

From Technology to Content: Research on the Development of VR Flow Experience

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Abstract

Immersion is a features of VR technology, and the most important condition for evaluating VR experience. With the improvement of VR technology, including the presentation accuracy of VR content, the degree of interaction is diversified, the user's immersion in VR equipment should not only be improved technically, but researched from the user's perception level. The paper defines two important factors, immersion and presence, in a participant's experience with a VR device. Although the current technology can already simulate the real environment information visually and audibly, the content of the VR environment is not enough for us to achieve a completely real experience. Based on the Flow theory of Csikszentmihalyi and the sensory immersion achieved by current technology, this paper proposes the key factors of how to achieve conscious immersion for users in VR media. We prove that immersion is an indicator of the true degree of sensory simulation of VR equipment and is the basis for the realization of flow experience. What really makes the participant feel a perfect experience is the content provided by the VR environment and gave participants a sense of presence, it is not limited to video or games. On the premise of the Multi-Sensory, Immersion, Interactivity and Imagination experience achieved by using virtual reality technology, combined with the content creation of flow theory, the interactive immersion achieved by users is an important method to realize the awareness immersion of VR equipment.

Keywords: *Flow Experience, VR, Immersion, Presence.*

1. Introduction

Virtual Reality (VR for short) has been a hot topic of public discussion in recent years. VR equipment builds a three-dimensional scene through computer technology and allows users to perceive it with the help of specific equipment and supports an experience of interaction. [1] Immersion is one of the three features of VR

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technology, and it is also a method for users to have a good experience in VR devices.

Immersion is experience of subject cognition in consciousness space and it's a situation of Flow. What he means in the dictionary is "to concentrate wholeheartedly on something." There are two perspectives to this concept in current research. One is immersion, which is based on new media technologies such as virtual reality and combines special narrative techniques to create an immersive experience with fake and real media images. The other is presence, which is based on the user's psychological situation. When a user experiences a VR environment with a higher level of presence, the user will have a higher level of believability in the environment. Based on presence, we introduce flow experience. It proposed by psychologist Csikszentmihalyi in his theory of flow. When the individual is very deeply engaged, immersed in an activity. This is the perfect moment of real time outflow, the flow of joy and creativity. [2] According to this view, we are at our best experience situation when we enter the flow experience.

Combined with the current development of VR technology, standing in different angles and directions, the understanding of immersion is different. In the fields of computer science and graphics concerned with the construction of virtual reality environments, the term used is 'Immersive environment', and immersion reflects the advancement of visual simulation technology. [3] Therefore, it is necessary to improve the realism of the content picture and the hardware level of the VR equipment. For users, the improvement of technology will inevitably bring about product innovation, and a cost must be paid to have a better flow experience. In this paper, from the perspective of video content, combined with psychological methods, "immersion" will be the object of discussion, a clearer understanding of immersion, and the design of VR content based on flow theory. The content related to the features of flow theory can improve the user's experience of VR content from the content without improving the VR equipment. Thus, mass users can have a better flow experience in VR devices, whether in video or game content.

2. Literature Review

Because in the previous part we mentioned that the definition of immersive experience is different in different disciplines. So, we will first define the concepts we mentioned and summarize the previous studies.

2.1 Development of VR Technology

VR known as virtual technology and virtual environment, is new practical technology developed in the 20th century. Simulation, allowing users to feel as if they were there, seeing things in three-dimensional space instantly and without restrictions. [4] With the development of science and technology, virtual reality technology has also made great progress, and gradually become a new field of science and technology. VR market is also expected to grow to \$20 billion by 2022. Currently, virtual reality technology is being used in various fields of medical, defense, entertainment, and other industries. VR features three-dimensional spatiality, real-time interaction, and immersion. It can provide users with information that does not exist in reality through display equipment, etc. [5] According to human visual characteristics, VR display devices provide a viewing range of more than 100 degrees. Using head tracking technology and interactive technology, realizes all-round visualization and interactivity of virtual reality items. [6]

2.2 Immersion and Presence

Many people are confused about the terms Immersion and presence. Mel Slater defines the terms: Immersion refers to the objective level of sensory fidelity a VR system provides. Presence refers to a user's subjective psychological response to a VR system. [7]

It defines that 'Immersion' as an objective property of a system, and higher or lower immersion as the extent to which a VR system can support natural sensorimotor contingencies for perception. [8] At higher immersion,

according to the definition of VR, we can see the environment generated by higher resolution computer graphics, hear the sound effect of higher degree of reproduction, have more realistic interaction and feedback, and even have haptic or Simulation of olfactory information. Immersion means how much can be simulated in the human five senses.

