Experiencing Waiting Time in Virtual Reality

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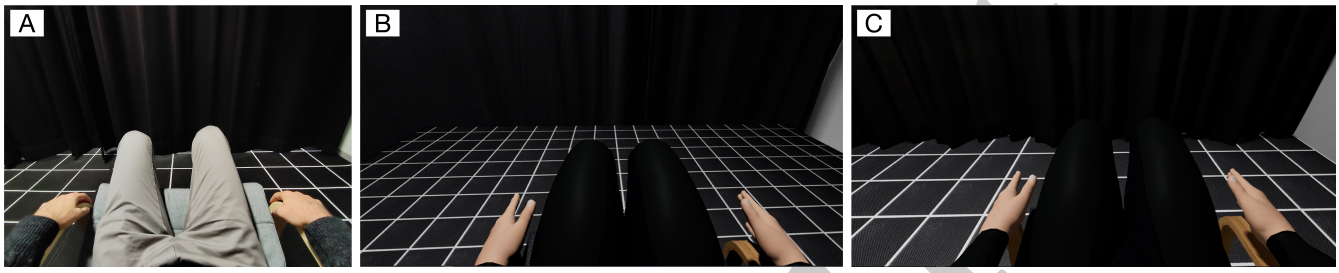

Figure 1: First-person perspective of our environmental conditions: A) *Real* B) *360-picture avatar* and C) *3D-model avatar*

ABSTRACT

This article investigates the impact of waiting in Virtual Reality (VR) on the perception of time. We manipulated the visual quality of a virtual room replicating a real one (360°-picture vs. 3D-model) with and without avatar embodiment (no-avatar vs. avatar). We only observed a significant difference in the estimated time duration between the real and the virtual worlds when using no avatar within a 3D model of the room. Our early results suggest that a VR environment with an avatar and a simple 3D model or 360 picture room is not significantly perturbing time perception and thus could be used for diagnosis and therapy of psychiatric conditions related to altered time perception.

KEYWORDS

Virtual Reality, time experience, embodiment

1 INTRODUCTION

The sense of time lets us feel as "being present here and now", a fundamental prerequisite for our well-being [12]. Both passage of time and structure of time can be distorted under psychiatric conditions and give rise to a broad range of psychopathological symptoms that are related to time experience (passage: slowing down, acceleration; structure: disturbed temporal order, asynchronies), e.g. as the feeling of being "stuck in time" [2].

Virtual reality (VR) is a very effective tool for the study of human cognition as for remediation. However, empirical evidence for differential time experiences in VR and real world are lacking. A recent study demonstrated the influence of modified and unnatural movements of a virtual sun on cognitive functions and time judgments [7]. However, the possibility that VR is intrinsically altering our perception of time is an important question to answer. The ability to reliably study and manipulate the subjective experience of time in VR will open novel perspectives for clinical application as well as fundamental cognitive research. Therefore, in this first experiment we explored the possible impact of different VR simulations of a simple room without distractions or any external or environmental time cues (e.g. sun light or clocks). In waiting situations the perceived time duration can change substantially. It is often due to the uncertainty about how long you have to wait [9] and the experience of wasting time [6]. Consequently, we choose a simple "waiting" scenario for our experiment. Additionally, the sense of time and self-consciousness is corroborated by studies showing the association with interoception, i.e. bodily information necessary for the sense of the bodily self [12]. In VR, a person's body can be substituted by a virtual one. This process called "avatar embodiment" has demonstrated to considerably influence the VR experience and even disturb self perception [8]. It is therefore interesting to measure the time perception with and without avatar.

