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ReVBED : A semi-guided virtual environment for inducing food craving in a binge-eating therapy process

FLORIAN RAMOUSSE, GUILLAUME LAVOUÉ, PATRICK BAERT, Univ. Lyon, Centrale Lyon, CNRS, INSA Lyon, UCBL, LIRIS, UMR 5205, ENISE, F-42023, France

VIKESH BHOOWABUL, SÉVERINE FLEURY, BAPTISTE RAVEY, University Department of Psychiatry, Eating Disorders, CHU Saint-Etienne, Jean Monnet University, France

AURÉLIA GAY, CATHERINE MASSOUBRE, CHU Saint-Étienne, University Department of Psychiatry and Addiction/ Eating Disorders, Addictions and Extreme Bodyweight Research Group (TAPE), EA7423, Jean Monnet University, France

CLÉMENTINE HELFENSTEIN-DIDIER, Univ. Lyon, Centrale Lyon, UMR CNRS 5513, LTDS, France



Fig. 1. VR environment screenshots (From left to right : bedroom, teenager bedroom, living room, kitchen)

Food craving is a main pathological issue in Eating Disorders (ED), associated with binge eating such as bulimia nervosa and binge eating disorder. Common therapies are currently based on Cognitive and Behavioral Therapies (CBT). However, a significant number of patients are not receptive to conventional CBTs.

Virtual Reality (VR) is now used as a variant of CBTs, especially VR based cue exposure therapy, but only food triggers are generally considered in this form of therapy. In this context, we developed the ReVBED environment: a semi-directed VR exposure scenario allowing the induction of food craving by including multimodal stimuli. The proposed paper presents the ReVBED environment and scenario, and the planned clinical study of which aim is to evaluate its effectiveness for inducing food cravings in bulimia nervosa and binge eating disorder patients, with subjective and objective measurements.

CCS Concepts: • **Human-centered computing** → **Interaction design**; *Interaction design processes and methods*; • **Computer methodologies** → Computer graphics; Computer systems and interfaces.

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Authors' addresses: Florian Ramousse, Guillaume Lavoué, Patrick Baert, florian.ramousse1@ec-lyon.fr, Univ. Lyon, Centrale Lyon, CNRS, INSA Lyon, UCBL, LIRIS, UMR 5205, ENISE, F-42023, Saint-Etienne, France; Vikesh Bhoowabul, Séverine Fleury, Baptiste Ravey, University Department of Psychiatry, Eating Disorders, CHU Saint-Etienne, Jean Monnet University, Saint-Etienne, France; Aurélia Gay, Catherine Massoubre, CHU Saint-Étienne, University Department of Psychiatry and Addiction/ and Eating Disorders, Addictions and Extreme Bodyweight Research Group (TAPE), EA7423, Jean Monnet University, Saint-Etienne, France; Clémentine Helfenstein-Didier, Univ. Lyon, Centrale Lyon, UMR CNRS 5513, LTDS, Saint-Etienne, France.

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1 INTRODUCTION

Food craving is defined as a strong desire or urge to eat [1]. It is closely linked to compulsive eating [4, 13], and a major therapeutic target in eating disorders with binge eating, such as Bulimia Nervosa (BN) and Binge Eating Disorder (BED). Craving is considered an important risk factor for relapse in patients with addictive disorder [2, 3].

While conventional Cognitive Behavioral Therapy (CBT) is still a reference treatment for BN and BED, a significant number of patients are insufficiently or not at all responsive to them, and effects fade from the first six months following the treatment [9, 10]. Usual stimuli used in CBT insufficiently covers the complexity of food craving and are not adaptable to patient daily life [7]. Strongly associated with anxiety, food craving also depends on stimuli that are difficult to reproduce in therapy: smell and taste stimulations, emotional state, psychosocial context, general physical condition and recent physical exertion, hormonal disturbances [12, 16], etc.

Immersive technologies for therapeutic use has been increasing in the last few years. Existing works of Virtual Reality (VR) use for eating disorders therapies focus on two issues: (1) correction of the representation distortion that the patient has of himself and for which VR environments help in the misrepresentation correction [6, 11]; (2) use of immersive environments to emphasize triggers of the disease (e.g., food) in order to better characterize the symptoms and perform Cue Exposure Therapy (CET) [8]. For the second, Riva et al. [14] show that eating disorders can be treated by virtual food presentations to reduce craving and anxiety. However, food craving and its metabolic effects could also be generated by the conditioned stimuli (e.g., sight, smell, taste, and the context or environment) [15]. Nonetheless, most VR-CET therapies known to date use only food exposure, as evidenced by two reviews from So et al.[15] and Ciężyńska et al.[5].

In this regard, our main objective is to provide an effective environment based on multimodal stimuli (i.e., not only food), developed in collaboration with hospital practitioners, to induce food craving in patients suffering from BN and BED.

