Virtual Reality-Cue Exposure Therapy for the treatment of Alcohol Use Disorder: Preliminary results

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Abstract. The present study is part of a larger multi-site clinical trial aiming to test the efficacy of Virtual Reality-Cue Exposure Therapy (VR-CET) in patients diagnosed with alcohol use disorder (AUD) considered resistant to treatment as usual (TAU). In this study, we focused on exploring alcohol craving, anxiety, and attentional bias as indicators of the efficacy of VR-CET as an additional treatment to TAU. Twenty-eight adult patients from the Addictive Behavior Unit from Hospital Clinic of Barcelona participated in the study. Patients were randomly assigned to the VR-CET group (12 patients) or the TAU group (16 patients). Both groups completed the same pre- and post-treatment sessions, in which significant information about substance misuse patterns was collected and several questionnaires were administered (AUDIT, STAI, MACS and Alcohol Stroop Test). The VR-CET group was subsequently administered a six-session protocol of VR exposure (one hour per session) and the TAU group continued with their current treatment. T-tests were performed to assess differences between pre- and post-treatment groups. Although group differences did not reach significance, the decrease in the measures was more evident in the experimental group. CET based on VR is proposed here as a potentially useful complement to habitual treatments for AUD patients.

Keywords. Alcohol use disorder, anxiety, craving, virtual reality, cue-exposure therapy.

1.   Introduction

Several studies have targeted alcohol craving, related anxiety and attentional bias as important mechanisms in the development, maintenance, and relapse of alcohol use disorder (AUD) [1]. Cue-exposure therapy (CET) is a commonly used psychological technique aiming to reduce craving through repeated and systematic exposure to alcohol-related cues without subsequent consumption [2]. Nevertheless, there is no consistent evidence regarding the efficacy of CET [3], mainly because treatments often present limited alcohol-related cues in a controlled, safe setting, which hinders later

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generalization to real-life situations. It has been proposed that Virtual Reality (VR) technology adds effectiveness to CET by providing an immersive environment, with multiple sensory inputs, that can induce greater craving and thus enhance ecological validity [4]. The present study is part of a larger multi-site clinical trial aiming to test the efficacy of Virtual Reality-Cue Exposure Therapy (VR-CET) in patients diagnosed with AUD considered resistant to treatment-as-usual (TAU). Preliminary outcomes on alcohol craving, anxiety and attentional bias are presented as indicators of the efficacy of VR-CET as an additional treatment to TAU.

2. Method

2.1. Participants

Twenty-eight adult patients (12 in the VR-CET experimental group; 16 in the control TAU group) from the Addictive Behavior Unit of the Hospital Clinic of Barcelona participated in the study. Patients age ranged from 36 to 67 years (M_{age} = 53.82, SD = 7.93). Inclusion criteria were moderate to severe AUD according to the *Diagnostic and Statistical Manual of Mental Disorders, (5th ed.; DSM–5; American Psychiatric Association [APA], 2013)* [5] criteria, with a minimum of three-day abstinence prior to the first session and classification as resistant to TAU (i.e., presenting at least one relapse within six months of detoxification, and having been on at least one ambulatory treatment in the last five years, or having started more than three ambulatory treatments in the last five years). Patients with severe cognitive impairment, severe co-morbid psychopathology, opioid addiction, epilepsy, or pregnancy were excluded from the study.

2.2. Instruments

Alcohol consumption, drinking behaviours and problematic alcohol-drinking patterns were examined with the Alcohol Use Disorder Identification Test (AUDIT) [6].
Alcohol Craving was assessed with the Multidimensional Alcohol Craving Scale (MACS) [7].
Anxiety (both trait and state) was explored with the State-Trait Anxiety Inventory (STAI) [8].
Attentional bias (interference) for alcohol-related words was explored with the Alcohol Stroop Test [9].
VR equipment included the Oculus Rift S head-mounted display (HMD), two sensors, a touch controller for each hand and a computer compatible with the VR equipment.
"ALCO-VR" software was the platform used to deliver the VR-CET approach, and included a menu of 22 different alcoholic beverages and four environments (restaurant, house, bar, and pub).