About presence, the existing sense in virtual reality means 'experimental psychological situation that exists in a virtual world, not in the real world' [9] Different users can experience different levels of presence with the same VR system, and a single user might experience different levels of presence with the same system at different times, depending on situation of mind, recent history, and other factors. [10] Studies show that in virtual reality using 3D avatars; people believe more when they feel a highly presence. [11] Compared with the high fidelity brought by VR equipment, high presence of VR environment will bring users high confidence in VR content.

2.3 Flow Theory

The starting point of research on immersion is the concept of Flow proposed by the Hungarian positive psychologist Mihaly Csikszentmihalyi in the 1960s. His thinking is based on the observation of the painter's sleepless situation in the creation process. They can ignore hunger, fatigue, and all kinds of discomfort," but they "lose interest very quickly" when the work is finished. [12] To study the internal motivation of this driving behavior, he proposed the "Flow Theory" and conducted a systematic study. He believes that: "The Flow Experience" is a coping and controllable "The subjective experience process of "challenge", which consists of a series of goals, and individuals in the "Flow Experience" situation can obtain continuous feedback in the process of exceeding these goals and can adjust their behavior according to this feedback. [13] The point of view is "based on interaction theory, rather than ignoring the situation to pay attention to human behavior", and it emphasized that Flow is a "dynamic equilibrium process". [14]

3. Discuss

According to previous research, the immersion achieved by VR technology is the more convincing the sensory data generated by the technology. So, the more believable the sensory data is, the more it can get presence. It is believed that Sensory immersion is a technology's ability to create a convincing, immersive environment with which the user can interact. [15] Slater and Wilbur (1997) define sensory immersion as the extent to which a display technology exhibits the following five characteristics: inclusiveness, extensiveness, surroundingness, vividness, proprioceptive. [16] In causal terms, the basic model of presence's antecedents looks something like this: technological features -immersion - realism/sensory fidelity - presence. [17] According to this model, it found a way to associate immersion and presence.

In this part, we will discuss the relationship between presence and Flow, and introduce Flow theory in detail in combination with the features of VR contents. And find the relationship between immersion, presence and Flow.

3.1 Presence to Flow

Consciousness is the core issue of flow theory. [18] Furthermore, presence is linked to all aspects of consciousness, especially self-consciousness. [19] So, to connect presence and Flow, consciousness is the key to research. It will start with consciousness. Riva develops presence as consciousness experience consisting of the following three layers, Proto presence, Core presence and Extend presence. [20] The proto presence is the basic, people can feel their body and receive information through their senses. At this level, in a virtual environment, the virtual avatar feels like an extension of the physical body. The core presence is a situated and

conscious sense of being in the present, in the here and now. [21] The extended presence is the sense of being in the external world as an historical and a future self that has a relatively persistent identity with fairly immutable properties. [22] In Ulrike Schultze's research, optimal presence is achieved when all three layers of consciousness are focused on a particular activity or situation in the external environment. [23] But he develops that when presence on the three Levels of Consciousness is integrated, the participant will enter a situation of flow for the best experience. This view is not entirely correct. But when we review the Flow Theory, we find that when we achieve flow experience, we will ignore the content that is not relevant to our current experience. This is reflected in the ambiguity of time and the neglect of other objects. From this view, the meaning and value of self-identity in extended presence are not of flow experience.

According to this theory, the core presence is more like the situation before Flow experience. When we can obtain sensory information from proto presence fluently and articulately, we can use our previous experience and knowledge to selectively interact with objects. And when we're in this situation for a long time, we get into a flow experience. What needs to be emphasized here is that presence is a feeling that relies on sensory input from the environment, interacts with objects, and is enhanced by the presence of meaning and value. The flow experience is a situation and is time-dependent and manifested as self-consciousness. So, when we achieve core presence on consciousness level, and maintain it, we are likely to enter a flow experience. Riva suggests that flow requires the experiences that is perceived as positive. [24] Obviously, in the extended presence, we feel value and meaning, which is positive. The extended presence will support us to obtain flow but if our consciousness is mainly maintained here, we will not be able to obtain flow. This is not contradictory. This requires us to focus our efforts primarily on gaining core presence.