2 DESIGN OF THE ENVIRONMENT AND EXPOSURE SCENARIO

2.1 Overview

The virtual environment is designed as an apartment made up of 4 separated rooms (listed in section 2.3 and see Fig. 1) connected by a neutral central hall devoid of stimuli. They are explored in this precise order respecting a defined exposure script. The script was constructed according to current knowledge of food craving induction in patients with BN and BED [12]. The main novelty is that the stimuli are not only food but multimodal stimuli (detailed in the section 2.3).

Another novelty is that the exposure is semi-guided : a narrative scenario is dictated by an external health professional interlocutor and defines the spatio-temporal framework as well as the course of the actions. This scenario (detailed in the section 2.2) is the common thread of the application, and justifies explorations in each room as well as the need for the actions to be executed. It also allows a rigorous identical and comparable evolution between each participant.

2.2 Scenario

The scenario describes the actions to execute as the evolution in the environment through a precise script. In short, the user is told that it is Friday evening, and he is returning from his workday after a busy week. His bank also tried to contact him several times. Some friends have warned him that they will stop by for an aperitif at his place in the early evening. He must manage the preparations for the evening alone. After tidying up the apartment and preparing the aperitif, friends finally warn at the last moment that they will not come.

The scenario was intentionally designed to be generally depressing for the participant.

2.3 Stimuli and Triggers

First, stimuli identified in scientific literature were discussed, completed and ranked during traditional CBT sessions between therapists (eating disorders unit of the CHU Saint-Etienne) and patients with BN and BED. Then, they were discussed and selected by therapists and VR specialists after internal trials and taking into account technical feasibilities and user comfort in the environment. Following the exhibition room visitation order, participants will face the following stimuli :

- Entrance hall (used to introduce the scenario) : Message from neighbors announcing possible noise disturbances;
- Bedroom : Anxiety generated by bills and gym brochures spread on the desk in the bedroom, mirror, the need to choose a new outfit;
- Teenager's bedroom : Uncomfortable sound environment in the teenager's room due to an excessive video game sound volume, teenager in his room who refuses having a conversation, first food visualization (sweet food);
- Living room : Living room table cluttered with snack remains, visualization of sweet food, television with sound broadcasting a cooking program;
- Kitchen : Visualization and handling of savory foods, preparation of a dinner aperitif to welcome friends, little voice reproducing an internal dilemma between resisting and succumbing to a food intake.

Thus, the virtual environment include both food and emotional stimuli.

3 CLINICAL STUDY AND DATA COLLECTION

3.1 Methods

30 patients with BN or BED and 30 paired subjects will be included. The exhibition is preceded by a tutorial phase allowing the material apprehension and the interactions available in ReVBED. During the exploration, food craving and anxiety will be evaluated with a Visual Analog Scale (VAS), before and after exploring each of the 4 exhibition rooms, using an oral question worded as follows : *How do you estimate your craving/stress level ?*, with a score between 0 and 10 in a Lickert scale. They will be associated with physiological measurements and clinical activity questionnaires (detailed in the section 3.3) used to phenotype participants on clinical dimension influencing craving . Mixed statistical models will allow analysis variations correlations of each of the variables measured within and between groups.

The study was approved by a local ethics committee (CPP Sud Méditerranée I) and registered in a clinical trial database (ClinicalTrials.gov Identifier : NCT05385653). Written informed consent will be obtained from all participants.

3.2 Physiological data

3 types of physiological data will be measured and used :

- Heart Rate Variability : cyclic fluctuations measures of recorded R-R intervals. Sensors are cutaneous, with non-invasive electrodes and placed at chest level;
- Pupillometry : phasic fluctuations measures in pupillary diameters or pupillary responses;
- Galvanic Skin Resistance : cutaneous conductance fluctuations measures. Sensors are cutaneous, with non-invasive electrodes and placed at fingertips, on index and ring finger.

3.3 Individual self-questionnaires

For all participants (including control subject), classic phenotyping self-questionnaires validated in French will be completed and reported before the ReVBED exposure scenario, including the

Dutch Eating Behavior Questionnaire (DEBQ), the Multidimensional Assessment of Interoceptive Awareness (MAIA), the Impulsive Behavior Scale (UPSS), the Difficulties in Emotion Regulation Scale (DERS), the Yale Food Addiction Scale 2.0 (YFAS 2.0), the Food Cravings Questionnaire-Trait-reduced (FCQ-T-r) and the Eating Disorders Inventory 2 (EDI-2) (only for patients).

4 CONCLUSION

We presented ReVBED, an innovative VR exposure protocol for BN and BED, created by a collaboration of clinicians and virtual reality specialists. This protocol will be used in a planned clinical study.

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