PSYC REALITY

White Paper on

EATING DISORDERS

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Curtin University Dubai

RIT Rochester Institute of Technology of Dubai

University of Birmingham Dubai

Virtual Reality for Binge Eating Disorder Treatment

A White Paper by PsycReality

In Collaboration With

Curtin University Dubai

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Preface

As CEO of PsycReality, my mission is to transform mental health for better through immersive technologies and scientific research. Especially in collaboration with global educational institutes to work on the topics which are impacting peoples' personal and family daily lives at large. In today's world, we are witnessing the progression and the transformation in mental health treatments with ever growing use of Virtual Reality (VR) and Artificial Intelligence (AI).

This white paper symbolizes the dedicated summer 2025 research programme that brought together mental health professionals, psychology educationists and students from the University of Birmingham Dubai and Rochester Institute of Technology Dubai to address one of the most prevalent mental health challenges of the era: Binge Eating Disorder (BED).

The idea of this research collaboration developed from a critical observation within clinical practices across the UAE, Kuwait, Oman, Brazil and Pakistan. Despite the availability of existing treatment methods such as exposure therapy, there is still need of more effective and practical BED interventions to avoid high relapse rates, address limited accessibility to dedicated cognitive behavioural therapists, and try to eradicate fundamental challenge of understanding the patterns, behaviours and triggering elements from existing clinical data sets.

Ms. Perla Al Aaraj from Rochester Institute of Technology Dubai and Ms. Animisha Saxena of University of Birmingham Dubai joined PsycReality team for summer 2025 research project, they were given task to explore how Virtual Reality exposure therapy and other possible immersive technologies could bridge these treatment gaps. Their work during literature review showed not only thorough academic work but also practical innovation that directly addresses the restraints of current BED interventions.

In this white paper, Ms. Al Aaraj and Ms. Saxena have discussed and provided details on existing technological interventions especially through Virtual Reality Exposure Therapy (VRET) and identified critical bottlenecks and favourable outcomes of these treatments which are helpful in adaption of these technologies in wider clinical settings. Additionally, they have further discussed the possibilities of use of Artificial Intelligence (AI) frameworks which are playing pivotal role in reshaping the treatments of eating disorders in general and in specific binge eating disorder. The prevalence of BED in UAE is reaching 13.9% and publication of this white paper is a step closer towards further developing technological and scientific backed solutions which not only will help reducing prevalence in UAE, but also globally.

Readers of this white paper are invited to be active part of new echo system of innovative solution development through technology, science and education to help people live better personal, social and family life

Bilal Shaheen Awan
Founder & CEO
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Introduction

Binge eating disorder is recognized as the most common eating disorder worldwide (Kessler et al., 2013). Eating disorders are a category of mental disorders described by persistent disturbances in eating Behaviours that result in an unhealthy change in food intake or its absorption, impairing both physical and psychological health (American Psychiatric Association. 2022). According to the *Diagnostic and Statistical Manual of Mental Disorders (5th ed., text rev.; DSM-5-TR)*, Binge Eating Disorder (BED) is defined by recurrent binge eating episodes marked by consuming unusually large amount of food within two hours followed by a feeling a loss of control. Episodes must involve at least three features such as eating rapidly, eating past fullness, eating when not hungry, or eating alone to avoid embarrassment. Afterwards, individuals experience significant feelings of guilt and distress. To meet the criteria, these episodes must occur at least once a week for three months, without the use of compensatory behaviours like purging or fasting, and outside the context of anorexia nervosa or bulimia nervosa. The consequences of BED, if left untreated, include emotional distress, weight fluctuations, and health complications (American Psychiatric Association, 2022).

The lifetime global prevalence of binge eating disorder is about 1.9% according to international surveys**.**, and it is frequently linked to impulsivity, emotional dysregulation, and negative mood (Mars et al., 2024). Individuals with BED also face a high comorbidity burden, including mood and anxiety disorders, suicidality, and medical conditions such as hypertension, obesity, chronic pain, and diabetes (World Journal of Psychiatry, 2022). In Arab countries, prevalence rates are even higher effecting about 2.6% of the population (Melisse et al., 2024). Concerningly, the risk of developing an eating disorder in the United Arab Emirates was reported to be 13.97% with 8.98% of individuals confirmed with a diagnosis. (Dalkey et al., 2023). Similarly, Radwan et al. (2025) reported that 31% of students screened using the Arabic version of the BEDS-7 were identified as being at risk for binge eating disorder. These findings highlight the need for existing therapies to address BED in the UAE.

