Trait and State Craving as Indicators of Validity of VR-based Software for Binge Eating Treatment

Joana PLA-SANJUANELO[a1], Marta FERRER-GARCIA[a], José GUTIÉRREZ-MALDONADO[a], Ferran VILALTA-ABELLA[a], Alexis ANDREU-GRACIA[b], Antonios DAKANALIS[c], Fernando FERNANDEZ-ARANDA[d], Adela FUSTÉ-ESCOLANO[a], Joan RIBAS-SABATÉ[b], Giuseppe RIVA[e], Carmina SALDAÑA[a], and Isabel SÁNCHEZ[d]

[a] *Department of Personality, Assessment, and Psychological Treatments. Universitat de Barcelona, Spain*

[b] *Department of Psychiatry and Mental Health, Igualada General Hospital, Spain*

[c] *Department of Brain and Behavioural Sciences, University of Pavia, Italy*

[d] *Department of Psychiatry, University Hospital of Bellvitge-IDIBELL and CIBEROBN, Spain*

[e] *Applied Technology for Neuro-Psychology Lab., Istituto Auxologico Italiano, Milan, Italy*

Abstract. The aim of this study was to establish whether virtual reality (VR) exposure to food cues is able to produce craving levels consistent with state-craving and trait-craving as assessed by the Spanish and Italian versions of the State and Trait Food Craving Questionnaires (FCQ-T/S). The results were compared in 40 patients with eating disorders (17 with binge eating disorder, 23 with bulimia nervosa) and 78 healthy control subjects without eating disorders. Controls and patients with higher levels of trait-craving and state-craving both showed a greater desire to eat during VR exposure. Results also showed that trait and state craving assessed by FCQ-T/S were able to predict the total mean craving experienced during exposure to the VR software in both clinical and control samples. These findings present preliminary evidence about the validity of a new virtual reality-based application for cue-exposure treatment in patients with eating disorders.

Keywords. Virtual reality, cue-exposure therapy, food craving, clinical sample, bulimia nervosa, binge eating, low-cost VR systems

Introduction

Previous studies have shown that people who usually binge or experience loss of control over eating are those with highest levels of craving, assessed as a stable and consistent feature – that is, as a trait [1], subjectively experienced as a strong desire to eat.

[1] Corresponding Author.

Food cue-exposure therapy (CET) has been proposed as an effective treatment for binge eating, given that it eliminates the association between stimuli related to binge eating and the craving response.
Traditionally, studies of CET for the treatment of bulimia nervosa (BN) have applied in vivo exposure [2, 3], in which patients are exposed to the foods they usually consume while bingeing, but they cannot accomplish a binge (response prevention). The results of these studies show significant improvements in symptoms, eliminating or significantly reducing binging and purging behaviors and, therefore, improving the overall health of the patient. Despite its benefits, in vivo exposure has certain limitations that must be considered. For example, therapists must have food available in their clinical office to carry out the exposure with the patient. Further, this context does not allow generalization to the different environments where the patient usually binges, and so in vivo exposure requires the therapist to be present in these real environments. Virtual reality (VR) technologies have been proposed as a new and alternative tool that improves on in vivo exposure. VR allows the simulation of realistic situations in which participants can interact in real time, producing an immersive and vivid sensation. Exposure to virtual reality stimuli has been successfully used in the field of drug addictions, and has proven its ability to elicit craving in people exposed to situations related to their addiction. Given the similarities between the craving experienced by people suffering addictions and that experienced by patients with BN and binge eating disorder (BED) [4], the use of exposure to virtual reality stimuli may prove suitable for the treatment of these pathologies. Indeed, studies of VR are now beginning to be published [5, 6, 7, 8].
VR seems to be an effective technology for eliciting food craving, especially in the case of participants with high scores on the State and Trait Food Craving Questionnaires (FCQ-T and FCQ-S) [9, 10]. The present study aims to replicate the results found in our previous study [10] with the incorporation of a clinical sample of patients meeting DSM-5 criteria for BED and BN, with the ultimate aim of identifying possible differences between control and clinical groups.

Methods

Participants and procedure

The sample comprised a control group formed by 78 undergraduate students (9 male and 69 female) without eating disorders, and a clinical group of 40 patients (10 male and 30 female), 17 of whom met DSM-5 criteria for BED and 23 the criteria for BN according to the SCID-I. Mean age was 22.66 ± 2.75 (range 19 to 36) in the control group, and 33.45 ± 9.77 (range 18 to 63) in the clinical group. The mean body mass index (BMI) was 21.83 ± 3.07 in the control group, and 27.46 ± 5.37 in the clinical group. Patients were recruited from two hospitals in the areas around Barcelona (Spain) and Milan (Italy), while all controls were recruited among college students at the University of Barcelona. After signing the consent form, all participants completed the Spanish or the Italian version of the State and Trait Food Craving Questionnaires (FCQ-T and FCQ-S) [11]. The FCQ-S measures the intensity of the current desire to eat (food craving) using 15 items divided into five dimensions. The FCQ-T measures a

person's characteristic food craving intensity using 37 items divided into nine dimensions.

