and Pillow [41] change the definition of presence from “willing suspension of disbelief” into “willing construction of disbelief” where people believe and support what they read or experience.

To achieve this state of “suspension” features such as interaction or perception of being involved in a real social and cultural context are more important than reconstruction with high level of visual fidelity.

As indicated by Riva [24] in clinical contexts, “forgetting the medium” is a condition especially requested in training situations where emotional components are very critical.

On the other hand, if the psychomotor or cognitive domains of learning [32] are the main issue, it is possible to carry on efficacy learning experiences also without high levels of suspension of disbelief.

11.3.2.2 Identification

The possibility to experience a sense of identification in VEs is another relevant factor in enhancing the state of presence. Basil notes that “a critical factor determining a sense of presence is a person’s parasocial identification with the virtual other ... presence simulations are likely to be more involving, more powerful and more real through the use of a protagonist that instils a sense of identification” (p. 1) [42].

In learning environments this factor plays a key role where subjects have to assume a defined role in virtual situations. Overall during social skills training or role playing, subjects have to recognize themselves as persons with a social position, role, identity, occupation, etc... in virtual experiences too. Without identification it is very difficult the transfer of knowledge between “virtual” and “real”. It offers trainees the opportunity to become leading actors in their learning and training process, enhancing the emotional impact and relevance of the virtual experience.

11.3.2.3 Motivations and goals

The level of motivation and the link between virtual training and own goals are two critical issues to consider. Learning experiences may be organized in the best way (good VEs, enough time for training, possibility to discuss after virtual experiences, etc.), but if they are not related with the actual needs and goals of subjects, they are not likely to achieve a suitable level of presence. So it is necessary to adjust all the technological devices and the training procedures to what subjects really want and need in their everyday professional contexts and situations.

At the same time, due to the complex relationship between these two factors, sense of presence could have an impact on motivation. Too similar and repetitive VEs could reduce the degree of interest in trainees (especially if they are high sensation-seekers [43]) after the first experiences with virtual reality.

On the other hand, Romano and Brna noted “virtual reality has a great potential as an educational tool precisely because it can gain and keep students’ attention” (p. 266) [8] and enhance their motivation. These issues explain and justify the use of a lower level of technology where necessary according to the fixed goals: for some types of skills, such as spatial skills, Romano suggests to use a desktop solution because this system and HMD-based VEs allow very similar kinds of learning but HMDs can trigger nausea, dizziness and visual difficulties that lead to consider a desktop approach more appropriate [8].

The ideal scenario is represented by the possibility of users to perceive the virtual situations as very motivating and connected with their real interests and needs.

11.3.2.4 Emotional state

In order for the virtual learning-by-doing to be effective, the experience must seem real and engaging to the participants, as “if they were in there”: they should feel (emotionally and cognitively) present in the situation. According to cognitive-behavioral approach and constructionism [17-21], the emotional component is a basic feature to allow a sense of presence and an efficient and effective learning process. Different authors [44-46] have noted that virtual experiences could allow subjects to experience the same emotions and psychological states obtained in real situations.

Another theoretical framework very useful to understand the subjective and emotional experience of presence is Csikszentmihalyi’s theory of flow [47], where “presence refers to a merging of action and awareness, during which a person loses self-consciousness and a sense of time, focusing on the present, and blocking out the past and the future” (p. 654) [12]. In this approach particular balances between “challenges” and “skills” VR could offer produce emotional states that have many common features with psychological sensation of

presence. Gaggioli et al. in this book have presented an ongoing research project studying the relationship between presence and qualitative experiences. An integrated approach should consider the *quality of the subjective experience* as another core characteristic that VR designers have to consider in order to develop functional synthetic worlds in education and training. The sense of presence depends also on the perceived and subjective characteristics of the experience. According to Csikszentmihalyi's theory of flow [47], the possibility to reach optimal experiences plays a key role during subjects' different activities: also in virtual sessions it is important to create and tune the environments allowing users to potentially reach this kind of psychological state. This framework can be extremely relevant in learning, where challenges and difficulties need to be carefully managed, together with motivation and learning goals. This issue is clearly connected with the level of motivation: in fact it is not just evoked by engagement, but also by an optimal balance between perceived challenges and skills.

