

External Eating as a Predictor of Cue-reactivity to Food-related Virtual Environments

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Abstract. The objective of this study was to assess the association between external eating style and food craving experienced during exposure to food cues in virtual reality (VR) environments in both clinical and non-clinical samples. According to the externality theory, people with external eating experience higher reactivity when exposed to food cues, which in turn increases the probability of overeating. Forty patients with eating disorders (23 with bulimia nervosa and 17 with binge eating disorder) and 78 undergraduate students were exposed to 10 different food cues in four VR environments (kitchen, dining room, bedroom, and café). After 30 seconds of exposure to each VR environment, food craving was assessed using a visual analog scale. External, emotional and restrictive eating styles were also assessed using the DEBQ. The results showed a strong association between external eating and cue-elicited food craving. After controlling for the presence of eating disorder diagnosis, external eating was the best predictor of reported food craving. The results lend support to the externality theory but highlight the need for further research in specific patterns of functioning in patients with bulimia nervosa and binge eating disorder.

Keywords. External eating, food craving, virtual reality exposure, bulimia nervosa, binge-eating disorder.

Introduction

Obesogenic environments have been repeatedly and strongly associated with the increase in overeating patterns in Western societies. The continuous exposure to high calorie foods in every-day life leads some individuals to increase their food intake and thus raises the risk of obesity. However, despite the increase in overweight adults and

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children in recent years, not everybody reacts to the availability of food by overeating. According to van Strien et al. [1, 2] there are three main psychological theories that explain differences in overeating behavior: the restrained eating theory [3], the psychosomatic theory [4], and the externality theory [5].

The restrained eating theory states that unsuccessful dieting can cause overweight due to bingeing. The psychosomatic theory proposes that some individuals eat as a response to negative emotions in order to reduce levels of stress and anxiety. Finally, according to externality theory, individuals eat in response to food-related stimuli, regardless of their internal state of hunger and satiety. Despite their limitations, these theories have been widely used in research to explain overeating in cases in which individuals are not hungry and there is no physical need for food intake. It has also been suggested that knowing the eating style of patients could facilitate the tailoring of treatments according to their specific characteristics. Therefore, the predominance of one eating style or another should be taken into account when choosing the most appropriate intervention.

Cue exposure therapy (CET) with prevention of bingeing has been proposed as an effective treatment for bulimia nervosa (BN) patients [6, 7]. The rationale behind this intervention is based on the conditioning process [8]. In this model, the intake of binge food is the unconditioned stimulus, and all the stimuli associated with this binge-behavior are the conditioned stimuli. Exposure to conditioned stimuli (for example, chocolate) elicits physiological responses, which are subjectively experienced as food craving, and this in turn leads to excessive food intake. It is reasonable to think that patients with high external eating will show higher reactivity when exposed to food cues and, consequently, the likelihood of excess intake will increase. In these cases, CET may be an appropriate treatment option [9]. Previous research has assessed the relation between external eating and craving for food. Burton et al. [10] found that an external eating style, assessed with the Dutch Eating Behavior Questionnaire (DEBQ), was the main predictor of food craving in a sample of adults. However, in that study craving was assessed using a self-report questionnaire and participants were not exposed to food cues. Therefore, a further step forward would be to assess whether external eating is associated with the food craving experienced during exposure to specific foods in virtual reality (VR) environments.

Objectives

The main objective of this study was to assess the relation between the external eating style and the food craving experienced during exposure to food cues in VR environments. The results of previous research suggest that high scores on external eating will be strongly associated with craving and will be a good predictor of this response during exposure to virtual food cues. Differences between non-clinical and clinical populations were also explored.

A secondary objective was to assess the usefulness of VR technology as an exposure technique for inducing food craving in external eaters.

Methods

Participants and procedure

The sample consisted of two groups: a non-clinical group, comprising 78 undergraduate students without eating disorders (nine males and 69 females), and a clinical group, comprising 23 bulimia nervosa and 17 binge eating disorder (BED) patients according to DSM-5 criteria (ten males and 30 females).

After signing a consent form, all participants were administered the Dutch Eating Behavior Questionnaire (DEBQ), a self-reported questionnaire that assesses three different eating styles in normal weight and overweight adults: external eating (DEBQ-EX), emotional eating (DEBQ-EM), and restraint eating (DEBQ-RE) [1]. Participants were also measured to obtain their body mass index (BMI), and were then exposed to 40 VR environments. These virtual environments were the result of combining four VR scenarios (kitchen, dining room, bedroom, and bakery/café) and the 10 foods that each participant assessed as the ones that produced the highest levels of craving from a list of 30 foods. First, participants were exposed to the foods that provoked the lowest levels of food craving in the four VR scenarios. In the later exposure steps, they were exposed to the foods that provoked the highest levels of food craving in the four virtual scenarios. Once in the VR scenario, participants were asked to sit at a table. On the table there was one of the selected foods according to the hierarchy. Participant could manipulate the food with the mouse of the computer. After 30 seconds of exposure to food, craving was assessed by means of a visual analog scale (from 0 to 100).

