

A validation study to trigger nicotine craving in virtual reality

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Figure 1: A: Virtual Reality Scenario; B: Motion Capture setup with a professional actor

ABSTRACT

We built a virtual beer garden that contained various smoking cues (both verbal and non-verbal) using a motion capture system to record the realistic smoking behaviour related animations. Our 3-min long VR experience was optimized for Oculus Quest 2 with the hand tracking function enabled. We conducted a pilot study with 13 non-treatment-seeking nicotine-dependent cigarette smokers. The preliminary results indicate that this VR experience led to high levels of presence, and that there is a significant increase of nicotine craving – but only for those who reported a high level of immersion.

Keywords: Virtual reality, nicotine craving

Index Terms: I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism—Virtual reality

1 INTRODUCTION

The rate of quit attempts among smokers increased by approximately 10% while the need for smoking cessation became double after the lockdown for the Covid-19 global pandemic [1]. Cue exposure therapy (CET) was found to be useful in reducing the craving and stop the relapse during or after the smoking cessation treatment. The idea of CET is to repeatedly expose patients to the stimuli (i.e., cigarette smell) in a controlled setting without the conditioned responses (i.e., having access to a cigarette) to break the association between the stimuli and the learned response to drugs [2]. In this work, we designed a Virtual Reality (VR) scenario with both verbal and non-verbal cues, proven to have the effect of triggering smoke craving. We implemented our scenario with realistic graphics and animations (motion captured data using professional actors). We then validated our implementation with 13 participants and collected both questionnaire and interview data.

2 BACKGROUND

Traditionally, CET has been delivered with pictures, videos, audios, imaginal and in vivo experiences. Corty and McFall used audiotapes regarding smokers and ex-smokers talking about urges

to smoke in their experiment during each response prevention session [3]. In a 1999 study, participants were asked to imagine the smoking situation with a comprehensive cue to build up the urge to smoke degree [4]. The standard imaginal cues could be contextual such as having a stressful day or seeing a character smoking on television [2]. The CET was based mainly on verbal description and communication between the subjects and the therapist. In 2003, VR was used for the first time for research related to nicotine craving [5]. Using their nicotine-craving questionnaire, they identified locations and items which are considered by smokers as triggers. Based on this, they built a virtual bar with smoking paraphernalia and alcohol. In a recent systematic review, the use of VR was proposed as beneficial as it creates a more immersive and safer environment for smoking intervention [6]. Other studies focused on building and comparing different VR scenarios to find the relation between the level of presence and nicotine craving [7]. Multiple results all pointed out that bars triggered higher craving. In a 2011 study by Paris M. et al., a cigarette in an ashcan and a woman smoking outside the store were used smoking [8]. Bordnick P. et al. also included someone offering to smoke at the VR party scenario [9], showing that implementing both the contextual and cigarette cues within VR provided a more realistic simulation and maximized the smoke craving level.

3 EXPERIMENTAL DESIGN

3.1 Environment and Animation

Our goal was to implement a realistic environment with smoking cues to increase the users' craving for cigarettes. The virtual environment was built in Unity 3D for Oculus Quest 2. Hand tracking function was enabled, so the users were free to make the "smoking gesture" with their hands. The environment was a late afternoon time in an outdoor beer garden depicting a typical after-work hang out with colleagues in a British pub. Participants were seating on a table and were instructed to remain seated for the duration of the experience. The environment contained smoking-related items such as unfinished cigarettes on an ashtray, a lighter, beer, and wine glasses. The scenario also included background sounds such as chattering. In the scenario, two characters, a female (A) and a male (B), were seating on the table next to the participant. They were having a mundane conversation unrelated to smoking for the first minute for the participant to acclimatize. After that, A took out a cigarette pack and started smoking, inciting B, an ex-smoker, to get one cigarette. B initially resisted, but eventually gave in and got one. The scenario ended with B looking at the participant and offered a cigarette. All the virtual characters and basic

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animations were created with Adobe Mixamo. The motion capture session was performed with two professional actors using an Optitrack system. After the mocap session, data was cleaned up in Autodesk Maya and retargeted to the virtual characters before importing them into Unity. The audio was also recorded during the mocap session, and we used it to lip-sync the characters. Finally, the cigarette was attached to the hand of A.