Schneider, Higgs, & Dourish, 2021

Although, Lisdexamfetamine can reduce binge frequency, its impact is limited by high relapse and dropout rates due to side effects and its narrow focus on neural mechanisms (Schneider, Higgs, & Dourish, 2021). This underscores the priority for alternative treatment strategies for BED.

The primary pharmacological treatment for BED constitutes the administration of Lisdexamfetamine, under the brand name Vyvanse, and is the only approved drug for the treatment of BED in adults by the UAE Ministry of Health and Prevention (MOHAP, 2021). It is a stimulant that works by affecting the brain's dopamine system, which effectively regulates impulsive eating Behaviours associated with binge episodes (Prätzel Ellwanger et al., 2025).

Cue Exposure Therapy (CET) is a treatment that targets classical conditioning mechanisms as sources of BED (Reilly et al., 2017). Food-related cues become inextricably linked to the pleasurable relief of eating through repeated uncontrolled consumption.

Over time, these cues elicit craving responses (e.g., physiological arousal, urges to binge) even in the absence of hunger and drive binging behaviours **(**Bouton, 2011**).** CET aims to control these craving responses through habituation or extinction, by repeatedly exposing patients to food cues without engaging in binge eating. CET weakens conditioned cravings by showing the brain that the cue no longer predicts reward (Jansen, 2023). However, 2D images that are most often used in CET lack ecological validity as they don’t produce adequate levels of craving responses (Martinez-Millana et al., 2020).

Cognitive Behavioural Therapy (CBT) is another important approach in the treatment of BED. It

has been widely recognized as the most empirically valid treatment for BED, due to its notable effect size (Hedges' g = 1.24-1.53) and the lowest relapse rates (23-32% at 12-month follow-up) among available interventions (Hilbert et al., 2019). The standard CBT format Binge Eating Disorder (BED) is a time-intensive intervention consisting of weekly hour-long sessions delivered over 12 to 24 weeks. Treatment follows a collaborative, 3-stage interactive between the therapist and patient (Grilo & Juarascio, 2023). Initial sessions focus on psychoeducation, understanding the CBT model of BED, and the creation of an individual case. A key aspect of this early stage is self-monitoring training to record disordered eating in the moment while simultaneously building regular and normalized eating habits. The second phase shifts to a cognitive restructuring, where patients learn to recognize and restructure negative thoughts related to body image and food, as well as problem-solving skills to manage cravings. The final phase emphasizes relapse prevention and solidifying these new skills to enhance long-term recovery (Grilo & Juarascio, 2023). Despite CBT being highly effective, its reliance on imagination while practicing coping strategies limits its implementation to real-life scenarios. (Ferrer-García et al., 2020).

Recently, Inhibitory Control training (ICT) has emerged as an accessible adjunct treatment to first line treatments such as CBT. ICT directly targets inhibitory deficits in BED through tasks requiring participants to either press a “go” button or abstaining from pressing a button (‘No go”) when presented with food cue images (high calorie/low calorie). The core principle is to repeatedly associate specific food cues with a motor inhibition response (Giel et al, 2017). While effective, the use of 2D images limit the generalization of inhibitory responses to real-life scenarios.

The use of Virtual Reality (VR) can enhance CET by improving the ecological validity and authenticity of food cue presentation and potentially increasing emotional and physiological engagement compared to traditional 2D images (Gutiérrez-Maldonado et al., 2016). According to Gutiérrez-Maldonado et al., (2018), he argues that the VR provides a fitting environment for treatment as it enables a higher level of self-reflectiveness than that enabled by 2-D images and imagination, and a greater level of control than that provided by direct “real” experience. Furthermore, VR can strengthen CBT by enabling patients to rehearse coping strategies in controlled but realistic environments under the guidance of a psychologist (Clus et al., 2018). Furthermore, the implementation of ICT through VR paradigms can enhance ecological validity and improve the generalization of inhibitory responses.

