

Literature Review 1 Zipei Wei

The two articles I choose were from IEEE Transactions on Visualization and Computer Graphics. The newer article was published by Richard Skarbez and Frederick P. Brooks in University of North Carolina, Chapel Hill. These two articles both focus on psychophysical effects in virtual reality design. The first article was published in 2010 and the newer article was published in April 2017. Both articles concentrated the concept that was proposed by Slater in 2009 and conducted two similar experiments based on the Slater's theory. Based on Slater previous experiments, when talking about user experiences in virtual reality, he proposed two investigating factors in virtual environments (VEs): The Place Illusion (PI) and the Plausibility Illusion (Psi). Both articles let the participants experienced the difference and reported how reality it is when they modified the various factors in Slater's theory. The older article published by Mel Slater evaluated the Place Illusion (PI) and the Plausibility Illusion together and helps provided a better guide for providing feedbacks with the virtual reality design [Slater. 2010]. The newer article mainly focuses on the Plausibility Illusion factors and was conducting a similar experiment as the older one. Both articles can serve as a great guide when designing the virtual reality. The results of both experiments showed how different factors would affect how users think how "real" it is when they are immersing in virtual reality environments.

The older article published by Slater first proposed a general question: How do we evaluate how 'real' it is when users are wearing the virtual reality devices? That is when talking about how 'real' it is, it is not only about asking the participants a Likert scale how likely it is that they really 'be there' [Slater 2010]. For instance, the human vision system can be fooled from time to time. Imaging we heard the story that a traveler traveling in the desert and saw a green plant right in front of him. But when he arrived, it becomes clear that the green plant is just a visual illumination that was projected far from him. So when taking into consideration about virtual reality, Slater proposed that we do not only measure the PI factor, which stands for "the sensation of being in the place" when submerged into the VEs. We also need to take a consideration of the Plausibility (Psi) factor, which measuring after what's happening in VEs, it is "really" happening [Slater 2010]. This means after we were convincing by the VEs in the first place, all the elements and factors in the VEs kept us believe that it is "really" happening. From here, we can see that Plausibility factors (Psi) could also be an important measurement as well. For example, often in time when we are playing the video game. We got conceived by the realistic of the game. Later on, we found out our virtual body didn't move the ways as we want. Suddenly we were noticed that we were fooled by the game and all of these are illusions. Hence, after Slater's theory, Slater conducted an experiment to measure how different factors in Place Illusion (PI) and Plausibility Illusion (Psi) yield the optimal results. Richard Skarbez and Frederick P. Brooks conducted a further experiment to measure the Plausibility Illusion (Psi).

In 2010, Slater proposed the 2-factors (PI and Psi) theory in VEs that delivery a further detailed measurement than the theory proposed from 2001 by Witmer Et al. In Slater experiment, 20 participants were selected from the university campus with an average age around 27. Among the participants, only two participants had experiences in virtual reality. Then the participants

are split into two groups to measure the Place Illusion (PI) and Plausibility Illusion (Psi). Each participant will have 5 trials with different configurations. They will stop each trial once they felt like they reached the optimal level of PI or Psi.

In this experiment, the configurations were measured with four properties and each property were given on different level of intensity. The four properties are Illumination, Field-of-view, Display type and Virtual Body. And each property has an increasing level of realistic, such as Display types are either Powerwall display or Head-mounted display. In most cases, Head-mounted display yields a better virtual reality. Before the experiment, each participant was trained how to adjust the level of different configurations as well as wearing a tight-fitting Velcro suit to track the whole body movement. With the number of configurations and level of each configuration, there are total 36 configurations to choose. In each trial, the system will start with different basic configuration and the participants were asked to adjust the configuration until they reached the optimal level of PI or Psi [Slater 2010]. There are several rules applied when adjusting the configurations:

- 1) Once they increase a level of one configuration, they cannot reverse the procedure.
- 2) The level of configuration can only be adjusted one increase level at a time.
- 3) To prevent random steps were chosen to yield the optimal result, the participants were rewarded with 10 euros. Every adjustment would cost 1 euros.
- 4) Repeat the previous step 5 times.

