Running head: SENSE OF PRESENCE

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Virtual reality is an event or entity
that is real in effect but not in fact.
(Michael Heim, 1993)

Abstract

This article introduces the presence construct offering in the same time a review of presence determinants. Highlighting the uneven interest manifested in this research area, interest which favours particularly *technological factors*, it advocates a shift of attention which would motivate studies focusing primarily on *human factors*. The article continues by outlining the methods and instruments developed for assessing presence, with an emphasis on the challenges and difficulties of measuring presence. Given its significance, the relationship between presence and task performance is also discussed.

INTRODUCTION

Sense of presence is one of the most interesting phenomena which enrich users' experience of interacting with any type of system. It allows the users to *be there* (Schloerb & Sheridan, 1995), and moreover to perceive the virtual world as another world in which they really exist. The inner nature of this phenomenon poses a series of serious problems for investigating presence, at both theoretical and empirical level.

The highly subjective nature of presence continues to challenge researchers for finding appropriate methodologies and instruments of measuring it. This is reflected in the ongoing theoretical work of conceptualising sense of presence. The difficulties relating to investigating presence led to a large set of definitions and measuring tools. Despite the

diversity characterising this set, there is a common ground shared by researchers in the presence field which refers to presence determinants.

Emphasising the meaning of mediation, a new concept, called telepresence has been introduced. Even though the idea of telepresence was anticipated by Robert Heinlein (1950) in his novel *Waldo*, the term was coined by Marvin Minsky (1980) and denotes a sense of being physically present at a remote world which is mediated by the system interface. This concept precedes and is closely related to the presence construct. Despite of being often taken as synonyms, there is however a subtle difference between presence and *telepresence*, rooted in the proximity to the site where one perceives, acts and ultimately experiences presence. Draper et al. (1998) defined telepresence as "the perception of presence within a physically remote or simulated site".

Another distinction, often mentioned in presence literature is that between presence and immersion. Immersion is usually associated with technological factors referring to the extent to which computer generated worlds are *extensive* (able to accommodate a large set of sensory systems), *surrounding* (able to provide information from any virtual direction), *inclusive* (able to shut out all information from physical world), *vivid* (able to provide rich information content, resolution and display quality) and *matching* (able to accurately reproduce the body movements previously tracked) (Slater, Linakis, Usoh, & Kooper, 1996; Slater, Usoh, & Steed, 1995). In contrast presence relates more to human factors, whose impact is unfortunately less explored.

DEFINING PRESENCE

One of the most common psychological phenomena experienced by users while they interact with virtual reality systems, is a sense of presence. However, a sense of presence can be experienced not only when people interact with virtual reality, but also during the use of any other media. Biocca (1997) argues that presence is "part of an ancient desire

for transportation ... over the space we live in".

Sheridan (1992) and Schloerb and Sheridan (1995) described presence as a sense of being physically present at the remote site. Loomis (1992) pointed out that presence is a basic state of consciousness, consisting of the attribution of sensation to some distal stimuli, or more broadly to some environment. Slater and Usoh (1993) described presence as "suspension of disbelief" experienced by users while being in a remote world and not the physical one.

Lombard (2002) also considered the first and the second order mediation applicable to the study of presence, where the second one relies beyond the human senses, on technology. Underlining the failure of mediation awareness, Lombard and Ditton (1997) conceptually delimited presence as "the perceptual illusion of non-mediation".

Analysing the above presence definitions, it is interesting identifying both the general class where presence concept has been included, as well as its distinctive set of features. Thus, the concepts used for delineating the genus were *state of consciousness* (Loomis, 1992), *psychological state* (Lombard, 2002), *subjective experience* (Heeter, 1992), *subjective perception* (Lombard, 2000), *sense* (Minsky, 1980; Sheridan, 1992) and *illusion* (Lombard & Ditton, 1997).

Considering presence merely as a sense can be unnecessarily restrictive. At the same time however, the state of consciousness enlarges the boundaries of the genus needlessly, since everything that occurs in the *internal world*, the subjective world of inner thoughts (Jung, 1971), represents states of consciousness. While a quite large array of terms delineating genus have been identified, the distinguishing features, which are supposed to differentiate sense of presence from other psychological phenomena are clearer. The unanimously accepted construct of *being there* is the core aspect of presence, which occurs within one's consciousness.

In seeking a closer juxtaposition to the theoretical framework underlying it,

presence is defined as follows (Sas & O'Hare, 2001, 2003):

> Presence is a psychological phenomenon, through which one's cognitive processes are oriented towards another world, either technologically mediated or imaginary, to such an extent that he or she experiences mentally the state of being (there), similar to one in the physical reality, together with an imperceptible shifting of focus of consciousness to the proximal stimulus located in that other world.

