

Effect of sound image localization on unnaturalness in augmented reality space

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[Background]

Before and after the start of this study, the COVID-19 pandemic occurred worldwide. To prevent the spread of COVID-19, a shift to a new lifestyle, such as refraining from going out when not necessary and avoiding "Three Cs," (Closed spaces, Crowded places, Close-contact settings) was required. In this way, restrictions on face-to-face activities led to the rapid spread of telework, online classes, and other online activities. Considering the effective use of augmented reality (AR) in the services of social activities in the future, it is necessary to reveal the effects of unnaturalness and other factors in the AR experience on users. In this study, "unnaturalness in the AR experience" was defined as "the incongruous sensation one receives from experiencing the unnatural overlay of information and content in the virtual space on the real world."

[Purpose]

Based on the past findings that whether or not sound image localization was possible in VR experiences affected discomfort, sense of immersion, and sense of self-motion, I aimed to examine following the hypothesis, that "The unnaturalness of AR experiences is smaller when sound image localization is possible for sounds emitted by objects in AR space than when it is not possible".

[Experiment]

In the experiment, mood was measured before and after experiencing AR contents. Six conditions were tested, combining three types of AR contents with different psychological effects (neutral, comfortable, and uncomfortable) and considering whether or not sound image localization was possible. Mood was measured using the Temporary Mood Scale, and AR contents were also subjectively evaluated in terms of reality and satisfaction. Subjective evaluation was conducted using a 7-point scale for reality and satisfaction, and participants were asked to describe the reasons for their evaluation of each item. The effects of the order in which the stimuli were experienced were also taken into consideration.

[Results of experiments]

AR content (neutral) significantly increased the negative mood "Tension" regardless of whether or not sound image localization was possible. AR content (comfortable) significantly increased "Tension" when sound image localization was not possible, and significantly increased "Vigor," a positive mood. When sound image localization was possible, "Fatigue," a negative mood, decreased significantly, and

"Vigor" increased significantly. AR content (uncomfortable) significantly increased the negative moods "Tension", "Confusion", "Depression" and "Anger" and it significantly decreased "Vigor" when sound image localization was not possible. When sound image localization was possible, "Tension", "Confusion", "Depression" and "Anger" were significantly increased. In addition, depending on the possibility of the sound image localization the amount of increase in negative mood was significantly different only for the "Tension" scale of the AR content (uncomfortable). When sound image localization was possible, it was found to be significantly higher than when it was not possible. When sound image localization was possible regardless of the type of AR content, the sense of reality and satisfaction were significantly higher than when it was not possible.

[Consideration]

The results of the experiment showed that the results of subjective evaluation of reality were significantly higher when sound image localization was possible, and that the amount of increase in the "Tension" scale before and after the experience of AR content (uncomfortable) was significantly higher when sound image localization was possible. In addition, the subject commented, "Because the reality was high, insects and other living objects felt uncomfortable." These results indicate that the unnaturalness of the AR experience is smaller when sound image localization is possible. It is expected that the findings on the effect of sound image localization on unnaturalness in the AR experience revealed in this study will be effectively utilized in the design of AR spaces.