After completing the questionnaires, participants were exposed to VR-based software developed for CET in binge eating. The software creates an exposure hierarchy as a result of combining four VR scenarios (kitchen, dining room, bedroom, and bakery/café) and the 10 foods that each participant has assessed as the ones that produce the highest levels of craving from a list of 30 foods. In the first steps of the hierarchy, participants were exposed to the foods that elicit the lowest levels of craving in the four different situations. During the last steps of the hierarchy, participants were exposed to the foods that provoke the highest levels of craving. In each environment, participants were asked to indicate the level of food craving on a visual analog scale from 0 to 100.

The virtual environments were presented using stereoscopic laptops. The level of immersion that this system achieves is lower than that achieved using other systems such as Head Mounted Displays (HMD); however, it is a low cost hardware and it can be used with very few technical complications, and so it is especially well suited for use by non-technologically specialized clinicians.

Statistical analyses

Correlation analyses were conducted to assess the association between trait-craving and state-craving scores obtained on the FCQ-T and FCQ-S and the mean food craving experienced in each of the four VR contexts (kitchen, dining-room, bedroom, and bakery/café).

Multiple regression analyses were also conducted to determine the percentage of variance explained by the model, including FCQ-T and FCQ-S scores as predictor variables. This analysis also assessed which of the two variables (trait-craving and state-craving) contributed more to predicting the food craving experienced during VR exposure. Analyses were conducted separately in control and clinical samples in order to explore differences between the two groups.

Finally, an independent Student's *t* test was also applied to compare FCQ-T and FCQ-S total scores obtained by the control and clinical samples. Significance levels of $p<.05$ were considered.

Results

The results in Table 1 show significant, positive correlations between both FCQ-T and FCQ-S scores and the mean craving experienced in each of the four VR contexts in the control group. The strongest correlations were found between food cravings and the FCQ-S scale. The results also showed significant and positive correlations between cravings experienced and state-craving scores on the FCQ-S in patients. However, no significant correlations were found between food cravings and the FCQ-T scale in the clinical group.

Table 1. Correlations between trait-craving and state-craving scores on the FCQ-T and FCQ-S and the mean food craving experienced in each of the four VR contexts in controls and patients.

		Kitchen	Dining room	Bedroom	Cafeteria
FCQ-T	Controls	.234* (*p*=.039)	.230* (*p*=.043)	.289* (*p*=.010)	.266* (*p*=.018)
	Patients	.176 (*p*=.276)	.196 (*p*=.226)	.176 (*p*=.276)	.005 (*p*=.975)
FCQ-S	Controls	.570** (*p*=.000)	.551** (*p*=.000)	.508** (*p*=.000)	.513** (*p*=.000)
	Patients	.427** (*p*=.006)	.423** (*p*=.007)	.542** (*p*=.000)	.347* (*p*=.028)

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

The results of multiple regression analyses are shown in Table 2. The model, which includes the variables of trait-craving and state-craving, is able to predict food craving experienced during VR exposure in the different 3D environments in both control and clinical samples. The results also show that our model explains 30% of the variance in food craving for the control sample, and 24.1% of the variance in food craving for the clinical sample. In both control and clinical samples, state-craving assessed by the FCQ-S makes the largest (beta=0.531 and beta=0.589, respectively) single contribution to explaining the craving experienced during exposure to foods in the virtual environments. The contribution was also statistically significant (*p*=.000 and *p*=.002, respectively).

Table 2. Multiple regression analyses including FCQ-S and FCQ-T scores as predictors of mean food craving during VR exposure in the whole 3D environments.

	Model	Predictors	Beta	*t*	*p*	R^2	Adj. R^2	*F*	*p*
Controls	Food craving					.300	.281	16.05	.000
		FCQ-T	.037	.347	.729				
		FCQ-S	.531	4.984	.000				
Patients	Food craving					.241	.199	5.859	.006
		FCQ-T	-.221	-1.241	.223				
		FCQ-S	.589	3.303	.002				

Finally, the Student's *t* test revealed a statistically significant difference between clinical and control samples in FCQ-T and FCQ-S total scores. The clinical group presented higher scores on both FCQ-T (*M*control = 86.41 ± 24.95 vs. *M*clinical = 129.72 ± 27.33, *t*116 = -8.64, $p<.05$) and FCQ-S (*M*control = 26.41 ± 10.93 vs. *M*clinical = 43.40 ± 12.15, *t*116 = -7.69, $p<.05$).

