



# Annual Review of CyberTherapy and Telemedicine

A Healthy Mind in a Healthy Virtual Body:  
The Future of Virtual Reality in Health Care

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## VR-based cue-exposure therapy (VR-CET) versus VR-CET plus pharmacotherapy in the treatment of bulimic-type eating disorders

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**Abstract.** Treatment guidelines recommend antidepressant medication for bulimic-type eating disorders either as an alternative to or in combination with cognitive behavioural therapy (CBT). This study compared the efficacy of two second-line treatments of patients with bulimic-type eating disorders resistant to CBT: virtual reality-based cue-exposure therapy (VR-CET) alone or VR-CET in combination with pharmacotherapy. Results showed that bingeing episodes, bulimic symptomatology (the bulimia EDI-3 score) and food cravings (FCQ-T/S) were significantly reduced after both interventions. However, no significant differences were found between the combined intervention and VR-CET alone. Improvements from the treatments continued at the 6-month follow-up. Our results support the use of VR-CET as an effective treatment of bulimic-type eating disorders, reducing bulimic symptoms and food cravings. The addition of antidepressants to VR-CET does not provide any additional benefit.

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**Keywords:** virtual reality, cue-exposure therapy, clinical sample, food cravings, bulimic-type disorders, binge eating

## 1. Introduction

Bulimic-type eating disorders represent a public health problem according to World Mental Health (WMH) surveys, affecting a broad section of the population [1, 2]. These disorders include both bulimia nervosa (BN) and variants of BN, of which binge eating disorder (BED) is the most common [1].

Cognitive behavioural therapy (CBT) is the first-choice treatment for BN and BED [3, 4]. Although several studies support the efficacy of CBT in treating BE and the psychopathology associated with BN and BED [5], a significant percentage of patients do not improve after undergoing CBT [6].

Treatment guidelines recommend antidepressant medication for bulimic-type eating disorders either as an alternative to or in combination with CBT [7]. Based on studies showing serotonin system dysfunctions in BN and BED, selective serotonin reuptake inhibitors (SSRIs) (e.g., fluoxetine) are the most commonly prescribed antidepressants, reducing binge eating in patients with bulimic-type eating disorders [8]. In general, randomised controlled trials (RCTs) suggest that combination therapies with certain antidepressants yield better results than pharmacotherapy alone, but are not more effective than psychotherapy alone [3, 8, 9].

Cue-exposure therapy (CET), an exposure-based extinction technique [10], has also been proposed as an effective second-line treatment for patients who show poor or no response to previous CBT and pharmacological therapy, reducing binge eating and other psychopathological symptoms in clinical patients [11, 12].

Several constraints of CET have led to its adaptation to virtual reality technology (virtual reality-based cue-exposure therapy (VR-CET)) [13]. VR-CET has been reported to reduce food cravings and anxiety [14], as well as eliminating episodes of binge eating in a BN patient [15] after systematic exposure to virtual food-related contexts and cues. In view of these findings, the present study aimed to compare the efficacy of two second-line treatments of patients with BN and BED resistant to CBT: VR-CET alone or in combination with pharmacotherapy.

## 2. Methods

### 2.1 Participants and procedure

The sample comprised of 32 outpatients of both sexes diagnosed with BN ( $n=16$ ) or BED ( $n=16$ ), according to DSM-5 criteria [16], and presenting active episodes of binge eating behaviour after an initial structured course of CBT. Participants were referred from five collaborating hospitals in Tarragona (Spain), Barcelona (Spain) and Milan (Italy).

Seventeen participants were taking a constant dose of antidepressant medication (i.e., fluoxetine) at the beginning of VR-CET and were allocated to the combined second-

line intervention (VR-CET plus pharmacotherapy), while the other 15 participants underwent VR-CET alone. Due to the non-random patient allocation, we ensured that participants assigned to each group did not differ significantly in terms of sex, age, diagnostic rates, measured body mass index ( $\text{kg}/\text{m}^2$ ), frequency of binge eating episodes, self-reported bulimic symptoms and food cravings assessed prior to the interventions (all  $p$  values  $> .05$ ). During the first session, participants were also assessed by validated VR-based cue-exposure software [14] to construct the exposure hierarchy of 3D interactive situations (environment and food) for use in the VR-CET sessions. The software creates an exposure hierarchy as a result of combining four VR scenarios (kitchen, dining room, bedroom and cafe) and the 10 food items each participant selected as the ones producing the highest levels of craving from a list of 30 virtual food items.