11.3.3 Content characteristics

11.3.3.1 Plot, story, narration and dramaturgy.

Also the characteristics of the "story" created when a subject is exploring a VE plays a key role in enhancing the sense of presence: to be a part of a narration, to play a more or less defined role in the story could influence the sense of identification (above analyzed) and the state of presence during a virtual experience. Virtual Reality could be seen as a new type of dramaturgy where the subject is the main actor that experience directly all the situations using mind and body: in Bolter and Grusin's point of view persons in VEs are more directors than actors because they are able to change their points of view when they want [38].

For example the use of text-based virtual words [12] can appear not optimal in the third millennium where emerging technologies allow to recreate a high realism using not words but 2D and 3D images. The use of text-based tools is not anachronistic or inadequate to the goal, but it is one of the most functional solution to allow a sense of presence in MOOs environments. Also in user's description of virtual experience it is possible to confirm the idea that presence can be determined in many ways, not necessary very technological: "The feelings that arise while MOOing can be more vivid for me than books or movies, and I think that this is because even though there is an element of role play (to a greater or lesser degree), there is also the knowledge that I am interacting directly (some might argue indirectly, but I'll let that go) with other human beings..." (p. 654) [12].

11.3.4 Interpersonal, social and cultural context

11.3.4.1 Interpersonal dimension

Towell and Towell [48] note that interaction with other users can be the significant factor in generating a sense of presence more than spatial representation. Social interaction can generate a sense of presence as it is evident in MOO participants' comments [12]. In user's description of virtual experience it is possible to point out the idea that presence can be determined in many ways, not necessary very technological: "the feelings that arise while MOOing can be more vivid for me than books or movies, and I think that this is because even though there is an element of role play (to a greater or lesser degree), there is also the knowledge that I am interacting directly (some might argue indirectly, but I'll let that go) with other human beings..." (p. 654) [12]. As indicated by the previous user's description, in some cases, to enhance a sense of presence, the possibility to create a social interaction is more important than the realism.

Also the possibility to create more anthropomorphic *avatars* enhances the sense of being in company of others and the sense of presence: as noted by Nowak and Biocca, “a virtual confederate (agent or avatar) represented by a high-anthropomorphic image or no image was perceived to be more social present and copresent in the interaction as compared to virtual confederate (agent or avatar) represented by a low-anthropomorphic virtual body” (p. 1) [49].

In learning virtual environments the “sense of being part of a group” (group composed by interactive *avatars* or others real persons), is important in applications where the skill to consider in training can be learnt only with more persons interacting (or not) between them. Social abilities, coping skills and all the similar training areas have to consider this presence factor.

11.3.4.2 Social, cultural and ecological validity

The possibility to reproduce the subjects’ social and cultural context is a key issue to consider in enhancing presence in VEs. In some cases the possibility to create a social interaction is more important than realism to enhance a sense of presence.

Low levels of presence are usually connected with the low importance dedicated to the reconstruction of a world socially and culturally perceived as correct by users: in these situations extra-individual characteristics seem no so relevant in comparison with technological and individual ones.

Considering again the “suspension of disbelief”, in order to achieve this state, features such as interaction or perception of being involved in a real social and cultural context are more important than reconstruction with high level of visual fidelity.

According to Riva [24], “multi-user VR can be considered as a particular form of computer-mediated communication (CMC)” (p. 353) and the focus moves from technological aspects of VEs to the consideration that “virtual” is a media that belong to a particular culture in which persons are not isolated individuals but actors involved in an interpersonal, social and cultural context. “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” (p. 356)[24]. In virtual environments used in different applications (psychotherapy, assessment, learning, etc...) “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” (p.356)[24].

All the factors that we have analysed so far play a role in the emergence of the sense of presence but not all of them may have the same importance at the same time and within the same application: a specific characteristic essential in a given learning context could be not functional in another one.

Furthermore, other factors such as cognitive [50] and learning styles, individual personality traits have to be considered in order to ensure a functional level of presence during a learning virtual experience or training.

The model presented is surely not intended to be exhaustive but can provide a flexible framework for both VR-training designers and researchers.

11.4 The relationship between sense of presence and transfer of knowledge and skills

We have seen how it is possible to account for the emergence of a sense of presence in virtual environments by using a complex and multi-factorial model; though, when considering presence in learning and training environments it is important to evaluate how

the sense of presence is related to training efficacy and following transfer of knowledge and skills to real-life professional contexts.