Conclusions

In agreement with our previous studies [9, 10], people with higher levels of trait-craving and state-craving also showed a greater desire to eat during VR exposure to virtual foods in the different 3D environments. Our results also determined the extent to which trait-craving and state-craving may predict food craving elicited via VR in both clinical and control samples.

The results showed that trait and state craving assessed by FCQ-T/S were able to predict the total mean craving experienced during exposure to the VR software in both clinical and control samples. State-craving, assessed by the FCQ-S, made the largest contribution to explaining the craving experienced during VR exposure in the two groups. The contribution was also statistically significant.

Although previous studies have found that people with higher levels of trait-craving usually present more binges and a higher tendency to lose control over eating [1], our results showed that state-craving was the main variable associated with perceived craving during VR exposure. Therefore, in both controls and patients, the craving experienced may be determined by contextual variables more than by stable individual variables.

Our findings suggest that this VR-CET model using stereoscopic laptops may be helpful in improving the treatment of binge eating behaviors for bulimia and binge eating disorder, given that the food cravings experienced during the VR exposure were consistent with state/trait cravings assessed by means of FCQ-S/T.

Acknowledgements

This study was supported by the Spanish Ministry of Science and Innovation (Project PSI2011-28801: "Tratamiento de la bulimia nerviosa mediante exposición a señales con realidad virtual").

References

[1] M.A. Gómez-Martínez, J.R. Yela-Bernabé, A. Salgado- Ruiz, M. Cortés-Rodríguez, Evaluación de la reactividad emocional ante imágenes de comida en bulimia nerviosa, Psicothema 23 (2011), 580-586.

[2] E. Martinez-Mallén, J. Castro, L. Lazaro, E. Moreno, A. Morer, E. Font, J. Julien, M. Vila, J. Toro, Cue exposure in the treatment of resistant adolescent bulimia nervosa, International Journal of Eating Disorders, 40 (2007), 596-601.

[3] J. Toro, M. Cervera, M. H. Feliu, N. Garriga, M. Jou, E. Martinez, E. Toro, Cue exposure in the treatment of resistant bulimia nervosa, International Journal of Eating Disorders, 34 (2003), 227-234.

[4] Granero, Roser; Hilker-Salinas, Ines; Agüera, Zaida; Jimenez-Murcia, Susana; Sauchelli, Sarah; Islam, Mohammed; Fagundo, Beatriz; Sánchez, Isabel; Riesco, Nadine; Dieguez, Carlos; Soriano, Jose; Salcedo-Sanchez, Cristina; Casanueva, Felipe; De la Torre, Rafael; Menchon, Jose Manuel; Gearhardt, Ashley N., Fernandez-Aranda, Fernando (2014). Food Addiction in a Spanish Sample of Eating Disorders: DSM-5 Diagnostic Subtypes differentiation and validation data. European Eating Disorders Review, Nov; 22(6):389-96.

[5] M. Ferrer-García, J. Gutiérrez-Maldonado, A. Caqueo-Urízar, E. Moreno, The validity of virtual environments for eliciting emotional responses in patients with eating disorders and in controls, Behavior Modification, 33 (2009), 830-854.

[6] J. Gutiérrez-Maldonado, M. Ferrer-García, A. Caqueo-Urízar, A. Letosa-Porta, Assessment of emotional reactivity produced by exposure to virtual environments in patients with eating disorders, CyberPsychology & Behaviour, 9 (2006), 507-513.

[7] J. Gutiérrez-Maldonado, M. Ferrer-García, A. Caqueo-Urízar, E. Moreno, Body image in eating disorders: The influence of exposure to virtual environments, CyberPsychology & Behaviour, 13 (2010), 521-531.

[8] C. Perpiñá , M. Roncero, F. Fernández-Aranda, S. Jiménez-Murcia, L. Forcano, I. Sánchez. Clinical validation of a virtual environment for normalizing eating patterns in eating disorders. Compr Psychiatry, 54 (2013), 680-6 doi: pii: S0010-440X(13)00034-5. 10.1016/j.comppsych.2013.01.007

[9] M. Ferrer-Garcia, J. Gutiérrez-Maldonado, M. Agliaro-López, X. Lobera-Espi, J. Pla, F. Vilalta-Abella, Validation of VR-based Software for Binge Eating Treatment: Preliminary Data, Studies in health technology and informatics, 199 (2013), 146-150.

[10] M. Agliaro-López, M. Ferrer-Garcia, J. Pla-Sanjuanelo, J. Gutiérrez-Maldonado, Inducción de craving por comida mediante realidad virtual no inmersiva, Revista de Psicopatología y Psicología Clínica, 19 (2014), 243-251.

[11] Cepeda-Benito, D.H. Gleaves, M.C. Fernández, J. Vila, T.L. Williams, J. Reinoso, The development and validation of Spanish versions of the State and Trait Food Cravings Questionnaires, Behavior Research and Therapy 38 (2000), 1125-1138.