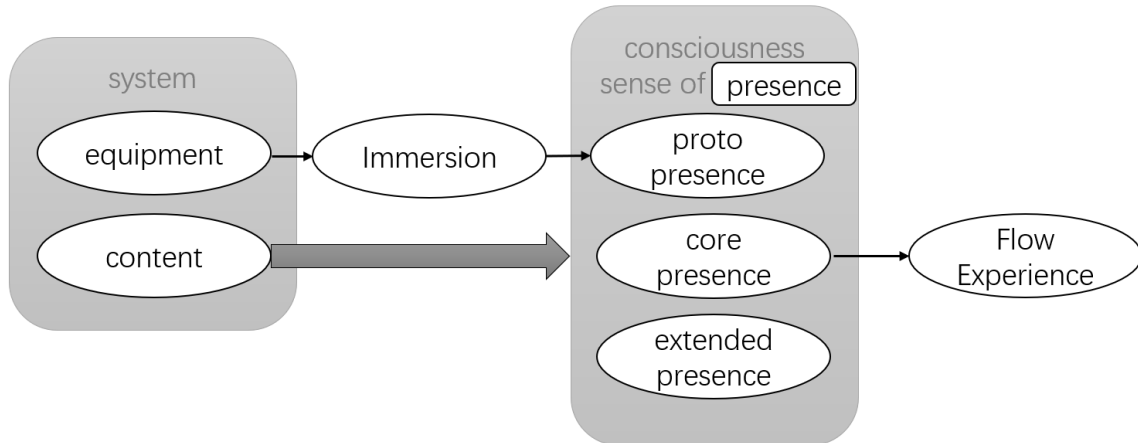


Figure 1. Process to Flow Experience.

3.2 Process of Flow Experience

Before we discuss the flow process, we must first define the factor that achieves the flow situation. For a long time, there are many viewpoints on the content dimension of flow experience, including single factor, two factors, three factors and multiple factors. But in either view, scholars emphasize the role of attentional concentration, intrinsic motivation, clarity of purpose, and a sense of control on flow. [25] In Klasen's experiments on flow experience during video games, it is proved that four of the factors—balance between ability and challenge, concentration and focus, clear goals and control affect the flow experience in video games. [26] Different studies, through different experiments, concluded that the order of importance of these

factors is different. Csikszentmihalyi has also warned against putting too much emphasis on any empirical measurement of flow, lest you lose the experience of flow in the process. [27] In this paper, we will discuss these factors without distinguishing which is more important. When participants have such factors, they will be better in the flow experience.

Most scholars agree that high concentration of attention is the more important factor. Rheinberg proposed a two-factor model of flow content: high concentration of attention (centering of attention) and smooth action of behavior (smooth action), where high concentration of attention is the core factors of flow. [28] When we are highly focused, we have a hard time noticing things outside of our current job and will stay that way for a long time. When we increase our level of concentration and focus, it is also easier for us to stay in the flow experience.

Clear goals in the activity are clearly defined to give people in flow a strong sense of what they are about to do. Likewise, the clarity of the goals can have a positive effect on flow.

A sense of exercising control is experienced, without the person actively trying to exert control. [29] We need to have a sense of control over the work we are dealing with, especially when faced with challenging tasks. A sense of control is necessary when we deal with difficult tasks.

Ability and Challenge Balance, Csikszentmihalyi explain this dimension as oncoming when a person's ability is at just the right level to cope with the situational demands, which are above average for the person. [30] When the task is not challenging, we will get bored, or the task is too difficult, we get anxious, and we don't get into the flow experience very well. Only when the two are in balance will they be better maintained in the flow experience.