Building on these advantages, VR also serves as a platform for integrating CET and CBT within a VR-enhanced CBT framework. This integration is critical because, as Schyns, Roefs, Smulders, and Jansen (2018) note, the effect of CET in Binge Eating Disorder (BED) may depend more on inhibition mechanisms than simply breaking conditioned responses. By combining CET with CBT, patients can apply coping strategies learned in CBT to inhibit cravings triggered by food cues. Importantly, VR-enhanced CBT has been shown to shorten treatment duration to 6–8 weeks compared to the typical 24 weeks required for traditional CBT, reducing both patient costs and clinical waitlists while increasing access to care (Dalle Grave, Sartirana, & Calugi, 2024; Ferrer-García et al., 2020).

In the UAE, where digital infrastructure and openness to tech-driven health solutions are strong, Virtual Reality (VR) presents a unique opportunity to enhance BED treatment. These findings set the stage for exploring our research question: **How can VR technology be effectively incorporated to treat Binge Eating Disorder?"**

Background

History of VR

The term Virtual Reality (VR) is used to describe a computer-generated simulation of a three-dimensional environment that creates interactive immersive experiences for users (Burdea & Coiffet, 2003). The 3D environments are designed to create a sense of telepresence, which allows users to experience the feeling of genuinely being in a realistic setting via the communication

medium (Steuer, J., 1992). VR technology typically encompasses a VR headset that utilizes dual high-resolution stereoscopic displays (one per eye), lenses to focus and merge these images into a cohesive 3D scene, head- and motion-tracking sensors, spatial audio, and input devices like controllers or haptic gear. Together, these tools project slightly different images to each eye to simulate depth and track the user's movements, while delivering directional sound and tactile feedback to dynamically adjust the virtual environment and make the experience feel credibly immersive (Pantelidis 2021).

In clinical settings, VR headsets are used to simulate reality in customized and controlled environments that expose patients to situations and cues through habituation or therapeutically supported experience. The ability of the VR to simulate realistic psychological reactions in individuals is directly related to the amount of presence experienced by the individual (Slater & Sanchez-Vives, 2016). Two important factors of presence in VR environments include vividness and interactivity. Vividness incorporates the sensory richness of simulated environments. It directly depends on the number of sensory channels (visual, auditory, olfactory) engaged during the simulation and the resolution or quality of the sensory input (Cummings & Bailenson, 2016). Interactivity describes the degree to which users can influence the mediated environment in real time (Steuer, 1992). It incorporates factors like speed which refers to how quickly the system responds to user actions (with under 20ms considered ideal). It also depends on range, which is the variety of possible actions, mapping is the naturalness of control schemes (e.g., hand-tracking vs. keyboard) and agency, referring to the user's meaningful impact within the environments. Although all these factors influence presence, agency has been identified as the strongest determinant of presence (Steed et al., 2016). According to Bostan and Marsh (2020), narrative coherence indicates the degree to which the environment contributes to the building of a consistent story and shape presence. These findings highlight key considerations that have shaped the design of virtual environments, particularly in clinical contexts where the creation of realistic and immersive experiences is essential.

Efficacy for different VR treatment paradigms

Clinically, VR has been most commonly used to treat BED in Cue exposure paradigms. Studies have shown that virtual food can prompt emotional reactions in people with eating disorders (EDs) that are equivalent to, or even stronger than, reactions elicited by actual food, and that these effects are stronger than those generated by static food images (Gorini et al., 2010). In line with this, Perpiñá et al. (2013) also discovered that virtual food cue exposure resulted in greater emotional arousal and dysphoria among ED patients versus control subjects. In non-ED individuals, exposure to virtual food cues increased the desire to eat. This demonstrates VR's capacity to evoke in-vivo–like food responses and reinforces its credibility as a therapeutic tool. Most studies favor immersive VR paradigms which fully simulates the environment, as it preserves contextual cues without the logistical challenges of augmented VR which overlays digital content onto one's view of the physical world, in real-world settings.