Is presence enough to ensure training efficacy? What other elements should be considered when designing Virtual Learning Environments?

A number of authors [17-21] have pointed out the importance of integrating moments fostering meta-reflection in the training experience. The moment of meta-reflection is important to support both construction of knowledge and cognitive learning: trainees should be offered an opportunity to reflect on their performances by providing them specific mechanisms, not always available in the real world, that trainees can experience within the training experience.

Romano and Brna [8], for example, proposed an approach to training time-limited decision-making skills which is based on the concept of *situation awareness*: “the VE is intended to have the strengths of virtual environments that provide close physical resemblance to the real environment, immediate feedback, and a strong sense of presence; but also the system should support various ways of reflecting on the relationship between the elements of the dynamically changing situation and the learner’s goal”. In the specific case of their system, called ACTIVE (Action Control Training in Virtual Environments), they conceived these supports in terms of additional powers (or superpowers), that is opportunities not normally available in the real world (such as collaborating with a peer, changing the point of view and roles, modifying time parameters of the simulation, consulting agents, going back to change an action, go forward in time to see the effect of his or her actions and negotiate to create a shared mental image of the problem, etc.) that trainees could exercise within the virtual environment thus improving the understanding of their performance.

The key problem is to engineer the system in a way such that situation awareness and presence are both achieved. The insertion of metacognitive and reflection tools can be considered “a way of displaying a selection of stimuli, stopping those coming from the environment to reflect on what has been just experienced” [8]. As pointed out by these authors, a question arises about what happens in this case to the sense of presence and whether it is preserved or lost: on the one hand, reflection is important, and the possibility to embed it in the virtual training environment is a real advantage as compared to real-world contexts. On the other hand, the learner should feel present in the environment in order to have a first-person recallable experience. How to balance these features?

About this, Waterworth and Waterworth [51] have introduced a difference between *focus* and *locus* of presence: according to them,

“when in a virtual environment, presence is typically shared between the VR and the physical world. ‘Breaks in presence’ are actually shifts of presence away from the VR and toward the external environment. But we can also have ‘breaks in presence’ when attention moves toward absence- when an observer is not attending to stimuli present in the virtual environment, nor to stimuli present in the surrounding physical environment- when the observer is present in neither the virtual world nor the physical world. We thus have two dimensions of presence: focus of attention (between presence and absence) and the locus of attention (the virtual vs. the physical world).” (p. 203).

It could be assumed that introducing reflection moments means more a shift of focus than a shift of locus. We thus argue that aid and support tools and meta-cognition, are not to be considered as alternative (or incompatible) to the sense of presence in the learning experience.

Although they may shift the “locus”/attention away from the virtual environment in itself, they probably don’t damage the sense of presence and involvement in the whole learning experience. How could this be possible?

Providing suitable help, support and feedback at the right moment (and according to individual preferences and choices) is a key element to provide continuity to involvement and engagement throughout the learning experience. It is also a way to ensure the possibility to experience more challenging situations than the ones one would be ready for.

We could hypothesize that the sense of presence in the virtual training experience is not limited to the sense of presence experienced in the virtual world but is something more complex and extends itself to the whole learning experience.

A learning and training experience carries on a “change” in persons who experiences the learning situation: there is generally an evolution between a first step that generates the need of training and a second one where a new skill or ability is gradually becoming present as a new characteristic for persons involved. According to the traditional approach used in cognitive-behavioral therapy about clinical situations [17-21], also “change” in learning contexts can be produced working on cognitive, behavioral and emotional components. A virtual experience characterized by a high sense of presence allows trainees to live actions, feelings, scripts, behavioral patterns, etc. Also the cognitive elaboration of what the trainee has done is connected with the experience, especially if there is a “space”, within and/or after the experience, specifically dedicated to this cognitive issue. Also in traditional training the *debriefing* step is used to discuss the different aspects of the experience.

In order to enhance the learning effects of a virtual experience, a good solution is probably represented not by keeping high the sense of presence as long as possible, but moving/shifting/switching dynamically from this situation of “sense of being there” (during the immersion in VEs) to a step of *break in presence* in order to reflect on the actions recently made (and emotions recently perceived), from a different and external point of view, like a movie director. An optimal learning process is characterized by the sequence of these different steps and a good trainer (or a well designed system) is able to foster this process.

11.5 Conclusion

Presence does play a very important role in the process of learning and transfer of skills.