PRESENCE DETERMINANTS

Several presence theories have been developed in the attempt to extend the understanding of presence. Draper (1998) identified a first group consisting of psychological models of presence and a second one consisting of technological models of presence. First class of theories includes telepresence as *flow* experience developed by Csikszentmihalyi (1990), behavioural cybernetics theory (Smith & Smith, 1985) and structured attentional resource model for teleoperation (Schloerb & Sheridan, 1995). The second class of theories groups different models elaborated by Sheridan (1992), Steuer (1992), Schloerb (1995), Zeltzer (1992), Witmer and Singer's (1998) and respectively by Slater and Usoh (1993).

The factors affecting presence can be grouped into technological factors which consider the system and its characteristics, and human factors referring to users' cognitive and personality aspects (Lombard & Ditton, 1997; Lessiter, Keogh, & Davidoff, 2000).

Technological Factors

A large amount of work has been carried out in the area of technological factors affecting presence. Lombard and Ditton (1997) provided a detailed account of this. Some of these factors are: visual display characteristics such as image quality, image size,

viewing distance, visual angle, motion, colour, dimensionality, camera techniques; aural presentation characteristics like frequency range, dynamic range, signal to noise ratio, high quality audio and dimensionality such as 3D sound. As stimuli for other senses, Lombard and Ditton (1997) referred to olfactory output, body movement, tactile stimuli, and force feedback.

Media and user characteristics were often mentioned as carrying a particular impact upon the level of sense of presence experienced by the users. However, there is little empirical research supporting this.

Human Factors

Psotka and Davison (1993) considered two categories of factors determinant of immersion, such as susceptibility to immersion and quality of immersion. The first set refers to human factors with an emphasis on cognitive aspects such as imagination, vivid imagery, concentration, attention and self-control, while the second set is primarily concerned with technological factors like affordances of Virtual Reality (VR), distractions from the real world or physiological effects.

Kaber, Draper and Usher (2002) noted that the personality traits discussed in the VR literature seem to be predominantly mentioned in the context of presence experienced within the VE. These factors were primarily referred to as immersive tendencies and attention. They cover an entire set of users' characteristics such as suggestibility of immersion, tendency to daydream, becoming lost in novels, concentration and robustness to distracting events.

Other personality factors impacting on presence are empathy, absorption, creative imagination, personality cognitive style and willingness to be transported in the VE (Lombard & Ditton, 1997; Heeter, 1992; Sas & O'Hare, 2001, 2003; Sas, O'Hare, & Reilly, 2003).

Discussion

Presence models and determinants are organised along the two fundamental groups such as technological and human factors. However, there is an uneven development of these theories along the two dimensions, since technological factors seemed to receive greater attention from the research community.

This indicates a gap, and the efforts invested in this line of research could be efficiently exploited for the development of hybrid theories, focusing simultaneously on both technological and human factors, and on the relationship between them, for providing a comprehensive explanation of presence.

The two groups of factors impacting on presence and taken as basis for grouping the presence theories should be seen on a continuum, rather than a dichotomy. Both human and technological factors should be seen as part of a wider equation whose addressing increases the potential of understanding and possible manipulating presence. A marriage between these two factors is a must for any attempt to build systems able to adapt themselves to user characteristics in order to control the level of presence.

Conceptualising presence is the initial stage of understanding this construct. It has been followed by the attempts of measuring presence. Different methods and measurement instruments have been proposed for offering quantitative indicators of the degree of presence that one can experience.

MEASURING PRESENCE

Despite its significance, measuring presence raises significant challenges, primarily related to the nature of presence. Presence is a psychological phenomenon, subjectively experienced inside the inner world of one's consciousness. Therefore, capturing and analysing it requires a certain degree of introspection, together with one's understanding of what presence means. In addition, presence is a state or a transient psychological

condition which is context-dependent, and which accordingly could vary within the same individual during an experiment.

Therefore, participants could encounter difficulties in assessing their level of presence after the task has been completed and the experiment has ended. Even more difficult is measuring presence during the duration of experiment. This involves asking somebody to be permanently aware of each change occurring in his/her level of presence. Such a requirement adds itself to those involved in the execution of the task, inducing therefore cognitive overload. This could either prevent the subjects to experience presence or affect the task performance. Either case impacts on the measurement validity.

Another difficulty in measuring presence is related to the complexity and multi-dimensionality of this construct (Lombard, 2003). This is reflected in the different definitions and theories trying to explain presence. In addition, presence research seems to be an interdisciplinary field, which benefits from inputs from various disciplines such as psychology, philosophy, computer science, media studies, drama studies etc., to enumerate the most important ones. These multiple perspectives provide valuable insights into understanding presence, but at the same time they come at a cost. A fully articulated and commonly accepted theory of presence requires a *lingua franca* of presence. The efforts invested in this direction can lead to a common ground in understanding presence.

Lombard (2003) identified two general approaches to measuring presence: *subjective measurements* and *objective measurements*. Subjective measures usually consist of self-rating questionnaires which require participants to evaluate the experienced level of presence. Some of the limitations of this approach have been introduced above. They are mainly related to the inner and versatile nature of presence, and to the level of introspection assumed that participants are able to achieve. Such kind of information could be elicited post experiment or during the experiment.

