Presence and Immersion: A Tale of Two Cities

Anna Felnhofer[1*] & Oswald D. Kothgassner[2]

[1] Department of Pediatrics and Adolescent Medicine, Division of Pediatric Pulmonology, Allergology and Endocrinology, Medical University of Vienna, Vienna, Austria

[2] Department of Child and Adolescent Psychiatry, Medical University of Vienna, Vienna, Austria

Highlights:

1) the „sense of presence" and „immersion" are logically distinct but related concepts which to date have often been confused an used synonymously
2) „immersion" may be conceptualized as an objective property of technology or the extent to which a user feels immersed
3) „presence", in turn, is a perceptual illusion in which the user has the impression of „being there" in the virtual environment
4) for a better terminological stringency, we suggest using the term „immnersiveness" to describe the technology and „immersion" to indicate the level to which a user feels immersed
5) also, we suggest conceptualizing presence as a consequence of immersive technology which is mediated by user factors (demographics, attention, motion sickness etc.)

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1 Introduction

Much has been written about virtual reality (VR) since its advent in the second half of the twentieth century. And even more debate has evolved around the cornerstones of human experience in virtual worlds. In particular, two constructs have been – and are to this date (e.g., Evans, & Rzeszewski, 2020) – at the forefront of scientific deliberation in the field of VR: the sense of presence and immersion.

Seemingly a myriad of – at times conflicting – definitions exist, which are meant to outline presence. Four decades after Marvin Minsky first coined the term telepresence and laid the basis for presence research (Minsky, 1980), the scientific community has not arrived at an agreed upon standardized conceptualization of presence yet. This uncertainty is best reflected in the various designations used for presence, such as: "feeling", "illusion", "sense", and "subjective experience", to name a few (see Lombard et al., 2015). Despite this terminological confusion, researchers, designers, and programmers agree that achieving high levels of presence should constitute a key goal when designing virtual environments (see Cummings & Bailenson, 2016). And indeed, data suggests that presence is associated with more enjoyment (Shafer et al., 2019), better learning (Makransky, & Petersen, 2021) and increased effectiveness of VR therapy (e.g., Bouchard et al., 2006; Gromer et al., 2019).

Similar to the sense of presence, the definition of immersion also lacks clarity and standardization. Among others, the terms "immersiveness", "immersibility", "immersion ability", "immersive quality of technology", "technological immersion" and "user immersion" are used to refer to various aspects of the technology or user experiences. Accordingly, some researchers (e.g., Slater, 2018) argue that "immersion" is simply an objective property of a technology, whereas others (e.g., Witmer & Singer, 1998) conceptualize "immersion" primarily as a user experience (i.e., the extent to which the user feels immersed), or as a personal trait (i.e., the user's ability to become immersed).

All in all, it remains undisputed that, if this field of research is to proceed to the next level, a comprehensive, precise and unambiguous taxonomy is needed. Much of the difficulty of gaining a full understanding of VR technologies and their effects on human experiences is due to the confusion of terms. This commentary – while not providing a comprehensive review of literature – is an attempt at briefly staking out the field and providing some guidance to those working with VR.

2 Distinguishing between presence and immersion

One of the first – if not the first – researchers to point out the blurred and at times overlapping definitions between the concepts of presence and immersion, was Mel Slater (1999, 2003). As early as 1999, he noted that the operationalization of presence and immersion presented by Witmer's and Singer's (1998) questi-

onnaires did not provide a clear enough distinction between the two. In fact, within the literature – to this date – the terms presence and immersion are employed in quite a confusing variety of ways, i.e., as synonyms (e.g., McGloin et al., 2013), or as one being simply a subcomponent of the other (e.g., Witmer & Singer, 1998). When looking more closely at the conceptualizations in literature, one may understand why this confusion comes about.

For instance, immersion was defined by Bob Witmer and Michael Singer (1998) as "a psychological state characterized by perceiving oneself to be enveloped by, included in, and interacting with an environment that provides a continuous stream of stimuli and experiences" (p. 227). As such, immersion is a human response, or, to be more precise, the extent to which the user focuses his/her attention on the VR environment. In this regard, immersion equates to user involvement. Accordingly, the seminal *Immersive Tendency Questionnaire* (*ITQ*) by Witmer and Singer (1998) provides a measure of individual differences of the propensity to become immersed or involved.

An opposing approach is introduced by Mel Slater (1999, 2003, 2018) who conceptualizes immersion as an objective property of technology. A system is regarded as high in immersion if it delivers a surrounding virtual environment with a wide field of view (360°), shuts out sensations from the physical world by covering the entire visual field (i.e., in form of a head mounted display, HMD), has high resolution and accommodates a variety of interactive sensory modalities such as haptic feedback, real-time motion capture and stereo audio (Slater, 1999, 2018). Following this classification, a HMD delivered virtual world is considered more immersive than a cave automatic virtual environment (CAVE), and a CAVE, in turn, is more immersive than a desktop monitor.

