

---

## Physiological Measures of Presence in Stressful Virtual Environments, Meehan *et al.*, 2002

---

Hugo Hueber (246095) — [hugo.hueber@epfl.ch](mailto:hugo.hueber@epfl.ch)

### Paper contribution

[0] explores the concept of "Presence" within virtual environments. The notion of "Presence" is complex to define: often perceived as "being there", it is thus a highly subjective measure, difficult to parameterize and reproduce. [0] hypothesizes that a virtual environment causing more presence would be one where the user's psychological response would be proportional to a psychological response in an equivalent real environment. In order to exploit this hypothesis, [0] uses a virtual environment that is stressful for the user, and influenced by elements of comparison, such as the presence of a passive haptic element, or a change in FPS.

[0] exploits a stressful environment proposed in [1]. The study focused on travel methods within a virtual environment, and their impact on immersion, while [0] focuses on presence within the virtual environment. Nevertheless, we can see that both papers are directly inspired by [2], notably for the use of the University College London questionnaire, used to measure presence, with Reported Presence, Reported Behavioral Presence, and Ease of Locomotion. The purpose is to compare the correlation with the previous studies, so that results can be compared and exploited correctly.

Regarding the psychological response, it is difficult to effectively measure its influence. The use of physiological measures is an ersatz of standard measures. [3] presents such measures. [0] starts with the measurement of three natural reactions in the presence of stress from [3], i.e. increased heart rate, increased sweating (via increased conductance, because if the skin perspires more, it is "saltier", and therefore conducts better), and body temperature. [0] results show that indeed, and in accordance with control questionnaires, the heart rate changes in response to the stressful environment. We can also see the influence of a passive haptic element, in this case a "false ground" to simulate a pit, to increase the presence. The simulation's quality, as measured by the FPS, will also have an influence.

The study focuses on finding an unbiased representation of presence. Drawn from [4], [0] tries to present a reliable, valid, sensitive and objective study. The authors also spend a whole section explaining how the different measures respect these values.

To sum up:

- [0] exploits an environment already present in [1];
- [0] reuses a questionnaire from [1] and [2] to get comparable results;
- [0] takes advantage of the psychophysiological shortcuts detailed in [3] to create a link between psychological and physiological responses;
- [0] attempts to follow the definitions in [4] regarding the characteristics of presence measurement, namely "reliable", "valid", "sensitive" and "objective".

## Analysis

At the time of the writing of this report (February, 29th 2020), according to Google Scholar, this paper has been quoted 580 times<sup>1</sup>. Essentially, the citations can be broken down into the following categories:

- Exploitation of the results of the use of physiological responses to determine presence, in addition to the traditional questionnaires;
- Exploitation of avenues for future research to improve presence, including passive haptic devices or the presence of others;
- Exploring "types" of presence, and behavioural differences from real life.

With regard to physiological responses to determine presence, research in therapeutic settings is fond of these topics. Virtual reality can be used to treat mental illnesses such as phobias or traumas. [5] proposes a "SWOT" (Strengths, Weakness, Opportunities, Threats) study of virtual reality for therapies. The study exploits the results of physiological responses of [0], in addition to other measures, such as medical imaging. Some studies go even further, such as [6], which uses various studies of presence to create a cognitive model for representation and analysis. Physiological responses are, of course, central to these studies. It is nevertheless interesting to consider more recent studies, such as [7], which states that some of the responses examined in some studies "resulted from exposure to the VR environment rather than stress". Virtual reality was indeed rather innovative at the time, whereas it is becoming more common nowadays, so the stress induced by it will have less influence on the studies.

Improvements in presence are also a very interesting subject of study. One example is passive haptic devices. [8] explores the "realistic" responses of users to different interactions in order to optimize or even maximize presence. The specific example used from [0] is the "board" to simulate a precipice. The influence of people is also to be explored. With, nowadays, more and more social games on the market (like VRChat), it is common to see the influence of people's presence on presence. [9] proposes an exploration of the influence of additional actors in the environment, while exploiting the physiological findings of [0]. [10] sums the progress of immersion for interactions purposes.

## Conclusion

As regards additional work, the study is ageing. Indeed, [0] proposes ways to improve presence, notably by reducing latency, interaction between other people, and the total elimination of cables, for example. Since 2002, it can be seen that these various elements have been resolved (e.g. VRChat, 2017, a virtual reality chat room game; e.g. Oculus Quest, 2019, a standalone virtual reality headset).