Both interventions consisted of six twice-weekly individual 60-minute sessions over three weeks. During each VR-CET session, participants were exposed to their corresponding virtual environments and food based on the previously established hierarchy. Participants could interact within the virtual environments in real time and move around the scenario, sit at a table, and handle the food displayed using the keyboard and the laptop's mouse. Once seated, craving and anxiety levels were assessed periodically in the participants on a visual analogue scale from 0 to 100. Exposure finished when the reported subjective anxiety decreased by 40% in relation to the level measured when the participant entered the virtual environment. Virtual environments were displayed on a 15.6-inch stereoscopic monitor. Earphones and polarised glasses were also used.

## 2.2 Measurements

Outcome assessment for core behavioural features included frequency (i.e., number) of binge eating episodes during the two weeks prior to beginning the second-line intervention, during the two weeks after the end of the intervention, and during the two weeks after the 6-month follow-up.

The 8-item bulimia subscale of the Eating Disorder Inventory<sup>TM</sup>-3 (EDI-3) [17] was administered to assess the self-reported tendency to engage in episodes of uncontrollable overeating (binge eating) at baseline (intake session), at the end of the second-line intervention, and at the 6-month follow-up.

To assess food cravings, the State and Trait Food Craving Questionnaire (FCQ-T/S) [18] was also administered at baseline, at the end of the intervention, and at follow-up.

## 2.3 Statistical analysis

Given the limited sample size, the non-parametric Friedman test was used to analyse the intervention effects (baseline *vs.* post-treatment *vs.* follow-up) on the psychometric variables of each group (VR-CET plus pharmacotherapy and VR-CET alone).

Post-hoc Wilcoxon signed-rank tests were also conducted with a Bonferroni correction applied (resulting in a significance level set at  $p < .017$ ) to determine specific significant differences in the psychometric variables between the time points (baseline, post-treatment and follow-up) in both groups.

Mann-Whitney U test was used to analyse the between-group differences both post-treatment and at follow-up

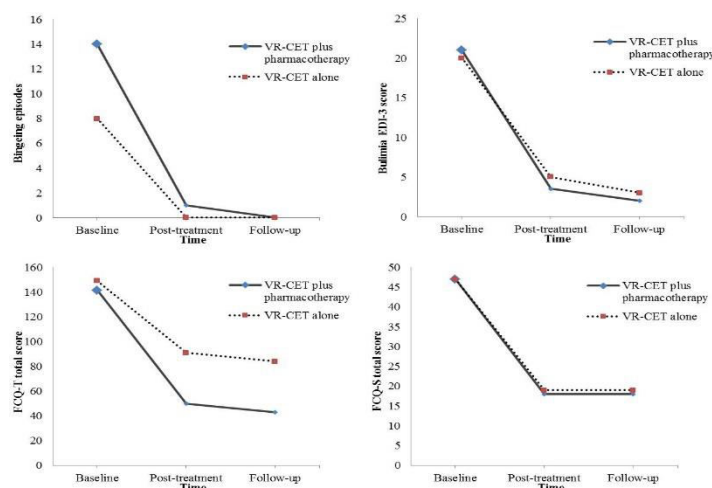


### 3 Results

There was a statistically significant difference in the intervention outcomes tested at the three time points (baseline, post-treatment and follow-up) both in the combined VR-CET plus pharmacotherapy ( $\chi^2(11) = 165, p < .001$ ) and the VR-CET alone ( $\chi^2(11) = 149, p < .001$ ) groups. Post-hoc analyses revealed significant differences in the frequency of bingeing episodes, the bulimia EDI-3 score, the FCQ-T total score and the FCQ-S total score between the baseline and post-treatment time points, and between the baseline and follow-up time points in both treatment groups (Table 1). As displayed in Figure 1, all participants showed significant reductions in the variables assessed post-treatment and at follow-up.

