



# Eating behavior style predicts craving and anxiety experienced in food-related virtual environments by patients with eating disorders and healthy controls

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## ABSTRACT

Eating behavior style (emotional, restrictive, or external) has been proposed as an explanation for the differences in response to food-related cues between people who overeat and those who do not, and has been also considered a target for the treatment of eating disorders (EDs) characterized by lack of control over eating and weight-related (overweight/obesity) conditions. The aim of this study was to analyze the relationship between eating behavior style and psychophysiological responses (self-reported food craving and anxiety) to food-related virtual reality (VR) environments in outpatients with bulimia nervosa (BN) and binge eating disorder (BED) and to compare them with healthy participants. Fifty-eight outpatients and 135 healthy participants were exposed to palatable foods in four experimental everyday real-life VR environments (kitchen, dining room, bedroom and café). During exposure, cue-elicited food craving and anxiety were assessed. Participants also completed standardized instruments for the study purposes. ED patients reported significantly higher levels of craving and anxiety when exposed to the virtual food than healthy controls. Eating behavior styles showed strong associations with cue-elicited food craving and anxiety. In the healthy group, external eating was the only predictor of cue-elicited craving and anxiety. In participants with BN and BED, external and emotional eating were the best predictors of cue-elicited craving and anxiety, respectively.

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## 1. Introduction

Overweight (Body mass index, BMI  $\geq 25$  kg/m<sup>2</sup>) and obesity (BMI  $\geq 30$  kg/m<sup>2</sup>) have grown alarmingly during last years in most world's countries. According to the World Health Organization

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(WHO), in 2014, 39% of adults aged 18 years and over (38% of men and 40% of women) were overweight and 13% (11% of men and 15% of women) were obese (WHO, 2015). This is more than half of the world's adult population and data are not more encouraging when analyzing pediatric samples. Beyond body image dissatisfaction and self-esteem concerns, these conditions are associated with chronic adverse health effects, disability, social stigmatization and a reduction in the overall quality of life and life expectancy (Calle, Teras, & Thun, 2005; Capodaglio, Faintuch, & Liuzzi, 2013;

Malnick & Knobler, 2006; Riva, Gaggioli, & Dakanalis, 2013). Importantly, binge eating (wherein one consumes a large amount of food whilst experiencing a sense of loss of control over eating) required for diagnoses of bulimia nervosa (BN) and binge eating disorder (BED) (American Psychiatric Association [APA], 2013), is a consistent predictor of overweight status and strongly associated with greater obesity severity, and increased risk for obesity-related chronic illnesses (Sonnevile et al., 2013; Tanofsky-Kraff et al., 2009).

Relevant explanations of human overweight and obesity include the growth of modern lifestyles with the availability of energy-dense food and the rise of sedentariness (Capodaglio et al., 2013; Maffei, 2000). Despite the potency of this obesogenic environment, however, not all people become overweight (van Strien, Herman, & Verheijden, 2009). Indeed, there are individual differences that may moderate and/or mediate responses to continuous exposure to high palatable food-related stimuli (Blundell et al., 2005). Eating styles (i.e., specific patterns of eating) have been proposed to explain response differences to obesogenic environments (Burton, Smit, & Lightowler, 2007; van Strien, Herman, & Verheijden, 2012). Three main eating styles, having their own aetiology (see below), are thought to be closely associated to overeating and weight gain –emotional, restrictive and external eating (Braet & van Strien, 1997; Dakanalis et al., 2013, 2014; van Strien et al., 2012).

Emotional eating or eating in response to internal emotional factors (i.e., fear, anxiety) is recognized as a risk factor for developing overweight (van Strien et al., 2012) and has been extensively addressed by the psychosomatic theory (Bruch, 1964). According to this theory and related longitudinal research (Dakanalis et al., 2014) increased food intake in response to emotional distress may occur in some individuals who, as a result of learning experiences early in life where food was used as a way of coping with psychological distress, confuse internal emotional factors with hunger, due to poor interoceptive awareness. Likewise, individuals may paradoxically develop an overweight physique by consciously restricting food intake to lose or maintain a particular body weight (i.e., restrained eating) irrespective of whether they are emotional or external eaters (van Strien, Frijters, Bergers, & Defares, 1986). This eating pattern was addressed by Herman and Polivy's (2005) theory of restrained eating and based on their laboratory work, in which individuals who restrained their food intake overate when their self-control was deliberately undermined. Eating in response to external stimuli (i.e., external eating), involving a decreased sensitivity to internal signals of hunger and satiety, has been addressed by externality theory (Schachter, 1971), according to which overweight/obese people are externally controlled or stimulus-bound, i.e., more reactive to food-related external cues and less sensitive to internal hunger and satiety signals than normal-weight people. While both the psychosomatic and externality theories start from the premise that people with overeating behavior have a lower awareness of internal signals of hunger and satiety, the externality theory goes further by highlighting that overeaters have also a heightened responsiveness to external cues of food, such as the smell, sight, and taste of food. Consequently, intake in overweight people would be externally guided, which represents a major problem if we take into account the huge number of food-related stimuli that continually bombard us in the modern world. By reviewing the history of and research on "external cues" as an important factor in the control of human food intake, Herman and Polivy (2008) introduced a distinction between normative and sensory external cues. According these authors, normative cues (e.g., portion size) refer to indicators of appropriate intake and affect all eaters indiscriminately, whereas sensory cues that refer to the properties of the food that make it more or less