VR treatment with cue exposure therapy in the existing literature has often been carried out in addition to CBT for the effective treatment of BED. There have been several randomized controlled trials evaluating the efficacy of VR in the treatment of BED in combined CBT and CET paradigms. A randomized controlled clinical trial involving 36 women with BED compared 3 interventions: Experiential Cognitive Therapy (ECT) that utilized VR, Cognitive Behavioural Therapy (CBT), and a Nutritional Group with Physical Training (NG+PT).

In ECT, the virtual reality component functioned as cue exposure to involve patients in virtual environments such as a kitchen, supermarket, and dining room to address triggering situations. By contrast, CBT followed Fairburn's protocol which emphasizes on cognitive restructuring, assertiveness, and motivation to change. Both experimental groups received 12 sessions of 60 minutes over three months. All interventions improved self-esteem, eating control, and

reduced binge episodes, however, ECT proved successful in enhancing body image, body satisfaction, and overall psychological state, while also maintaining long-term benefits. Notably, at a six-month follow-up, ECT achieved a greater reduction in binge frequency (50–60%) compared to CBT alone (30–40%) (Riva, Bacchetta, Baruffi, & Molinari, 2002).

Another study by Cesa et al. (2013), examined the application of Virtual Reality-enhanced Cognitive Behavioural Therapy (VR-CBT) in the treatment of Binge Eating Disorder (BED) in obese individuals. The VR sessions consisted of exposure to individualized triggering environments of supermarkets, restaurants, and beaches, with patients practicing emotional, relational, and decision-making skills using coping skills to resist binges. A fear and craving hierarchy were built into the therapy, with anxiety and craving measured on a visual analog scale (VAS) with the aim of achieving a 40% decrease in distress after 60 minutes of exposure. Patients were taught to recognize emotional and Behavioural triggers, while therapists employed cognitive strategies of countering negative thoughts, reframing triggers, and challenging weight-related stereotypes. Body image rescripting was achieved using virtual mirrors and avatars, with the Allocentric Lock Hypothesis guiding the updating of distorted self-perceptions. The virtual environments addressed key situations associated with binge eating maintenance and relapses which increased patients' perceived control, competence, and motivation. The study showed that VR provides immersive and controlled environments for the practice of coping skills and body image improvement, making it more effective than CBT alone with longer-lasting benefits at one-year follow-up.

VR helps building coping mechanism

According to meta-analysis by Low et al. (2021), it suggested, VR's capability to expose patients to virtual food and environmental triggers aids in helping patients build coping mechanisms which could explain the reduction in binge episodes.

To support these, a meta-analysis by Low et al. (2021) evaluated the efficacy of VR-augmented cognitive Behavioural therapy (CBT) for binge-purging eating disorders compared to conventional CBT. The study was based on six randomized controlled trials with a sample size of 297, the results determined that VR-augmented CBT significantly has greater reduction in binge frequency ($p = 0.04$; MD = 0.29 fewer binges/day) and situation-induced body dissatisfaction ($p = 0.003$; SMD = 0.72). Nevertheless, no significant differences were observed between the two treatments regarding changes in body mass index (BMI), the frequency of purges, or general body satisfaction. The researchers concluded that although VR-augmented CBT is more effective in decreasing binges and situation-specific body dissatisfaction, its effectiveness in enhancing overall body satisfaction and decreasing purges is no higher than standard CBT. According to the study's suggestion, VR's capability to expose patients to virtual food and environmental triggers aids in helping patients build coping mechanisms which could explain the reduction in binge episodes.

Lastly, Manasse et al. (2021) conducted a proof-of-concept trial evaluating a virtual reality-based inhibitory control training (VR ICT) for reducing loss-of-control (LOC) eating. Participants completed a daily VR Go/No-Go task at home for two weeks, they were asked to suppress reaching toward virtual high-calorie binge foods (e.g., pizza, brownies) when they appeared on a yellow plate ("No-Go" signal), but instead actively reaching for healthy foods on blue plates ("Go" signal). The task difficulty adapted to performance to maximize engagement. Findings were of high acceptability and feasibility, with participants finding the intervention easy to use and to integrate into daily routines. Loss of control eating

Proof of Concept Trial (Manasse et al.)