Statistical analyses

Correlation analyses were conducted to assess the association between food craving and the scores obtained in the external, restraint, and emotional eating scales of the DEBQ. Multiple regression analysis was also used, including scores of external, restraint, and emotional eating scales as predictor variables and mean craving experienced during exposure to the 40 VR environments as a dependent variable. Correlation analyses were conducted separately in control and clinical samples in order to explore differences between the two groups. However, a multiple regression analysis could not be conducted in the clinical group because of its small size. Instead, a hierarchical multiple regression was conducted with the whole sample, introducing the variable *Group* (control versus clinical) in the first step of the analysis in order to control the effect of the presence or absence of an eating disorder (ED) diagnosis.

Results

Bulimia nervosa and BED patients showed significantly higher BMI, age, mean food craving in the VR environments, and higher scores on emotional, external and restrictive eating than controls (Table 1).

Table 1. Between-subjects *t*-test, means, and standard deviations for age, BMI, and DEBQ subscale scores in control and clinical groups.

	Control group		Clinical group		<i>t</i>	<i>p</i>
	Mean	<i>SD</i>	Mean	<i>SD</i>		
Age	22.67	2.75	33.45	9.77	-6.840	<.001*
BMI	21.83	3.07	27.46	5.37	-6.137	<.001*
DEBQ-EM	28.55	10.69	34.15	12.26	-2.560	.012*
DEBQ-EX	31.54	6.80	36.55	4.86	-4.146	<.001*
DEBQ-RE	21.51	8.44	27.42	9.84	-3.403	.001*
Food craving	51.36	22.12	77.32	19.92	-6.236	<.001*

**p*<.05

As expected, positive correlations were found between external eating scores and food craving experienced during VR exposure in both the control and the clinical group (Table 2). This correlation was the only significant one in the control group; however, in the clinical group a strong negative correlation between emotional eating and mean food craving was also found.

Table 2. Correlations between mean food craving experienced in the VR environments and scores obtained on the three scales of the DEBQ in the control and the clinical group.

		DEBQ-EM	DEBQ-EX	DEBQ-RE
Mean	Control group	.086 (<i>p</i> =.453)	.345** (<i>p</i> =.002)	.006 (<i>p</i> =.958)
Food Craving	Clinical group	-.599** (<i>p</i> <.001)	.328* (<i>p</i> =.039)	-.153 (<i>p</i> =.347)

**p*<.05 (bilateral); ** *p*<.01 (bilateral)

The results of the hierarchical multiple regression analyses are summarized in table 3. The variable *Group* (model 1) predicted food craving and explained 25% of the variance. The overall model 2, consisting of the variable *Group* and the three DEBQ scales, also predicted the food craving experienced in the VR environments and explained 39% of the variance. After controlling for the effect of the *Group*, the three DEBQ scales still explained 13% of the variance. Without considering the *Group*, external eating made the strongest single contribution to the model; and emotional eating also made a statistically significant contribution.

Table 3. Hierarchical multiple regression analyses, introducing group, emotional, external and restrictive eating as predictors, and food craving in the VR environments as dependent variable.

Mode	Predictors	Bet	<i>t</i>	<i>p</i>	R^2	R^2_{adj}	R^2_{chan}	F_{chang}	p_{change}
1		a					<i>ge</i>	<i>e</i>	
1	Group	.501	6.236	<.001*	.251	.245	.251	38.88	<.001
				*				8	**
2					.386	.364	.135	8.258	<.001
									**
	Group	.422	5.204	<.001*					
				*					
	DEBQ-EM	-.226	2.625	.010**					
	DEBQ-EX	.385	4.659	<.001*					*
	DEBQ-RE	-.261	.795						
		.022							

* $p < .05$; ** $p < .01$

Discussion and conclusions

The main objective of this study was to assess the relation between external eating style and the craving experienced during exposure to food cues in VR environments. As expected, external eating was strongly associated with food craving both in participants without eating disorders and in patients with BN and BED. In accordance with previous studies [10], after controlling for the effect of having an ED diagnosis or not, externality was the best predictor of food craving. These results corroborate the externality theory [5], which states that certain individuals are more sensitive to external food cues than others and may overeat in response to these stimuli. In such cases, cue-exposure therapy could be a particularly useful intervention for reducing binge eating.

Another objective was to explore differences between clinical and non-clinical populations. The results showed higher levels of emotional, external and restrictive eating in patients than in controls, as well as higher levels of food craving, which would contribute to the occurrence of binge episodes and the higher BMI in this group. The present study suggests that lower emotional eating is related with food cue-reactivity in VR environments in BN and BED patients. Early studies noted the relationship between emotional and external eating [2], and overlapping between the two eating scales has frequently been reported. Indeed, Jansen et al. [11] suggested that the only pure external eaters were the ones with high scores in external eating and low scores in emotional eating.

The results obtained underline the usefulness of VR technology as an exposure technique for inducing food craving in BN and BED patients. They also highlight the need for further research on contextual and emotional variables related with bingeing in order to develop and apply more specific and appropriate treatments. Gender differences and specific diagnosis should also be considered in future research.

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