3.2 Measurements and Hypotheses

Participants filled out three questionnaires – the Presence and Plausibility Illusion (PPIQ), Anxiety level (AL) and Smoking Craving (SC). Our PPIQ had 12 items and was adapted from [10]. Our hypothesis was that the PPIQ level would be relatively high (H1). Both AL and SC were filled out before and after the VR experience to compute the difference in scores. There were 7 items of the anxiety measurement, adapted from [11]. We used a 100mm Visual Analog Scale (VAS) for self-assessment of SC “At this moment in time how much do you want a cigarette” [12]. Here, our hypothesis was that both the level of anxiety (H2) and the smoking craving (H3) would be higher after the VR exposure. All the questionnaires can be found in the supplementary files. The study was approved by the Research Ethics Committee at our university.

3.3 Participants and Procedure

We conducted the experiment at our VR lab with 13 nicotine-dependent non-treatment-seeking participants (5 females, age 20-26). After completing the pre-AL and pre-SC, they sat on a 45cm tall chair, the same height of the bench in the VR scenario. After the VR scenario they then finished the post-AL, post-SC, and the PPIQ, followed by an interview with questions such as: “Which part of the experience induced their smoke craving the most?”.

4 RESULTS

The results showed high scores in presence experienced in the virtual environment (PPIQ: 5.1 ± 0.89); all participants reported a PPIQ score higher than 3.5 on a 1-7 Likert scale.

The level of anxiety was lower after the experience (pre-AL: 6.6 ± 4.4 ; post-AL: 4.6 ± 3.2). However, this change is not statistically significant ($t(12) = 1.49, p = 0.163$).

Overall participants reported an increased level of smoking craving (pre-SC: 31.5 ± 22.5 ; post-SC: 45.7 ± 34.9) but not significant with a paired t-test ($t(12) = -1.77, p = 0.102$). Further analysis showed a correlation between the increment on the smoking craving ($\text{diff_SC} = \text{post_SC} - \text{pre_SC}$) and PPIQ ($r = 0.57, p = 0.04$). This suggests that those who experienced a higher level of presence also reported a higher score of smoking craving.

5 DISCUSSION

The scores from PPIQ showed that our VR experience was highly immersive and plausible, supporting H1. Additionally, when describing the situation in the interview, no one used ‘the cigarette on screen’ or ‘the person in the VR headset,’ but directly referring to the experience as something truly existed as if they actually visited the beer garden in real life. We hypothesized an increased level of anxiety post VR (H2). However, this was not supported by the results. We speculate that individual differences need to be taken into considerations when it comes to anxiety levels in VR. Also, two participants reported high levels of anxiety in pre-AL (Figure 2) thus making it unlikely that the scores after the experience would be higher for them.

We also found a positive correlation between level of presence and the change in smoking craving, indicating that those who reported a higher level of presence also reported a strong level of

nicotine craving, suggesting that H3 can be confirmed only when participants were focused on the events taking place in VR.

Interviews revealed several smoking cues missing that could further trigger nicotine craving. For example, the smell of tobacco and more interactions with the virtual characters. In the future, we will add more smoking cues such as allowing to light up a cigarette. We will also improve the dialogue to make it more interactive. We aim to compare the results of a craving triggering experience with a neutral experience. Furthermore, we will recruit a larger number of participants to validate our results.

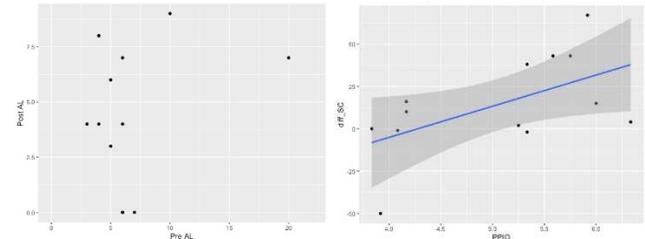


Figure 2 A: pre & post AL scatter plot; B: correlation between diff_SC and PPIQ.

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