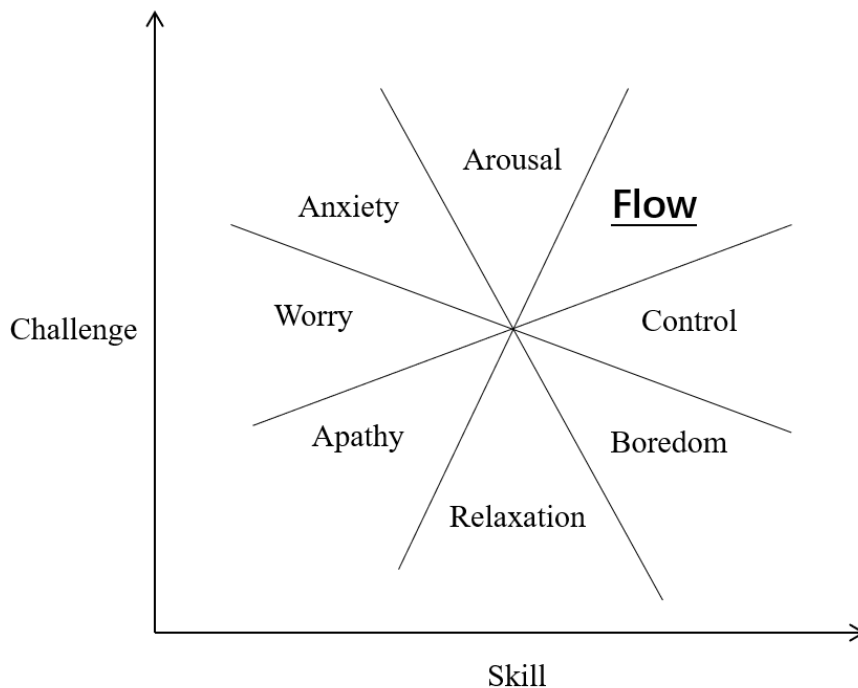


Figure 2. Skill-to-challenge relationship diagram

4. Process of VR-Flow Experience

In the previous section, we discussed the process of entering the Flow experience, combined with the flow

experience with VR content. In this section, we will use this information to propose how the content can be designed to allow users to quickly enter the flow experience. And how to maintain the flow experience of the content after entering the flow experience situation.

First, let's determine the conditions for a better entry into the flow experience. Proto presence is required for our VR device to have good sensory input. It includes continuous visual and auditory information, tactile feedback of the interaction between the participant and the virtual environment and is not limited to the input of sensory information such as smell and taste that may appear later. [31] When the information of the VR environment simulation is close to the real degree, we call it immersion.

According to the previous discussion, the provision of Proto presence is not the most important, but it is the most basic. Only when this condition is met can we proceed to the next step. Proto presence is based on our VR equipment. But what ultimately enters the flow experience is more realized by the exchange of virtual environment content and participant awareness.

Core presence is dependent on sensory input. After meeting this condition, based on the knowledge and experience in the participants' minds, the consciousness selectively interacts with the virtual environment and transforms the virtual environment. In this regard, we need to interact with the experienter with selective content according to the experienter's own situation. [21]

The content selected is based on the experience and skill level of the experienter. This mechanic is present in many PC games today. This mechanism of providing different game content based on player level is common in multiplayer competitive games. The level system is set based on the player's winning and losing performance in a certain period, and the player will refer to this level in the subsequent games to select players with similar strength to the player to compete. In a stand-alone game, it is reflected in the player's choice of the difficulty of the game at the beginning of the game, and there will be a mechanism to reduce the difficulty of the game after the player repeatedly fails.

Some data show that many VR device users have a high threshold for using VR devices, resulting in poor experience. The reason is that they do not provide differentiated content to different users, resulting in a low level of Core presence. For users who are new to VR equipment, we need a very detailed introduction and guidance.

Extended presence is generated when the participant's experience and knowledge are significant to the current environment. This is like the benefits of an in-game level system, such as differences in ranking or appearance. This will make us wait for the core presence, but excessive concentration and extended presence will take away the attention from the flow experience, which is not conducive to the maintenance of the flow experience.

On the other hand, we must come up with ways to maintain the Flow experience based on the previously identified factors. First, we need Clear goals, which is necessary in some games with a grand world view, because a lot of game content will easily make players lost. The game mechanics set for this are the main quest and side quests with prominent reminders. This is not contradictory to players having their own ideas and goals. Ability and Challenge Balance not only require players to choose by themselves, but also require a complete mechanism to balance the player's skill level and the game difficulty experienced. However, it cannot deprive players of the choice of difficulty of the game, because the sense of control is also a factor for the participants to maintain the flow experience. When players find that they cannot control their game content, they will immediately lose the flow experience. For example, in competitive games, when the obviously weaker side cannot win, they will be more responsible for their teammates in the game or do some unrelated things. At the same time, when we experience the content, we need to exclude irrelevant information, so that we can achieve a high concentration of attention as much as possible.

