Size Does Matter: An Experimental Study of Anxiety in Virtual Reality

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ABSTRACT
The emotional response of users induced by VR scenarios has become a topic of interest, however, whether changing the size of objects in VR scenes induces different levels of anxiety remains a question to be studied. In this study, we conducted an experiment to initially reveal how the size of a large object in a VR environment affects changes in participants’ (N = 38) anxiety level and heart rate. To holistically quantify the size of large objects in the VR visual field, we used the omnidirectional field of view occupancy (OFVO) criterion for the first time to represent the dimension of the object in the participant’s entire field of view. The results showed that the participants’ heartbeat and anxiety while viewing the large objects were positively and significantly correlated to OFVO. These study reveals that the increase of object size in VR environments is accompanied by a higher degree of user’s anxiety.

CCS CONCEPTS
- Human-centered computing → User studies. Empirical studies in interaction design. Virtual reality.

KEYWORDS
virtual reality, anxiety, large object, user experience

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1 INTRODUCTION
The emotional response is one of the most important factors in user experience study of virtual reality products. Accordingly, research is actively being conducted on how VR environments affect users’ emotional responses, particularly anxiety and fear.

Picture size has been found to have a significant effect on emotional perception. Bigger pictures elicit greater emotional arousal than smaller pictures [1]. However, it is still unknown whether bigger 3D objects in virtual reality environment could trigger higher level of anxiety than smaller objects. We propose a hypothesis that the increased size of objects in VR scenes triggers higher levels of user anxiety.

In this study, we use a VR experiment to initially reveal how the size of objects in a VR environment affects people’s anxiety level and heart rate. We investigated the subjective units of distress scale (SUDS) through experiments in which users observe virtual objects with varied sizes.

2 METHODS
38 participants (15 of which are female) volunteered to participate in this study. The participants are aging from 22 to 31 ($M = 25.84, SD = 3.33$). All participants had normal or corrected normal visual acuity. The virtual scenario was rendered on a standard windows PC and displayed on a Head-Mounted Display (HMD) HTC Vive Pro Eye. We applied the NISSEI HR-70 watch type photoelectric expression pulse monitor PulNeo to record the heart beats of participants.

In our experimental setup, participants could rotate their heads at will to observe the complete contour of the large object. Thus, we designed a new method for quantifying the object’s size in the participant’s field of view called omnidirectional field of view occupancy (OFVO) for this task, supplemented by the traditional horizontal and vertical viewing angles as the evaluation criteria for quantifying the size of the object. Since each participant had the same initial position in the VR scene, and we asked the participants to sit on the chair and not to move, the view observed by the participants could be approximated as a fixed omnidirectional image. OFVO is calculated as the proportion of the entire picture viewed by the participant that is occupied by the large object. We
We found that among the three small geometric objects (cube, sphere, and cuboid), although the sphere did not have the highest OFVO, participants reported significantly higher anxiety rating about the sphere ($M = 2.11, SD = 2.07$) than cube ($M = 1.26, SD = 1.48$) and cuboid ($M = 0.79, SD = 1.13$, $F(2, 111) = 6.35$, $p = 0.002$, $\eta^2 = 0.103$). There was no significant difference between the anxiety level of the small cube and the small cuboid ($p = 0.097$). There were no significant differences between the large planet and the large gray sphere in SUDS ($p = 0.82$). The texture image of the planet did not cause higher anxiety.

Participants’ mean heart rate data at the last second of the 15-second rest period was recorded as a baseline. Participants’ mean heart rate change relative to baseline in each scene were statistically analyzed. We found a significant correlation between the participant’s heart rate changes and OFVO ($r = 0.86, p < 0.001$)(Fig. 3b).

4 CONCLUSION

In this study, we investigated how large objects in VR scenes affect people’s anxiety and heart rate change. We proposed a new measurement to describe the size of objects in VR environments: OFVO, and discovered a positive correlation between OFVO and anxiety. We infer that in VR scenarios, objects of larger size trigger greater anxiety in users compared to objects of smaller size. The objects used in this experiment were not consistent in appearance except for size, which is a limitation of the study design. Manipulating the size of the same object is one way to improve the experimental design. This study has important implications for future research and VR product design on the perception and emotion of large-sized objects in VR environments.

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