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Multimodal interactive VR mindfulness experience

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ABSTRACT

Several attempts have been made to enhance mindfulness through Virtual and Mixed Reality. To date, they only offer users an alternative way of presenting guided imagery (e.g., mentally visualizing a beach vs. rendering a beach). We propose a preliminary study investigating whether allowing users to actively explore guided imagery through their actions (e.g., grasping virtual objects with hands) affects the mindfulness experience. To this aim, we present a preliminary study on a VR scenario for mindfulness practice that encourages the user's interactive behavior in two conditions: interactive multimodal VR vs. audio-only. No significant difference was observed in self-reported mindfulness between the two conditions.

CCS CONCEPTS

• **Software and its engineering → Virtual worlds software**.

KEYWORDS

VR, mindfulness, multimodal interaction, guided imagery

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1 INTRODUCTION

The last two decades have shown a strong interest in techniques to improve human well-being and mental health in line with Positive Psychology [10]. Among several techniques, mindfulness, i.e., orienting "attention on the present moment and approaches experiences with a non-judgmental, non-reactive, and accepting attitude" [9], is becoming increasingly popular. The most well-known basic mindfulness practices include body scan and focusing on one's breath. Others, such as mindful walking or multi-sensory exploration, require more active user behaviors. So, several systems were developed to enhance mindfulness practices' benefits using novel technologies, such as Virtual and Mixed Reality [1, 7, 8].

Current VR-based solutions are "passive", i.e., non-interactive visual content (e.g., a beautiful landscape) is displayed to accompany the audio guide [1, 7] and users are "instructed to passively observe the video" [1]. Interaction in such applications is minimal (e.g., the content is adjusted according to head movements) or impossible.

Our long-term research aim is to study whether the possibility of complex interactions in VR, such as grasping virtual objects, during the practice may impact the person's mindfulness. Also, we aim to study whether the amount of such active behaviors (or interactions in VR) is related to the reported degree of mindfulness. It remains an open question whether letting users interact with virtual objects may contribute to a better mindfulness experience [2] or, conversely, be distracting or irritating. Literature does not provide a clear answer to this question: while, e.g., [11] encourages enhancing the possibilities of interaction in VR for mindfulness practice, [4] points out that too much interaction may result in "moving the user's attention away from observing their experience".

In this paper, we propose an application for mindfulness training that uses immersive VR and allows interaction with virtual objects. The user may (but does not have to) perform hand actions with virtual objects. Thus, they may show some active behaviors. Similar studies were performed, and while results are contrasting (e.g., [1, 12]), some of them show the positive impact of VR content on self-reported levels of mindfulness (see the survey in [5]).

We hypothesize that 1) interactive multimodal VR (i.e., audio and visual) is more beneficial (measured through standard mindfulness questionnaires) than audio-only (i.e., no-VR), and 2) interactive multimodal VR brings benefits in terms of self-reported entertainment, calmness, quietness, happiness, and activation. As this is preliminary work, we present results from 21 participants experiencing the multimodal VR condition first, followed by the audio-only one.

2 MATERIALS AND METHODS

We develop a Unity[1] VR application whose architecture is depicted in Figure 1. The 3D coordinates data (position, rotation) of the VR headset and controllers are the input of the XR Plug-in Framework[2].

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[1] https://unity.com
[2] https://docs.unity3d.com/Manual/XRPluginArchitecture.html

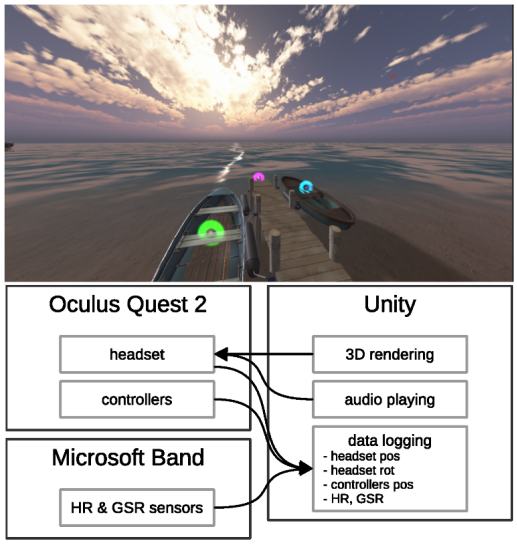

Figure 1: (top) The application architecture and the experimental setup. (bottom) The dock on which participants perform the mindfulness exercise.