5. Conclusion

Flow is a situation of mind that is fully focused and devoted to the activity itself. Participants in a situation of flow can fall themselves in the current activity and sometimes even lose the concept of time, space, and the perception of the surrounding environment. The contribution of this paper is to draw a strict distinction between immersion, presence, based on sensory experience and cerebral awareness. In this situation, participants can experience the VR environment completely. At the beginning of VR content design, incorporating the four factors in the paper into the game design architecture can make participants better experience VR content. At present, the combination of powerful computer interactivity and VR content functions to construct an appropriate VR environment can already provide participants with a realistic sensory experience. But the current VR content is not very good for the participants, so we need to improve the content.

In the paper, we explain the significance of the flow in the participant's situation of the VR experience, including how immersion presence and flow relate to and influence each other. The process of reaching flow is proved theoretically, and the corresponding method is also proposed in combination with the discussion. This paper proposes that VR content needs to be rationally designed using flow theory, to allow participants to achieve a better experience. Whether it is the refinement of the VR user experience process and the design of the method is intended to be applied to the future VR content design for interaction between human senses.

References

- [1] Kaufmann, Hannes, Dieter Schmalstieg, and Michael Wagner. "Construct3D: a virtual reality application for mathematics and geometry education." *Education and information technologies* 5.4 (2000): 263-276.
DOI: <https://doi.org/10.1023/A:1012049406877>
- [2] Molnár, György, and Zoltán Szűts. "Augmented Reality, Games and Art: Immersion and Flow." *Augmented Reality Games I*. Springer, Cham, 2019. 61-67.
DOI: https://doi.org/10.1007/978-3-030-15616-9_5
- [3] Kong Shaohua. "From Immersion to Flow experience: Re-understanding of "Immersive Communication"." *Journal of Capital Normal University: Social Science Edition* 4 (2019): 74-83.
- [4] Witmer, Bob G., and Michael J. Singer. "Measuring presence in virtual environments: A presence questionnaire." *Presence* 7.3 (1998): 225-240.
DOI: <https://doi.org/10.1162/105474698565686>
- [5] Mine, Mark R. "Virtual environment interaction techniques." UNC Chapel Hill CS Dept (1995).
- [6] Jeong, Wonjun, and Seokhee Oh. "Correlation between the immersion and presence: focused on virtual reality contents." *2020 International Conference on Information and Communication Technology Convergence (ICTC)*. IEEE, 2020.
DOI: <https://doi.org/10.1109/ICTC49870.2020.9289207>
- [7] Bowman, Doug A., and Ryan P. McMahan. "Virtual reality: how much immersion is enough?." *Computer* 40.7 (2007): 36-43.
DOI: <https://doi.org/10.1109/MC.2007.257>
- [8] Slater, Mel, Bernhard Spanlang, and David Corominas. "Simulating virtual environments within virtual environments as the basis for a psychophysics of presence." *ACM transactions on graphics (TOG)* 29.4 (2010): 1-9.
DOI: <https://doi.org/10.1145/1778765.1778829>
- [9] Cheng, Li-Keng, Ming-Hua Chieng, and Wei-Hua Chieng. "Measuring virtual experience in a three-dimensional virtual reality interactive simulator environment: a structural equation modeling approach." *Virtual Reality* 18.3 (2014): 173-188.
DOI: <https://doi.org/10.1007/s10055-014-0244-2>
- [10] Bowman, Doug A., and Ryan P. McMahan. "Virtual reality: how much immersion is enough?." *Computer* 40.7 (2007): 36-43.

DOI: <https://doi.org/10.1109/MC.2007.257>

[11] Kang, Sing Bing. "Hands-free interface to a virtual reality environment using head tracking." U.S. Patent No. 6,009,210. 28 Dec. 1999.

[12] Csikszentmihalyi, Mihaly, and Mihaly Csikzentmihaly. *Flow: The psychology of optimal experience*. Vol. 1990. New York: Harper & Row, 1990.

[13] Csikszentmihalyi, Mihaly, and Mihaly Csikzentmihaly. *Flow: The psychology of optimal experience*. Vol. 1990. New York: Harper & Row, 1990.