Loss of control eating episodes decreased by 80% from baseline through two-week follow-up, with associations between reduced impulsivity and improved LOC eating episodes.

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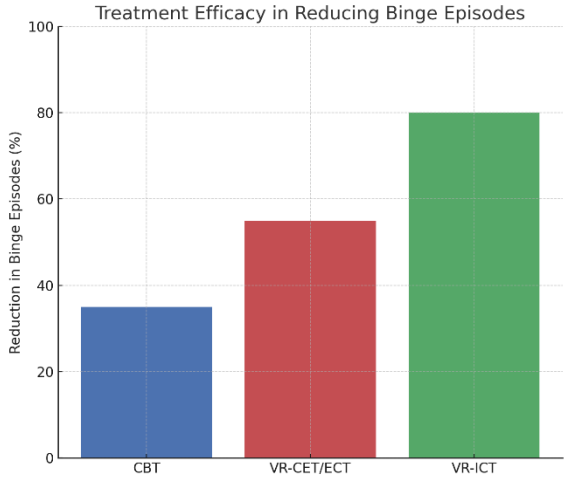
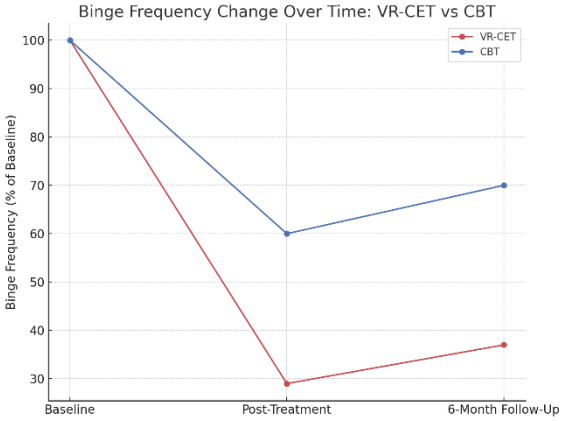


***Graph 1**. Comparison of the treatment efficacy of treatments for BED.*

Effectiveness of VR

The efficacy trials show strong results for the application of VR in treatment of binge eating disorder; however, it is important to establish further support through effectiveness trials to determine its usability in real world clinics. Two studies have shown promising results for the effectiveness of VR-based technology in clinical settings. While efficacy trials frequently combine CBT with VR-CET within VR-ECT paradigms, effectiveness studies have primarily examined VR-CET accompanied with selected CBT strategies during therapy sessions. Nameth et al. (2021) conducted an uncontrolled pilot trial which tested immersive VR-based Cue Exposure Therapy (VR-CET) for binge eating. The protocol included eight 1-hour sessions with a 2-session assessment phase where participants filled out ratings of anxiety and cravings for 30 binge foods and 4 virtual settings to build a personalized 13-step exposure hierarchy. Then, followed by 6 intervention sessions with gradual VR food-cue exposure, moving forward only if anxiety related to losing control reduced by 40%. Sessions combined exposure, coping skills training, and post-immersion processing, with optional emotional primings (recalling emotional stressors prior to exposure) to intensify engagement. The study included 11 adults (predominantly female) with bulimia nervosa (BN) and binge-eating disorder (BED) subjects with a history of treatment failure. Participants exhibited large decreases in binge frequency, with objective binges reduced by 71% by treatment and 56% of participants abstinent for 7 days. At the six-month follow-up, relapse was observed (28% increase in binge frequency), yet binge episodes remained 63% below baseline. The results highlight VR-CET's clinical potential, with immersive aspects such as food manipulation and environmental cues increasing realism. Emotional priming may have additionally contributed to retained effects during critical stressors.



