Efficacy of Virtual Reality for triggering smoking craving: Relation with level of presence and nicotine dependence

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Abstract. Virtual Reality environments that reproduce typical context associated with tobacco use could be useful for smoking cessation. The main objective of this study was to confirm the validity of 8 environments to produce smoking craving and to determine the relation of craving with nicotine dependence and level of presence. Results showed that all the environments were able to generate desire to smoke and a direct relation was found between sense of presence and craving.

Keywords. Virtual Reality, nicotine dependence, craving, presence

Introduction

Multi-component psychological interventions have proven broadly to be effective for smoking cessation[1,2]. Nevertheless, relapse rates after treatment remain high. Between 40% and 70% of patients who complete treatment return to smoke. Therefore, it is necessary to incorporate more effective strategies for relapse prevention in such programs. Cue-induced craving is considered the main responsible for relapse after smoking cessation[3]. Cue Exposure Treatment (CET) consists of controlled and repeated exposure to stimuli associated with substance use in order to extinguish craving responses[4]. Although CET has been proved in the treatment of opiates and alcohol addiction[5,6], few studies have been conducted on the use of cue exposure for tobacco cessation, so further research is needed.

Virtual reality (VR) technology has shown its efficacy as an exposure tool in several psychopathological disorders[7]. Virtual reality exposure provides several advantages over conventional methods (e.g. in vivo exposure, imagery exposure). Since it allows participants to experience vivid real-life re-creations, VR permits a strict control over variables while mainteining a high ecological validity. Given the above, several studies have already used VR for assess smoking craving. These studies, that have used mainly paraphernalia and virtual bars, have shown that VR could be a good alternative to traditional exposure methods to generate craving[8,9]. Nevertheless, as most of them use decontextualized cues, the generalization of the extinction to everyday life situations becomes difficult. In order to adapt this technology to smoking cessation interventions, more diverse environments that enhance the probability of generalization of extinction in real life are needed.

The aim of this study was to assess the validity of 8 immersive virtual reality environments to produce smoking craving as well as determine the relation of level of presence and nicotine dependence with self-reported craving.

1. Method

1.1. Participants

Twenty-five former smokers with a mean age of 29.7 (SD = 13.4) participated in the study. Most of them were male (69%). Inclusion criteria for participation were aging 18 or older and to smoke 10 or more cigarettes per day over the previous two years. Participants involved in any smoking cessation treatment and suffering other substance dependence other than nicotine were also excluded.

1.2. Assessment

- Subjective craving: Measured with a visual analogical scale from 0 to 100.
- Sense of presence: Spanish translation of the Presence Questionnaire[10.]
- Nicotine dependence: Number of cigarettes per day.

1.3. Procedure

Participants were exposed, in random order, to 7 complex virtual scenes with smoking related cues that reproduce typical situations where people smokes: Being in a pub, having lunch and having breakfast at home, drinking coffee in a cafe, after having lunch at a restaurant, waiting in the street and watching TV at night; and to a virtual environment without smoking cues: The museum.

Virtual reality environments were developed based on the literature about smoking craving and on the information obtained from a questionnaire made *ad hoc* and administered to 154 smokers [mean age (*range*) = 30.3 (18-67); mean number of cigarettes per day (*SD*) =13.9 (6.39)] that compiled data about the situations and stimuli included in these situations which produced most desire to smoke. Figures 1 to 4 show images of some of the developed virtual environments.

Environments were presented with a Head Mounted Display (5DT HMD 800 Series) with tracking sensors (Intersense Inertia Cube[3]). Participants could interact with avatars and objects in real time with a mouse device during the exposure in order to make the experience as realistic as possible.

Subjective craving were assessed before the experiment and during the exposure to each environment. Sense of presence experienced by participants in the virtual environments was assessed at the end of the experiment.

1.4. Statistical analysis

Repeated measures analysis were conducted in order to test if there were significant differences between smoking craving level experienced by participants in the virtual environments and those reported before VR exposure.

Several correlations were also conducted in order to study the strength of the relation between smoking craving and the sense of presence experienced by participants in the virtual environtments, and between smoking craving and nicotine dependence. Confidence level was 95%, and the statistical package used was the SPSS-15.

Figure 1. After having lunch at home

Figure 2. Watching TV at night

Figure 3. Being in a pub

Figure 4. After having lunch at a restaurant

2. Results

Table 1 shows that mean craving levels were significantly higher in all the environments than on the pre-exposure assessment (mean = 19.5; SD = 14.3). Significant differences between craving level experienced in front of the black computer's screen (pre-exposure measure) and the craving experienced in each virtual situation show very large effect sizes, which stress the strength of these differences. All the environments, including the museum, were able to generate desire to smoke.

Table 1. Craving levels during the exposure to virtual environments and differences between pre-exposure craving and craving experienced in each virtual environment

	Mean	SD	F	p	η^2
Lunch at home	46.5	28.6	34.5	p<.001	.59
Watching TV at night	45.2	29.8	35.9	p<.001	.60
Being in a pub	44	28.4	28.7	p<.001	.54
Lunch at restaurant	43.5	25.8	35.2	p<.001	.59
Coffee at café	41.4	26.4	43.3	p<.001	.64
Waiting in the street	40.9	26.2	38.2	p<.001	.61
Museum	39.6	26.3	27.5	p<.001	.53
Having breakfast	37.2	27.2	18.5	p<.001	.43

Nevertheless, having lunch at home, watching TV at night, being in a pub and having lunch at a restaurant seem to produce more craving than the other situations.

With regard to nicotine dependence and sense of presence, as Table 2 shows, only the correlation between presence and craving levels was significant. Nicotine dependence, understood as the number of cigarettes smoked per day, seems not to be related with experienced craving in this study.

Table 2. Correlations between craving and presence, and between craving and nicotine dependence

	Presence	Nicotine dependence (number of cigarettes per day)
Smoking craving	.480* (p = .013)	.095 (p=.664)

* Correlation is significant at the level .05 (bilateral)

3. Conclusions

These results suggest that complex virtual reality environments that simulate real situations are able to elicit craving. Previous studies has examined smokers' responses to smoking-related and neutral cues finding that smoking-related cues, such as viewing or holding a cigarette, imagining a scenario involving smoking or being at smokers' real situations, elicits greater reactivity[11]. Likewise, several studies have reported the success of virtual environments for inducing smoking craving[12-14]. Nevertheless, these studies only use virtual paraphernalia or avatars smoking in bars or parties as cues. In contrast, the present study provide evidence about the capability of virtual environments simulating a wide range of real life situations to elicitate craving in smokers.

Virtual Reality technology could be useful in the improvement of CET for substance use disorders and more specifically for smoking cessation programs. Moreover, having a wide number of virtual situations would enhance the probability of generalization of extinction in real life.

Furthermore, results obtained in the present study warn of the need to pay attention to some variables that could be related to the effectiveness of the exposure. The strong relation between the sense of presence experienced in the virtual environments and the level of smoking craving makes evident the need to take into account those characterictics, both from patients and from virtual devices, which may influence sense of presence when subjects are exposed. Unexpectedly, nicotine dependence seems not to influence craving in this study. Nevertheless, this result may be due to the low levels of dependence shown by participants [mean = 14.8 (SD = 4.7) cigarettes per day].

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