Besides performing the audio and video rendering of the 3D scene, Unity saves the headset and controllers' data in a log file to analyze the participant's interactive behavior. The application displays a VR scenario of an island that the user can freely explore. For the aim of the work presented in the paper, the user is asked to walk along the dock and stand in front of the sea (see Figure 1) to perform the mindfulness experience (see next Section for more details).

The experiment has two conditions, lasting 10 minutes each and involving a mindfulness experience: i) multimodal VR (interactive condition) and ii) audio-only (passive condition). Mindfulness experience in both conditions is guided by a pre-recorded voice adapted to VR from the "leaves on a stream" exercise [3].

Participants' self-assessments were collected to analyze 1) mood before and after the two conditions and 2) mindfulness after the two conditions. Participants' mood is measured using the Visual Analogue Scale (VAS), a self-administered scale to measure: Sad-Happy, Bored-Fun, Passive-Active, Nervous-Calm, and Irritable-Quiet. Mindfulness is measured using the TMS scale [6].

Twenty-one participants took part in the experiment. They experienced the VR condition, followed by the audio-only one. In the VR one, they were invited into a lab and were administered the VAS scale. After wearing the VR headset, they started the experience: a pre-recorded voice tutorial was played back, instructing them how to use the VR controllers to walk, turn around, and manipulate objects. After finishing the mindfulness exercise, each participant filled out the VAS scale and the TMS questionnaire again. The audio-only condition was taken after one week to allow for brainwashing. Participants were instructed to complete the VAS scale, perform the audio-only exercise, and fill out the VAS scale and the TMS questionnaire.

3 ANALYSIS AND RESULTS

Analyses were performed to check the variables' normality distribution. A repeated measures analysis of variance (ANOVA) with a two-level within-subjects factor, namely "time" (pre vs. post), and a two-level within-subjects factor, that is "condition" (VR vs. audio), was performed, considering as dependent variables the mood states evaluated with VAS scale: Happy, Fun, Active, Calm, Quiet. Furthermore, we evaluated the effect of the mindfulness experience by performing a repeated measures analysis of variance considering post-evaluated TMS score as the dependent variable.

Mood - A 2 × 2 ANOVA was performed considering each level of the five mood or affective states as dependent variables, as measured by the VAS scale. Results showed no significant interaction (time * condition effects, but the main effect of time was significant for all the dependent variables ($p < .001$)). The main effects significantly improved the mood states of the participants. However, pairwise comparison analysis showed that the VR condition reported a significant improvement between the pre- and post-intervention phases in the mood states: Happy (Mean diff. = -0.813; SE = 0.187; df = 15; t: -4.333; p = 0.003), Fun (Mean diff. = -1.063; SE = 0.359; df = 15; t: -2.959; p = 0.043), and Quiet (Mean diff. = -0.813; SE = 0.245; df = 15; t: -3.313; p = 0.022). Conversely, the audio condition significantly improved only the "Fun" mood of the participants (Mean diff. = -0.688; SE = 0.218; df = 15; t: -3.149; p = 0.03).

Mindfulness - Results of repeated measures ANOVA for TMS showed no significant differences between audio and VR mindfulness conditions. Data showed an average mindfulness state in both conditions, with the audio-based condition (Mean = 3.1; SE = 0.177) descriptively higher than the VR (Mean = 2.81; SE = 0.133).

4 DISCUSSION AND CONCLUSION

We presented a novel interactive multimodal VR application for practicing mindfulness. Results of a study on 21 participants experiencing VR first followed by audio-only show that: 1) the VR condition significantly impacts the number of mood variables compared to the audio-only condition; 2) the VR and audio-only conditions do not differ regarding self-reported mindfulness. More specifically, experiencing the interactive VR-based mindfulness practice positively influenced the participants' self-reported state of happiness and quietness (these effects were not observed for the audio-only condition). That is, the interactive VR condition seems more beneficial than the standard audio-only practice, and VR appears to be efficient in reducing irritation and enhancing quietness. Regarding self-reported mindfulness, the two conditions did not show significant differences. This aligns with results in [1] who used the same questionnaire to assess mindfulness. However, a trend in the data suggests that the audio condition may increase mindfulness in VR.

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