appetizing (e.g., high palatability) have a more powerful effect on certain people (obese, dieting, or hungry individuals); for further details, including evidence that the sensory effect is grounded in physiology, see, Herman and Polivy (2008).

A heightened reactivity to environmental food-related cues such as the sight and smell of food has been proposed to increase food craving, i.e. an appetitive motivational state that promotes the ingestion of desired foods (Brockmeyer, Hahn, Reetz, Schmidt, & Friederich, 2015) even in a state of satiety, and consequently, food intake (Burton et al., 2007; Ferriday & Brunstrom, 2011; Nederkoorn & Jansen, 2002; Nederkoorn, Smulders, & Jansen, 2000; van Strien et al., 2012). However, research reveals that not only the external eating style (Nederkoorn, Smulders, Havermans, & Jansen, 2004; Nederkoorn et al., 2000; van Strien & Ouwens, 2003) but also the restraint (Cepeda-Benito, Fernandez, & Moreno, 2003; Dakanalis et al., 2015; Hill, Weaver, & Blundell, 1991; Nammi, Saisudha, Chinnala, & Boini, 2004) and emotional eating (Dakanalis et al., 2014; Davis, Levitan, Smith, Tweed, & Curtis, 2006; Deaver, Miltenberger, Smyth, Meidinger, & Crosby, 2003; Wardle et al., 1992; van Strien et al., 2009) styles are related to higher levels of food craving and binge eating. Given also the positive associations between food cravings and excessive overeating (Brockmeyer et al., 2015; Hetherington & Mcdiarmid, 1995), BMI (Burton et al., 2007) binge eating, BED and BN (Chao, Grilo, & Sinha, 2016; Greeno, Wing, & Shiffman, 2000; Joyner, Gearhardt, & White, 2015; Waters, Hill, & Waller, 2001), an increasing body of studies have focused on the relation between eating styles, food craving (a frequently cited antecedent of binge eating; Chao et al., 2016; Schulte, Grilo, & Gearhardt, 2016), and lack of control over eating. The results of these studies have been inconsistent to date, emphasizing the complexity of these relations. In their research, Burton et al. (2007) found external eating to be the principal predictor of food craving in both males and females; however, restrained eating was negatively associated with craving in females, while emotional eating was not significantly associated with food craving. In other research, a positive and significant correlation between binge behavior and both external eating and emotional eating has been found (Mason & Lewis, 2014). Such responsiveness to food cues is not specific to overweight people according to van Strien et al. (2009), but is a general characteristic of humans. Indeed, according to Rodin (1981), external eating may be an evolutionary adaptive response that is related to the concept of a thrifty genotype (Neel, 1962).

Heightened reactivity to food-related cues has also been proposed to elicit anxiety in individuals with binge behaviors. Martínez-Mallén et al. (2007) stated that exposure to food-related cues elicits not only food craving but also anticipatory anxiety, and that it is this anxiety that leads to binge behaviors. On the bases of this model, the association between food-related cues and anxiety is established during the initial stages of the bulimic condition. After binges, individuals experience negative emotions, such as shame, guilty, and discomfort. With time, people who binge associate those foods usually eaten during binges, as well as other specific and contextual cues (environmental and temporal), with high levels of anticipatory anxiety. This anxiety can lead to what the authors name "bulimic hunger" (Martínez-Mallén et al., 2007). Despite the fact that this model has not been studied enough, data suggest that anxiety elicited by food exposure better discriminates between clinical and non-clinical samples than craving (Pla-Sanjuanelo et al., submitted). Whereas a certain level of craving is expected to be found in non-clinical samples when they are exposed to palatable food (Ferrer-Garcia, Gutiérrez-Maldonado, Treasure, & Vilalta-Abella, 2015; Nederkoorn et al., 2004), anxiety levels are expected to be low in these samples, given that food is not a stressful stimulus for healthy people.

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