2.3. Procedure

Before providing signed informed consent, patients were randomly assigned to the VR-CET group (12 patients) or the TAU group (16 patients). Both groups completed the same pre-treatment sessions, in which significant information about abstinence, comorbidity, other substance consumption and medication was collected, and several questionnaires were administered [AUDIT, STAI (the trait and state part), MACS, and Alcohol Stroop Test]. The mean (SD) score of the AUDIT of the sample was 17.21 (10.66). As a baseline treatment, both groups received TAU at the Addictive Behaviors Unit from Hospital Clinic of Barcelona. In addition to TAU, the experimental group received six VR-CET, which involved repeated CET to alcohol-related cues and contexts using the "ALCO-VR" software. Each session lasted for one hour. In all sessions, olfactory inputs were included and corresponded to the alcoholic beverages the user was exposed to. After each VR-CET session, participants received a short debriefing with the aim of reducing anxiety and craving levels and thus minimizing any later alcohol consumption. The post-treatment session was identical to the pre-treatment session

[MACS, STAI (the state part) and Alcohol Stroop Test], except that AUDIT and anamnesis were omitted.

2.4. Statistical analysis

Possible pre-test differences between the experimental and control groups were assessed by means of Student's T-tests. T-tests were also performed to assess differences between pre- and post-treatment groups. Statistical power was also calculated with the aim of establishing whether the study was under-powered or the sample size was sufficient to detect an existing effect. All analyses were performed using IBM SPPS version 25.0 (Armonk, NY: IBM Corp).

3. Results

Table 1 shows means and standard deviations of the pre-and post-treatment results as assessed through four variables: STAI-Trait, STAI-State, MACS and Stroop Test.
The T-tests performed revealed no statistically significant differences between groups (experimental vs control) at pre-treatment for any of the variables measured: STAI-Trait ($t = 1.388$; $p = 0.176$), STAI-State ($t = 1.162$; $p = 0.255$), MACS ($t = 0.076$; $p = 0.9396$) and Stroop Test ($t = 0.166$; $p = 0.8693$).

Concerning differences between pre-treatment and post-treatment, T-tests indicated no statistically significant differences for both the experimental or control group across the different variables measured. Although group differences did not reach significance, the decrease in the measures was more evident in the experimental group.

The statistical power obtained was 0.623, revealing that the sample of the current study ($n = 28$) might not capture the effect even if it exists in the population, therefore expounding that the sample selected might not be representative of the population.

Table 1. Mean and Standard Deviation of the pre- and post-treatment results as assessed by the following measures.

Measures	Pre-treatment session		Post-treatment session	
	Experimental	Control	Experimental	Control
STAI-Trait	23.83 (11.40)	30.42 (13.13)		
STAI-State	12.72 (9.14)	17.71 (12.56)	7.45 (8.73)	15.07 (7.49)
MACS	25.58 (11.30)	25.92 (11.88)	19.08 (9.24)	19.71 (7.61)
Stroop Test	18.84 (10.36)	19.67 (14.76)	15.89 (12.72)	18.00 (14.62)

Note: Multidimensional Alcohol Craving Scale (MACS), the State-Trait Anxiety Inventory (STAI) and the Alcohol Stroop Test.

4. Conclusion

This study presents an innovative VR-based software that may be suitable for improving the existing treatment methods for alcohol addiction. The post-treatment changes recorded here are interpreted as a result of a process of desensitization regarding alcohol cues and are considered an interesting indication of the clinical potential of VR technology in AUD treatments. Some limitations that may influence our data are gender imbalance, presence of co-morbid diagnosis, differences in medication or in reported days of abstinence, as well as the small sample size. Nevertheless, the study is an ongoing project, and more data is required to state the efficacy of VR-CET as a potentially useful complement instrument to habitual treatments for AUD patients.

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