Presence, in this context, is understood as a human reaction to an immersive system (Slater, 2003). Interestingly, this view is shared by Slater and Witmer/Singer, in that they both understand presence as a reaction to technology, and – more precisely – a perceptual illusion, within which the virtual world becomes the dominant one for the user. The user has a "sense of being there" in the virtual environment (International Society for Presence Research, 2000) even though he/she is physically located in another one (i.e., the lab). In line with this, most current presence questionnaires are based on or include this factor (e.g., *Igroup Presence Questionnaire, IPQ*, Schubert et al., 2001).

Although the user has the impression of being in another place, he/she knows that he/she is not factually "in" it. The user remains conscious that he/she is actually in the lab. Hence, it is safe to say that presence is not a cognitive illusion (Slater, 2018). Rather, it is an inherently perceptual one or, more precisely, a "perceptual illusion of non-mediation" (Lombard & Ditton, 1997). A user fails to perceive the role of a device (e.g., HMD) in the delivery of the technologically mediated experience and consequently reacts to virtual stimuli as if they were real, notwithstanding that he/she knows that in fact they are not. The user reacts unconsciously and automatically to a potential threat in VR (e.g., a virtual spider, darkness, heights), whereas the cognitive evaluation of the stimulus ("it was not real") follows with some delay (Slater, 2018).

3 Presence as a consequence of immersion

In line with this reasoning, presence is understood as a consequence of the immersive quality of a technology. The assumption is that if a given technology is less immersive (e.g., a computer screen) levels of presence will be lower than, for instance, in a HMD-delivered environment.

A meta-analysis (Cummings & Bailenson, 2016) aggregating 83 studies provides support for this hypothesis. The authors found a medium-sized effect of technological immersion on presence experiences. Particularly, the implementation of sophisticated user-tracking, as well as the use of stereoscopic vision and wider fields of view have a significant impact, whereas changes to the quality of content, both visual and auditory, did not make any difference in presence levels. While this work provides guidance for VR programmers and designers who wish to maximize presence experiences, it does not take into account a potentially crucial factor – individual differences in presence. This pertains – on the one hand – t o the individual predisposition to experience presence and – on the other hand – to differences in factually experienced presence.

Users may experience different levels of presence within the same VR system, and, vice versa, different technologies with differing levels of immersion may induce the same presence experiences in different users (Salter, 2003). Varying presence levels within the same VR system have been reported in numerous studies (see IJsselsteijn, 2004), adding – on the one hand – sustenance to the assumption that presence is not a completely deterministic function of system immersion, and – on the other hand – prompting researchers to investigate specific psychological factors.

Demographic factors (gender, age; e.g., Felnhofer et al., 2012, 2014) as well as user's perceptual, motor and cognitive abilities (visual acuity, susceptibility to motion sickness, attentional abilities; e.g., Coxon et al., 2016; Iachini et al., 2019) have been considered. However, studies have yet to reach a definite conclusion about their specific impact on presence experiences.

Another psychological factor which may also be of relevance, is the so called "suspension of disbelief" (Slater & Usoh, 1994). This describes the users' propensity of suspending their belief that they are "located in a world other than the physical one" (p. 134). It seems closely related to what has been coined the "book problem" (Biocca, 2003). The book problem pertains to the observation that people can also experience presence with low immersive media such as books, TV-shows or films. Most likely, constructive cognitive processes shape this phenomenon and may explain why some users experience high levels of presence in low immersive VR, whereas others do not. However, the book phenomenon has also been contested by researchers (Waterworth & Waterworth, 2003), who assume that it is more about the emotional engagement of a reader/ a spectator. They argue, that people are so emotionally with the narrative or plot that they feel *as if* they were present.

4 Conclusion and recommendations for future research

First and foremost, we agree with Mel Slater that the specific features of VR technology are an essential factor in the equation of human VR experiences. Also, it is evident that the technology – or rather, its components – can be classified objectively according to their capability of inducing immersion. However, to avoid confusion, we suggest using the term "immersiveness" instead of "immersion". "Immersiveness" means the degree of being immersive and may serve as a denomination of a technology's feature. "Immersion", in turn, rather means the state of being immersed as a user, and hence, is confounded by what we traditionally understand under the term "sense of presence", i.e., being "in" an environment.