Physiological response as a way to measure presence is to be studied. [0] tries to hint to aim at it with a fiable and scientific procedure. However, because of bias, a more recent study about the sense of presence against a stressful environment could be of use.

---

<sup>1</sup> [scholar.google.com/scholar?q=Physiological+Measures+of+Presence+in+Stressful+Virtual+Environments](https://scholar.google.com/scholar?q=Physiological+Measures+of+Presence+in+Stressful+Virtual+Environments)

## Bibliography

- [0] Meehan, Michael & Insko, Brent & Whitton, Mary & Brooks, Jr, Frederick. (2002). *Physiological Measures of Presence in Stressful Virtual Environments*. ACM Transactions on Graphics.  
<https://nil.cs.uno.edu/publications/papers/meehan2002psysiological.pdf>
- [1] Usoh, Martin & Arthur, Kevin & Whitton, Mary & Bastos, Rui & Steed, Anthony & Slater, Mel & Brooks, Jr, Frederick. (1999). *Walking > Walking-in-Place > Flying, in Virtual Environments*. Proceedings of the 26th Annual Conference on Computer Graphics and Interactive Techniques ACM.
- [2] Slater, Mel & Usoh, Martin & Steed, Anthony & Mary, Queen & College, Westfield. (1995). *Taking Steps: The Influence of a Walking Technique on Presence in Virtual Reality*.  
[https://www.researchgate.net/publication/2457602\\_Walking\\_Walking-in-Place\\_Flying\\_in\\_Virtual\\_Environments](https://www.researchgate.net/publication/2457602_Walking_Walking-in-Place_Flying_in_Virtual_Environments)
- [3] Andreassi, John L.. (1995). *Psychophysiology: Human behavior and physiological response*. Hillsdale, N. J., Lawrence Erlbaum Associates.
- [4] Sutherland, Stuart. (1996). *The international dictionary of psychology*. New York, The Crossroads Publishing Company.
- [5] Rizzo, Albert & Jounghyum Kim, Gerard. (2005). *A SWOT Analysis of the Field of Virtual Reality Rehabilitation and Therapy*. Presence, Vol. 14, No. 2, April 2005, 119–146.  
<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.533.5546&rep=rep1&type=pdf>
- [6] Seth, Anil K. & Suzuki, Keisuke & Critchley, Hugo D. (2012). *An interoceptive predictive coding model of conscious presence*. Front. Psychology 2:395.  
<https://www.frontiersin.org/articles/10.3389/fpsyg.2011.00395/full>
- [7] Martens, Marieke AG & Angus Antley & Daniel Freeman & Mel Slater & Paul J Harrison & Elizabeth M Tunbridge. (2019). *It Feels Real: Physiological Responses to a Stressful Virtual Reality Environment and Its Impact on Working Memory*. Journal of Psychopharmacology 33, no. 10 (October 2019): 1264–73. doi:10.1177/0269881119860156.  
<https://journals.sagepub.com/doi/full/10.1177/0269881119860156#articleCitationDownloadContainer>
- [8] Slater, Mel. (2009). *Place illusion and plausibility can lead to realistic behaviour in immersive virtual environments*. Philosophical transactions of the Royal Society of London. Series B, Biological sciences, 364(1535), 3549–3557.  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2781884/>
- [9] Ravaja, Niklas & Saari, Timo & Turpeinen, Marko & Laarni, Jari & Salminen, Mikko & Kivikangas, Matias. (2005). *Spatial Presence and Emotions during Video Game Playing: Does it Matter with Whom You Play?*. Presence Teleoperators & Virtual Environments · August 2006.  
[https://www.researchgate.net/profile/Niklas\\_Ravaja2/publication/220089641\\_Spatial\\_Presence\\_and\\_Emotions\\_during\\_Video\\_Game\\_Playing\\_Does\\_It\\_Matter\\_with\\_Whom\\_You\\_Play/links/0fcfd5092ede92130b000000.pdf](https://www.researchgate.net/profile/Niklas_Ravaja2/publication/220089641_Spatial_Presence_and_Emotions_during_Video_Game_Playing_Does_It_Matter_with_Whom_You_Play/links/0fcfd5092ede92130b000000.pdf)
- [10] Bowman, Doug & McMahan, Ryan. (2007). *Virtual Reality: How Much Immersion Is Enough?*. Computer. 40. 36 - 43. 10.1109/MC.2007.257.  
<http://www.cs.rug.nl/~roe/courses/OriInf/Bowman-Virtual-Reality>