[14] Nakamura J, Csikszentmihalyi M. The concept of flow. *Oxford handbook of positive psychology*. Oxford University Press, 2009: 89–105

[15] Schultze, Ulrike. "Embodiment and presence in virtual worlds: a review." *Journal of Information Technology* 25.4 (2010): 434-449.

DOI: <https://doi.org/10.1057/jit.2010.25>

[16] Slater, Mel, and Sylvia Wilbur. "A framework for immersive virtual environments (FIVE): Speculations on the role of presence in virtual environments." *Presence: Teleoperators & Virtual Environments* 6.6 (1997): 603-616.

DOI: <https://doi.org/10.1162/pres.1997.6.6.603>

[17] Schultze, Ulrike. "Embodiment and presence in virtual worlds: a review." *Journal of Information Technology* 25.4 (2010): 434-449.

DOI: <https://doi.org/10.1057/jit.2010.25>

[18] Guoyao, Tang, and Zhou Wenjie. "The Study on Self-consciousness in Flow." *Philosophy Study* 10.10 (2020).

DOI: <https://doi.org/10.17265/2159-5313/2020.10.002>

[19] Herbelin, Bruno, et al. *Neural mechanisms of bodily self-consciousness and the experience of presence in virtual reality*. No. BOOK_CHAP. De Gruyter, 2016.

DOI: <https://doi.org/10.1515/9783110471137-005>

[20] Riva, Giuseppe, John A. Waterworth, and Eva L. Waterworth. "The layers of presence: a bio-cultural approach to understanding presence in natural and mediated environments." *CyberPsychology & Behavior* 7.4 (2004): 402-416.

DOI: <https://doi.org/10.1089/cpb.2004.7.402>

[21] Fabrega Jr, Horacio. "The feeling of what happens: body and emotion in the making of consciousness." *Psychiatric Services* 51.12 (2000): 1579-1579.

DOI: <https://doi.org/10.1176/appi.ps.51.12.1579>

[22] Schultze, Ulrike. "Embodiment and presence in virtual worlds: a review." *Journal of Information Technology* 25.4 (2010): 434-449.

DOI: <https://doi.org/10.1057/jit.2010.25>

[23] Schultze, Ulrike. "Embodiment and presence in virtual worlds: a review." *Journal of Information Technology* 25.4 (2010): 434-449.

DOI: <https://doi.org/10.1057/jit.2010.25>

[24] Riva, Giuseppe, Fabrizia Mantovani, and Andrea Gaggioli. "Presence and rehabilitation: toward second-generation virtual reality applications in neuropsychology." *Journal of neuroengineering and rehabilitation* 1.1 (2004): 1-11.

DOI: <https://doi.org/10.1186/1743-0003-1-9>

[25] Chen Xin. "Flow experience and its research status." *Journal of Jiangsu Normal University: Philosophy and Social Sciences* 40.5 (2014): 150-155.

[26] Klasen, Martin, et al. "Neural contributions to flow experience during video game playing." *Social cognitive and affective neuroscience* 7.4 (2012): 485-495.

DOI: <https://doi.org/10.1093/scan/nsr021>

[27] Csikszentmihalyi, Mihaly. "A response to the Kimiecik & Stein and Jackson papers." *Journal of Applied Sport Psychology* 4.2 (1992): 181-183.

DOI: <https://doi.org/10.1080/10413209208406460>

[28] Rheinberg, Falko, and Regina Vollmeyer. "Flow experience in a computer game under experimentally controlled conditions." *ZEITSCHRIFT FUR PSYCHOLOGIE-JOURNAL OF PSYCHOLOGY* 211.4 (2003): 161-170.

[29] Jackson, Susan A., and Herbert W. Marsh. "Development and validation of a scale to measure optimal experience:

The Flow Situation Scale." *Journal of sport and exercise psychology* 18.1 (1996): 17-35.

DOI: <https://doi.org/10.1123/jsep.18.1.17>

[30] Csikszentmihalyi, Mihaly, and Isabella Selega Csikszentmihalyi, eds. *Optimal experience: Psychological studies of flow in consciousness*. Cambridge university press, 1992.

[31] Dinh, H. Q., Walker, N., Hodges, L. F., Song, C., & Kobayashi, A. (1999, March). Evaluating the importance of multi-sensory input on memory and the sense of presence in virtual environments. In *Proceedings IEEE Virtual*, pp. 222-228.

DOI: <https://doi.org/10.1109/VR.1999.756955>