Furthermore, we agree that presence is a perceptual illusion which is determined – on the one hand – by the technological makeup of the virtual environment. On the other hand, the link between the system immersiveness and presence is arguably influenced by user factors. These factors include state psychological variables (experience of motion sickness, changing levels of attention, emotional engagement etc.) and trait variables (demographic factors, cognitive abilities, the propensity of suspending disbelief etc.). For a schematic illustration of these relations, see Figure 1.

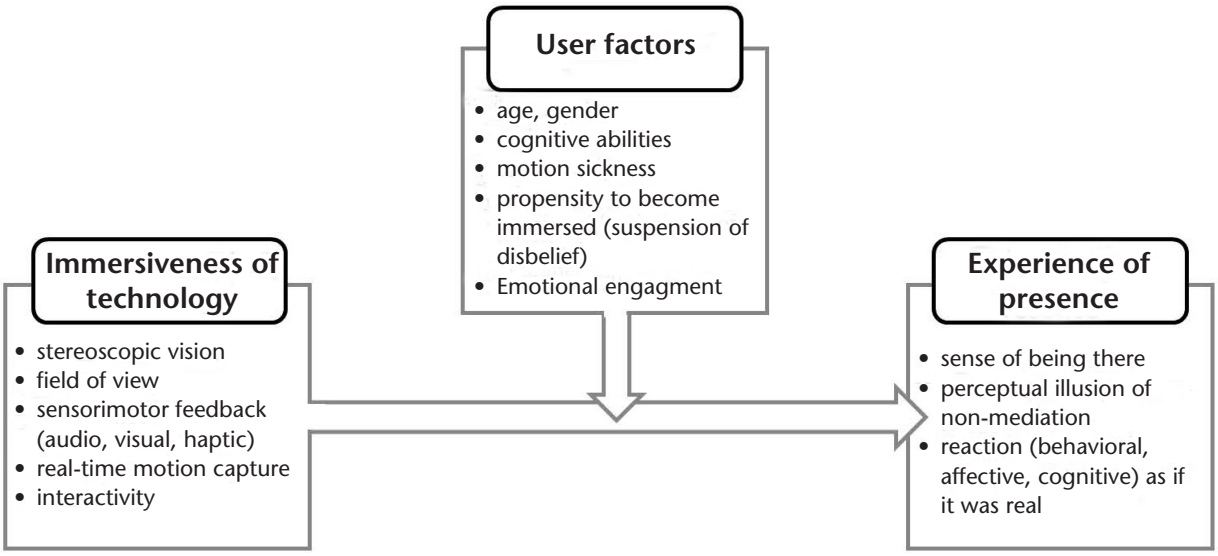

Figure 1. Assumed relationships between technology immersiveness, user factors and presence

To enhance stringency and cross-study-comparability, future papers should adopt a unified terminology and clearly define and describe the adopted operationalizations. Research designs should address the moderating influence of user factors on the link between the immersiveness of technology and presence. Particularly, the question of which perceptual and cognitive functions cause some people to experience high levels of presence and prevent others from doing so. Here, existing models of presence (see *Process Model of Presence Formation* by Wirth et al., 2007) and comprehensive frameworks for immersive technology use (e.g., Suh & Prophet, 2018) are certainly of use.

Finally, of course, measuring the sense of presence in a valid and reliable fashion is still an unresolved issue. Unlike immersive technologies, which may be assessed objectively based on their level of immersiveness (e.g., proposed categorization by Di Natale et al., 2020), measuring presence remains a challenge. Mostly, self-report questionnaires are used post VR-exposure, which are prone to subjective biases (recall-bias etc., see Lombard et al., 2015). Although physiological (e.g., heart rate, skin conductance level, see Felnhofer et al., 2014) and behavioral parameters (e.g., startle reflexes, proxemics, postural responses, see IJsselsteijn, 2004) have been used as indicators for presence, their utility remains questionable (see review by Grassini & Laumann, 2020). In sum, a lot remains to be discovered in the field of VR. As technology continues to evolve, we will certainly not cease to remain curious about the ever-changing possibilities of designing highly engaging, involving, inspiring and true-to-life experiences in all kinds of virtual worlds.

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Contact information

Anna Felnhofer: anna.felnhofer@meduniwien.ac.at
(ORCID: 0000-0002-0081-7489)
Oswald D. Kothgassner: oswald.kothgassner@meduniwien.ac.at
(ORCID: 0000-0002-3243-0238)

*Corresponding author

Anna Felnhofer, Department of Pediatrics and Adolescent Medicine,
Division of Pediatric Pulmonology, Allergology and Endocrinology
Medical University of Vienna, Waehringer Guertel 18–20,
1090 Vienna, Austria, T: +43-(0)1-40400-32720,
e-mail: anna.felnhofer@meduniwien.ac.at

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