The main advantage of the subjective measures consists of their accessibility. They

also come at low cost and very important, appear to be valid and reliable measures (Prothero, Parker, Furness, & Wells, 1995). As Lombard (2003) mentioned, "several presence questionnaire instruments that may be valid and reliable across different participant groups, experimental conditions, stimuli, and settings, have been or are currently in development". Such questionnaires have been developed by Lessiter et al. (Lessiter et al., 2000), Lombard (2000), Schubert (1999), Witmer (1998), Slater et al. (2000).

In order to overcome some of the limitations related to subjective measures of presence, another approach started to emerge. At the core of objective measures lies the hypothesis that, while the users experience presence, a series of physiological and behavioural modification occurred in their bodies. The particular physiological modifications considered as reflecting presence are skin conductance, blood pressure, heart rate, muscle tension, respiration, eye movement, posture etc. (Lombard, 2003).

These measures involve the recording of such modifications, in real time and present the considerable advantage of being unobtrusive. They can be also carried out without requiring subjects' involvement in these measurements. The objective measurements have their own limitations, such as high cost and difficulties in administrating them. However, their main drawback concerns the limited evidences of the fact that physiological modifications correlate with presence.

Another aspect of major interest regarding presence is its relationship with task performance. The significance of this relationship justifies the efforts invested in defining and measuring presence. At the same time, this issue has generated serious theoretical treatments and empirical investigations.

PRESENCE AND TASK PERFORMANCE

The existence of a relationship between presence and task performance is arguable and has given rise to a long-standing debate in the presence research area. More empirical studies are required in order to refute/support this dependency and offer insights into its nature. Theoretical work and empirical studies have highlighted two possible research positions. The first position states that presence is merely an epiphenomenon (Ellis, 1996; Welch, Blackmon, Liu, Mellers, & Stark, 1996), and consequently its impact upon task performance is limited. According to this position, the role of presence consists only of affectively colouring the user's experience. The second position argues that presence impacts on the performance of tasks carried out within the virtual environments. There are two perspectives on this position.

The first one views it as a mediated relationship. In other words, presence and task performance could be in fact related to a third extraneous variable or set of variables (Stanney et al., 1998; Slater et al., 1996), which impact on both presence and task performance. These extraneous variables were considered to be related to the technological aspects of VEs, such as improved VEs (Stanney et al., 1998) or immersion (Slater et al., 1996).

The second, and probably the most important possible explanation of this mysterious dependency between presence and task performance argues for a causal relationship (Sadowski & Stanney, 2002). This perspective has fuelled most of the research in the field. However, the issue of causal relationship presents a two-fold problem. Firstly, it is a challenge to design an experiment for highlighting the causal relationship, which would go beyond mere correlation and secondly this relationship, if it exists, would seem to be highly *task-dependent* (Stanney, 1995; Slater et al., 1996).

The significance of the content being delivered through any mediated experience has been related to the nature of activity or tasks in which the user participates, which in turn

seems to impact on presence (Lombard & Ditton, 1997). Heeter (1992) distinguished between two potential groups of tasks which could impact differently on presence, which are related to two fundamental types of activity: learning or playing. Particularly, in the case of tasks involving a ludic component, the sense of presence is likely correlated with enjoyment, which in turn is likely correlated with task performance (Barfield, Zeltzer, Sheridan, & Slater, 1995). Tasks or activities which involve ambiguous verbal and nonverbal social cues and sensitive personal information exploits better the medium's potential to offer presence than do simple nonpersonal tasks (Lombard & Ditton, 1997). Correlations between performance improvement and presence appear to be positive. However, they are usually weak since less than 10% of variance in the performance seems to be accounted for the perceived presence (Snow, 1996).

Despite this limitation, the causal relationship presence–task performance has increased face validity based on the perceptual and cognitive psychology of skills transfer (Stanney et al., 1998). In this light, an additional benefit of understanding this relationship consists of the transfer of skills from the VE to the real world. Slater et al. (1996) considered presence merely as a facilitator whose main contribution consists of enabling the user to perform naturally, in a similar way one does in the real world, or in other words inducing one's "natural reactions".

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Terms and Definitions

- *Presence*: A psychological phenomenon enabling the mental state of being there, in either technologically-mediated or imaginary spaces.
- *Telepresence*: A psychological phenomenon of being mentally present at a technologically-mediated remote world.
- *Immersion*: A quality of a system, usually computer generated-world, consisting in a set of technological factors which enables users to experience presence.
- *Task Performance*: The proficiency of accomplishing a task which allows discriminating users (i.e. experts/novices).
- *Technological Factors*: Aspects characterising a technical system (i.e. computer generated world) and its components, which impact on the quality of interaction and task performance.
- *Human Factors*: User characteristics in terms of personality and cognitive factors, which impact of the quality of interaction with any artefact and task performance.