2 EXPERIMENT

We conducted an experiment with a *between-subjects* design with the presence of an avatar and the environment as factors. Our design consisted of these conditions: *Real*(baseline condition), *360-picture no-avatar*, *360-picture avatar*, *3D-model no-avatar* and *3D-model avatar*. For the *Real* condition, we turned our lab into a waiting room by separating a specific area from it using curtains. This waiting area only featured a carpet and a chair to avoid any distracting elements. For the environmental factor, the real environment was recreated, using 3D models for the chair and the carpet as well as a 360° camera capturing a real room. Our solution for representing an avatar was

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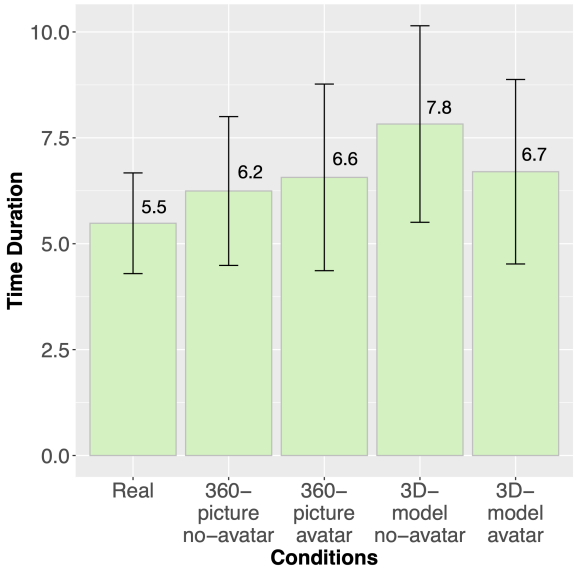

Figure 2: Waiting time estimations (standard error bars)

tracking the head, the hands, the hip and the feet to calculate the positions of the other body parts with inverse kinematics. In the no-avatar conditions we neither show an avatar nor the controllers. We used a slightly modified form of scales about subjective time, self and space (STSS) [3]. Since our study lasted only 20 minutes and considering central tendency bias we modified the question based on [10]:"*Intuitively (without further thinking), how long do you think the waiting time lasted (in minutes and seconds)?*". Once participants signed the consent form, they filled a personal questionnaire and the simulator sickness questionnaire (SSQ) [4], which was used only to determine any negative VR effects that might have affected the results. After the system was calibrated, the investigator informed the subjects that there was a problem and that he had to ask a colleague for help. He told the subject to sit quietly on the chair and not to close the eyes too often. The experimenter left the room and waited 7.5 minutes before reentering and apologizing for the inconvenience. Then they were asked to fill out the STSS and again the post experiment SSQ.

3 RESULTS

Our effective sample consisted of 75 participants, divided into five groups of 15 participants per condition. The mean age of the participants was 21.7 years (SD_{age} = 2.4), 45 of the 75 were female. A one-way Anova was used to analyze the STSS items between groups. It resulted in a significant difference for estimated time duration ($F(4,70) = 2.77$; $p = 0.034$) (see Figure 2). The Tukey HSD post-hoc test for multiple comparisons of means was used to identify the corresponding conditions. It revealed a significant difference of the estimated time duration by participants between the *3D-model no-avatar* condition ($M = 7.8, SD = 2.3$) and the *Real* condition ($M = 5.5, SD = 1.2$) at $p < .05$. All other items of the STSS showed no significant difference between the conditions.

4 DISCUSSION

We found only one significant difference in subjective time for the *3D-model no-avatar* condition. An avatar in VR is very important to provide synchronized visuomotor feedback to the user [1] and to enhance immersion [11]. Its absence could have created an alteration of time perception, potentially linked to a reduced plausibility of the virtual environment. Certain inconsistencies in the quality of simulation can increase interest of participants in the environment [5] which in turn could lead to an extended perception of time.

5 CONCLUSION

In this study, we investigated the possible distortion of time perception in VR. Our results suggest that waiting time estimations are not significantly affected by the environment quality, but possibly by the absence of an avatar. It is an interesting result indicating that time perception could reliably be studied and manipulated in VR with different visual environmental qualities. Nevertheless, further investigations are needed. Our future work will replicate our experiment with a larger sample size and investigate the possibility of accelerating or de-accelerating waiting time using zeitgebers (e.g., speed of clocks or day-night cycle) as suggested by [7].

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