**Table 1.** Differences in the frequency of bingeing episodes (binges), bulimia symptoms (EDI-B), and trait (FCQ-T) and state (FCQ-S) food cravings between the three time points tested (baseline vs. post-treatment; baseline vs. follow-up; and post-treatment vs. follow-up).

	Binges		EDI-B		FCQ-T		FCQ-S	
	Z	p	Z	p	Z	p	Z	p
<b>Combined intervention</b>								
Baseline - Post-treatment	-3.63	<.001	-3.62	<.001	-3.58	<.001	-3.52	<.001
Baseline - Follow-up	-3.53	<.001	-3.47	.001	-3.52	<.001	-3.35	.001
Post-treatment - Follow-up	-1.63	.102	-1.88	.059	-1.97	.049	-0.42	.674
<b>VR-CET alone</b>								
Baseline - Post-treatment	-3.30	.001	-3.18	.001	-2.73	.006	-2.59	.010
Baseline - Follow-up	-2.99	.003	-2.99	.003	-3.29	.001	-2.80	.005
Post-treatment - Follow-up	-0.74	.461	-1.18	.238	-1.76	.078	-0.71	.480



**Figure 1.** Median of the number of bingeing episodes, bulimic symptoms (EDI-3) and food craving levels (FCQ-T/S) at baseline, post-treatment and 6-month follow-up.

Mann-Whitney U test indicated no significant differences between the two intervention groups (combined intervention vs. VR-CET alone) in the number of bingeing episodes ( $U = 96.5$ ,  $p = .200$ ,  $r = .23$ ), bulimic symptoms ( $U = 106$ ,  $p = .423$ ,  $r = .14$ ), and trait ( $U = 87$ ,  $p = .126$ ,  $r = .27$ ) and state food cravings ( $U = 114$ ,  $p = .619$ ,  $r = .09$ ) post-treatment. No significant differences were also found between the two groups for the number of bingeing episodes ( $U = 106$ ,  $p = .505$ ,  $r = .12$ ), bulimic symptoms ( $U = 102$ ,  $p = .465$ ,  $r = .13$ ), and trait ( $U = 101$ ,  $p = .451$ ,  $r = .13$ ) and state food cravings ( $U = 93$ ,  $p = .282$ ,  $r = .19$ ) at follow-up.

#### 4 Conclusions

The main objective of this study was to compare the efficacy of two second-line treatments of patients with BN and BED (VR-CET alone vs. VR-CET plus antidepressant medication) who had previously undergone CBT unsuccessfully. In agreement with our previous studies [14, 15], VR-CET reduced the frequency of bingeing episodes, bulimia symptoms and food cravings in CBT-resistant patients. Therefore, VR-CET can be used to improve conventional treatments (i.e., CBT and pharmacotherapy) for bulimic-type eating disorders.

Adapting *in vivo* CET to virtual reality technology offers several advantages such as enabling the therapist to recreate real-world environments containing significant specific stimuli and providing safe contexts for patients, which are generally preferable to full exposure prior to contact with the real world [13].

Our findings support those of other studies investigating the efficacy of pharmacological interventions in both BN and BED [3, 8, 9]. Overall, combined psychotherapy and pharmacotherapy in patients with BN and BED does not provide better results than psychotherapy alone [3]. Our results did not show significant differences in the frequency of bingeing episodes, bulimia symptoms and food cravings post-treatment and at the 6-month follow-up between those receiving the combined therapy (VR-CET plus antidepressants) and those undergoing VR-CET alone. This lead us to conclude that the addition of antidepressants to VR-CET did not provide any additional benefit.

Our study had some limitations such as the non-random patient allocation and the lack of a control group that could have led confounder variables to have an effect on the outcomes measured. Furthermore, the small size of the sample makes it difficult to generalise the present results.

Despite these limitations, our study supports the application of VR-CET in clinical settings and provides evidence that VR-CET is a valid and useful tool for enhancing CBT in BN and BED patients either alone or in combination with medication.

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