The sense of presence makes the learning experience engaging, relevant and trainees will experience thoughts, emotions and behaviors similar to those they could experience in a real-life situation, thus allowing the creation of a recallable experience. The user can make mistakes accepting failures and reflecting over them, since he/she makes them in a protected environment and so they do not have such severe consequences on the real world and on the user’s self-esteem. The sense of presence in the training situation is important also after the learning experience, when it is matter to recall it to solve problems and manage situations in the professional context: the higher the sense of presence during the experience, the higher the emotional involvement, the higher possibility of recalling, through associations, the training situation.

However, the concept of presence is a very complex one and throughout this chapter we tried to overcome two “equations”: the first is the “*technology-means-presence equation*”, and the second is the “*presence-means-efficacy* (in terms of learning and training efficacy and transfer of knowledge and skills) *equation*”.

As to the first one, we have seen that many factors other than technology are at stake and that presence can be obtained in very different ways and by means of very different

technological devices, according to training goals. The remark that technological level is not directly related to the sense of presence experienced by the users is quite relevant since costs and effort for the development of virtual environments can be quite high and should be carefully considered. As Rizzo and colleagues [52] point out, it is always necessary to carry out a realistic cost/benefit analysis in order to evaluate which is the added value of VR in different applications as compared with traditional approaches and furthermore whether the same learning outcome that one would achieve in highly immersive and realistic VR could also be obtained with a lower-tech solution. Also, it should be considered that the simple use of highly immersive technology alone could not be effective unless it is not coupled to specific design strategies, such as for example “goal-based scenario approach” strictly tying the experience to training goals and making it relevant for the trainee.

As to the second equation, within the training process the sense of being present in the VR environments is not the only factor (in order) to ensure training efficacy: in order to change this potential into real training efficacy, it is also important that meta-cognition and reflection are embedded in the VR experience (or readily available by a trainer which is present). Trainees should be offered the opportunity of switching between presence and absence in terms of meta-reflection over the experience which is being carried out. This can bring two benefits:

- providing a ready feedback and support after mistakes or during the experience in order to improve performance understanding;
- fostering and broadening the process of categorization of the experience, in order to facilitate following recall when in “real-life” situations.

The learning process [17-21] consists of a phase more focused on *action* (behavioral) eliciting *emotions* (emotional), followed by a process of reflection and reframing (*cognitive*). VR training ensures this type of process through moments of high sense of presence in the more behavioral-emotional phase and moments of “absence” or shift of focus during cognitive reflection.

Within this perspective, it seems very interesting to further investigate the network of factors related to the emergence of the sense of presence in order to maximize the efficacy of Virtual Training.

Further research is needed, focusing on experimental and on-field validation of different models of presence applied to learning and training experience and following skills transfer: in order to carry out these studies, a key point will concern the possibility to rely on a flexible and articulated methodology and measurement tools able to catch the multidimensionality of the concept of sense of presence.

11.6 References

- [1] M. Roussos, A. Johnson, T. Moher, J. Leigh, C. Vasilakis and C. Barnes, Learning and building together in an immersive virtual world, *Presence: Teleoperators and Virtual Environments*, **1999**, 8, pp. 247-263.
- [2] S. Stansfield, D. Shawver, A. Sobel, M. Prasad and L. Tapia, Design and Implementation of a Virtual Reality System and its Application to Training Medical First Responders, *Presence: Teleoperators and Virtual Environments*, **2000**, 9, pp. 524-556.
- [3] W. Winn, A Conceptual Basis for Educational Applications of Virtual Reality, *Technical Report TR 93-9*: <http://www.hitl.washington.edu/publications/r-93-9/> **1993**.
- [4] A. T. Lee and S. R. Bussolari, Flight simulator platform motion and air transport pilot training, *Aviat Space Environ Med*, **1989**, 60, pp. 136-140.