The results of the experiment are very interesting. For the Place Illusion (PI) group, the Illumination was set to the lowest level but with the highest level of Virtual Body when met the stopping conditions. For the Plausibility Illusion (Psi) group, the stopping conditions were met with the middle level of illumination and lowest level of Virtual Body. Secondary yield results for Psi group are the highest level of Illumination, lower level of Field-of-view, the higher level of Display type (HMD) and middle level of Virtual Body. Also, results have shown: Overall, PI group choose the better Display Type (HMD) more often than the Psi group. Summarize this results, Slater concluded that: Natural sensorimotor contingencies affect the PI most and Illumination realism may be important factors of Psi [Slater 2010]. In the results, HMD yields a better result for PI is due to the HMD changes the views according to the head movement will generate a better natural sensorimotor effect. In the same time, they found the virtual body is important in both PI and Psi [Slater 2010]. Overall, HMD display and field-of-view are important for PI and Illumination is important for Psi. However, virtual body played an important factor in both PI and Psi.

After Slater proposed two factors for evaluating user experience in virtual environments (VEs) in 2009 [R. Skarbez 2017]. Researchers at the University of North Carolina, Chapel Hill proposed a new experiment that mainly focuses on evaluating the Plausibility Illusion (Psi) factor in virtual environments. Instead of including factors like Field-of-view or different versions of Display Type, Frederick experiment mainly focuses on by changing the visual factors that displayed on the screen and see how these factors yield to the optimal level of Psi].

In Slater's experiment, they constructed four configurations that affecting the screen display: VH (Virtual human behavior coherence), VB (Virtual body behavior coherence), P (Physical coherence) and S (Scenario coherence). Each configuration will yield a different screen display and interaction. For instance, Increment of VH will generate a realistic conversation and walking animations, Increment of VB will generate a fully tracked avatar, Increment of P will generate a better physical simulation when the participants kicked the balls in VEs and Increment of S will generate a more realistic scenario. There are total 81 configurations of this experiments (3 VH, 3 VB, 3 P, 3 S).

Twenty-one participants were selected for the experiment with average age of 24 (10 male, 11 females). The experiments were conducted the similar way as the Slater's experiments. Each participant will start from the highest levels of coherence in the first place. This will be the reference of evaluating "optimal sensation of reality". In each trial, participants were randomly given a basic configuration and they were told to reward the points once they reached the optimal sensation. Results of the experiment shown configuration {2, 2, 1, 2} were selected most. The experiment shows the majority of users immediately upgrade the virtual body twice. Following most users upgrade the Scenario. By interviewing the participants, 90.9% of users claimed the virtual body is the most important factor. The second important factor is scenario coherence. Also, some participants claimed physical coherence has an extended effect and is sensitive to sex [R. Skarbez 2017]. By summarizing the results, they concluded that Virtual Body have a primary effect on Psi and they suspect that Virtual Body would have a significant influence on PI.

Both articles conducted statistic significant experiments from different approach. The first experiment serve as a general guideline of the second article, where the second article specifically examining a detailed factor. They both can be a very useful guide in Virtual Environment industrial design. Apparently the Psi experiment was based on the theory from the previous article and the Slater's theory. Then this brings a question to think, how good are Slater's theory?! Will the virtual environment really projected by the PI and Psi ? Will there be some interactions between PI and Psi? Since both experiments showed that the important factors between PI and Psi are highly correlated, then evaluating PI and Psi individually may not be significant difference. Should we investigate the correlation later after publication of these two articles? Nevertheless, the interesting part that I learned in these two articles are about how they set up the experiment and how they evaluate the experiment results (Chi-square, Markov Chain...etc). Their experiments show that it is not only important to design the experiments, the more important part is how the experiment results are evaluated and justified. Overall, I believe the PI illusion and Psi illusion would really help to improve the realistic of virtual reality design and both of experiments are scientific qualified.

Reference:

APA:

[1] R. Skarbez, S. Neyret, F. P. Brooks, M. Slater and M. C. Whitton, "A Psychophysical Experiment Regarding Components of the Plausibility Illusion," in *IEEE Transactions on Visualization and Computer Graphics*, vol. 23, no. 4, pp. 1369-1378, April 2017.
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[2] Mel Slater, Bernhard Spanlang, and David Corominas. 2010. Simulating virtual environments within virtual environments as the basis for a psychophysics of presence. In ACM SIGGRAPH 2010 papers (SIGGRAPH '10), Hugues Hoppe (Ed.). ACM, New York, NY, USA, Article 92, 9 pages. DOI: <https://doi.org/10.1145/1833349.1778829>

BibTex:

[1]
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[2]
@inproceedings{Slater:2010:SVE:1833349.1778829,
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