- [5] S. Delp, P. Loan, C. Basdogan and J. Rosen, Surgical Simulation: An emergin technology for training in emergency medicine, *Presence: Teleoperators and Virtual Environments*, **1997**, 6, pp. 147-159.
- [6] R. Satava and S. Jones, Virtual Environments for medical training and education, *Presence: Teleoperators and Virtual Environments*, 6 **1997**, pp. 139-146.
- [7] J. Calvin, A. Dickens, R. Gaines, P. Metzger, D. Miller and D. Owen, The SIMNET virtual world architecture, *IEEE Virtual Reality Annual International Symposium*, **1993**.
- [8] D. M. Romano and P. Brna, Presence and reflection in training: support for learning to improve quality decision-making skills under time limitations, *Cyberpsychology and Behavior*, **2001**, 4, pp. 265-77.
- [9] V. S. Pantelidis, Reasons to use virtual reality in education, *VR in the schools: <http://www.soe.ecu.edu/vr/reas.html>*, 1 **1995 (Revised 2000)**.
- [10] K. M. Osberg, Virtual Reality and Education: A Look at Both Sides of the Sword, *Technical Report TR 93-7: <http://www.hitl.washington.edu/publications/r-93-7/>* **1992**.
- [11] F. Mantovani, *VR Learning: Potential and Challenges for the Use of 3D Environments in Education and Training*, in C. Galimberti, ed., *Towards CyberPsychology: Mind, Cognition and Society in the Internet Age*, IOS Press, Amsterdam, **2001**, pp. 207-225.
- [12] D. Jacobson, Presence revisited: imagination, competence and activity in text-based virtual worlds, *Cyberpsychology and Behavior*, 4, **2001**.
- [13] M. Lombard and T. Ditton, At the hearth of it all: the concept of presence, *Journal of Computer-Mediated Communication*, 3, **1997**.
- [14] M. J. Schuemie, P. Van Der Straaten, M. Krijn and C. A. Van Der Mast, Research on presence in virtual reality: a survey, *Cyberpsychology and Behaviour*, 4, **2001**, pp. 183-201.
- [15] S. Papert, *Mindstorms: Children, computers and powerful ideas*, Basic Books, Inc., New York, **1980**.
- [16] R. Schank, *Virtual learning: A revolutionary approach to building a highly skilled workforce*, McGraw-Hill, New York, **1997**.
- [17] H. J. Eysenck, Learning theory and behavior therapy, *Journal of Mental Science*, 105 **1959**.
- [18] B. F. Skinner, *The technology of teaching*, Appleton-Century-Crofts, New York, **1968**.
- [19] A. Bandura, *Principles of behavior modification*, Holt, Rinehart & Winston, New York, **1969**.
- [20] W. C. Becker, *Applied psychology for teachers. A behavioral-cognitive approach*, Science Research Associates, Inc., Chicago, **1986**.
- [21] M. J. Dougher, Cognitive concepts, behavior analysis, and behavior therapy, *Journal of Behavior Therapy and Experimental Psychiatry*, **1997**, 28, pp. 6-70.
- [22] W. A. Ijsselsteijn, M. Lombard and J. Freeman, Toward a core bibliography of presence, *Cyberpsychol Behav*, **2001**, 4, pp. 317-21.
- [23] W. A. Ijsselsteijn, J. Freeman and H. De Ridder, Presence: where are we?, *Cyberpsychology and Behavior*, **2001**, 4, pp. 179-82.
- [24] G. Riva, Design of clinically oriented virtual environments: a communicational approach, *Cyberpsychology and Behavior*, **2000**, 3 pp. 351-357.
- [25] R. M. Banos, C. Botella, A. Garcia-Palacios, H. Villa, C. Perpina and M. Alcaniz, Presence and Reality Judgment in Virtual Environments: a unitary construct?, *Cyberpsychology and Behavior*, **2000**, 3, pp. 327-335.
- [26] K. Nowak, Conceptualizing, Differentiating and Measuring Copresence and Social Presence, *4th Annual International Workshop PRESENCE 2001*, Temple University, Philadelphia, PA, USA, **2001**.
- [27] B. Witmer and J. L. Singer, Presence Measures for Virtual Environments: Background and Development, U.S Army Research Institute, Simulator System Research Unit, United States Army Research Institute for the Behavioural and Social Science, **1996**.
- [28] K. Mania and A. Chalmers, The effects of levels of immersion on memory and presence in virtual environments: a reality centered approach, *Cyberpsychology and Behavior*, **2001**, 4, pp. 247-64.
- [29] M. Slater and S. Wilbur, A Framework for Immersive Virtual Environments (FIVE): Speculations on the Role of Presence in Virtual Environments, *Presence: Teleoperators and Virtual Environments*, **1997**, 6, pp. 603-616.
- [30] N. Enlund, The Production of Presence - Distance Techniques in Education, Publishing and Art, *ACS'2000 Proceedings*, Szczecin, **2000**, pp. 44-49.
- [31] C. Heeter, Reflections on Real Presence by a Virtual Person, *4th Annual International Workshop PRESENCE 2001*, Temple University, Philadelphia, PA, USA, **2001**.
- [32] M. Selverian, H. S. Hwang and C. Mason, A Model Of The Psychology Of Virtual Learning, *4th Annula International Workshop PRESENCE 2001*, Temple University, Philadelphia, PA, USA, **2001**.
- [33] S. Papert, *Situating Constructionism*, in I. H. A. S. Papert, ed., *Constructionism*, Eds. Norwood: Ablex, NJ, **1991**.
- [34] M. Nicaise and M. Crane, Knowledge constructing through hypermedia authoring, *Educational Technology, Research and Development*, **1999**, 47, pp. 29-50.
- [35] K. Reed, *Mastering fiction writing*, F&W Publications, Cincinnati, **1991**.

- [36] F. Biocca and M. R. Levy, *Communication in the age of virtual reality*, Earlbaum, Hillsdale, NJ, **1995**.
- [37] M. L. Ryan, *Possible worlds, artificial intelligence and narrative theory*, Indiana University Press, Bloomington, IN, **1991**.
- [38] D. Bolter and R. Grusin, *Remediation. Understanding New Media*, The MIT Press, Cambridge, London, **1999**.
- [39] R. Schroeder, *Possible worlds: the social dynamic of virtual reality technology*, Wetsview Press, Boulder, CO, **1996**.
- [40] D. J. Schiano and S. White, First noble truth of cyberspace: people are people (eve when they MOO), in C. M. Karat, A. Lund, J. Cortaz and J. Karat, eds., *Human Factors in computing systems: CHI 98 Conference*, Association for Computing Machinery, **1998**.
- [41] R. J. Gerrig and B. H. Pillow, *Developmental perspective on the construction of disbelief*, in J. De Rivera and T. R. Sarbin, eds., *Believed-in imaginings: the narrative construction of reality*, American Psychological Association, Washington, DC, **1998**, pp. 101-109.
- [42] M. D. Basil, The Importance of Identification To A Sense Of Presence, *4th Annual International Workshop PRESENCE 2001*, Temple University, Philadelphia, PA, USA, **2001**.
- [43] M. Zuckerman, The sensation seeking motive, *Prog Exp Pers Res*, **1974**, 7, pp. 79-148.
- [44] M. M. North, S. M. North and J. R. Coble, Virtual reality therapy: an effective treatment for psychological disorders, *Studies in Health Technology and Informatics*, **1997**, 44, pp. 59-70.
- [45] G. Riva, Modifications of body-image induced by virtual reality, *Perceptual and Motor Skills*, **1998**, 86, pp. 163-70.
- [46] F. Vincelli and G. Riva, Virtual reality as a new imaginative tool in psychotherapy, *Studies in Health Technology and Informatics*, **2000**, 70, pp. 356-8.
- [47] M. Csikszentmihalyi, *Attention and the Holistic Approach to Behaviour*, in K. S. Pope and J. L. Singer, eds., *The Stream of Consciousness*, Plenum Press, **1978**.
- [48] J. Towell and E. Towell, Presence in text-based networked virtual environments, *Presence: Teleoperators and Virtual Environments*, **1997**, 6, pp. 590-595.
- [49] K. Nowak and F. Biocca, The influence of Virtual Bodies and Agency on Copresence, Social Presence an Physical presence, *4th Annual International Workshop PRESENCE 2001*, Temple University, Philadelphia, PA, USA, **2001**.
- [50] S. Corina and G. O'hare, The Presence Equation: An Investigation Into Cognitive Factors Underlying Presence, *4th Annual International Workshop PRESENCE 2001*, Temple University, Philadelphia, PA, USA, **2001**.
- [51] E. L. Waterworth and J. A. Waterworth, Focus, locus, and sensus: the three dimensions of virtual experience, *Cyberpsychology and Behavior*, **2001**, 4, pp. 203-13.
- [52] A. A. Rizzo, B. K. Wiederhold and J. G. Buckwalter, Basic issues in the use of virtual environments for mental health applications, *Studies in Health Technology and Informatics*, **1998**, 58.