***Graph 2**. Binge frequency rates over time: Nameth et al. (2021)*

Another study conducted by Ferrer-García et al. (2017), was a randomized controlled trial comparing VR-based Cue Exposure Therapy (VR-CET) with alternative cognitive Behavioural therapy (A-CBT) in adults with treatment-resistant bulimia nervosa (BN) and binge eating disorder (BED). The VR-CET procedure consisted of six 60-minute sessions administered twice weekly over three weeks. Patients first rated 30 virtual foods and 4 environments (kitchen, dining room, bedroom, café) for craving and anxiety levels to generate a personalized 40-scenario exposure hierarchy. During sessions, patients interacted with 3D virtual foods (e.g., lifting, zooming) without ingestion, progressing only once anxiety decreased to 40%. The trial enrolled 65 adults who had not responded to first-line CBT. Outcomes demonstrated that VR-CET outperformed A-CBT, with greater abstinence rates (53% vs. 25% for binge; 75% vs. 31.5% for purging in BN) and greater improvements in the frequency of binging, craving for food, and state and trait anxiety. Significant improvements were also seen in EDI-3

bulimia scores but no between-group differences in concerns with body image (e.g., drive for thinness). At a 6-month follow-up, abstinence rates remained substantially higher in the VR-CET group, 70% vs. 26%). (Ferrer-García, 2019). The findings confirm VR-CET's superiority over A-CBT in reducing core BN/BED symptoms, with interactive food manipulation and graded exposure contributing to its effectiveness as a second-line intervention. Both patients and clinicians rated VR-CET as highly acceptable, while reporting high satisfaction and approving it as an effective, recommendable treatment for eating disorders. Despite these promising results, the limitations of both studies included a small, non-representative sample and confounding with concurrent treatments. Additionally, the absence of placebo control, and reliance on general anxiety measures rather than food-specific measures may limit results. Longer-term outcomes, the role of hunger in treatment response, and age of onset effects need to be examined in future studies.

General Limitations of VR Treatment

Research on VR for BED remains limited. Firstly, there is a lack of longitudinal studies where follow-ups exceed one year, especially in clinical settings. Since those studies report low to moderate relapse rates, there is a need to study the effects of treatment over extended periods. Additionally, most studies have been conducted in European countries with small, predominantly Caucasian samples, which restricts the generalizability of findings and highlights the need for cultural and demographically diverse research.

Aattrition has been partly attributed to certain side effects of VR use. The most prevalent adverse effect is cybersickness, a condition initially described by Regan and Price (1994), that is characterized by dizziness, nausea, fatigue, and disorientation. It is caused by sensory conflict between visual (indicates motion) and vestibular inputs (perceives no motion). Even though it is usually brief and reduces with repeated exposure, these side effects remain a consideration (Quintana et al., 2015). Lastly, content availability presents a major obstacle. Despite VR hardware advances having lowered both cost and usability barriers to its use in psychological treatment and assessment, there are no commercially available, validated VR applications for clinical treatment. Existing programs have been developed within research settings only and are not available to clinicians outside those studies, which leaves them without accessible tools. Development and distribution of evidence-based VR platforms are critical for broader clinical adoption.

Clinical and Technological Recommendations for PsycReality

PsycReality is a multinational company founded in 2020 with the mission of developing accessible, research-backed VR software for the treatment of mental health conditions. They combine smart map design with VR technology to craft innovative experiences and clinically validated ambient soundscapes to deliver innovative therapeutic experiences and evidence-based medical solutions.

The organization is headquartered in Ireland and maintains an expanding client base across the United Arab Emirates, Kuwait, Oman and Pakistan, supported by an active research team in Brazil. PsycReality's software is compatible with the Oculus series (Oculus Quest 2 and Quest 3), which is a widely available VR hardware. PsycReality specializes in both immersive and augmented virtual reality simulation technologies, ensuring scalability and accessibility in diverse clinical and community settings. Over time, PsycReality aims to integrate haptic feedback and neural feedback into VR treatment to further enhance treatment outcomes. They further endeavor to adopt artificial intelligence within VR environments to enable personalized and customizable therapeutic experiences.

This white paper outlines the guide for developing PsycReality's software and establishing standardized protocols for the treatment of Binge Eating Disorder in collaborating clinics. The initiative aims to reduce treatment time, improve clinical effectiveness and most importantly the accessibility of new cutting-edge treatment to real-world healthcare settings. Furthermore, the paper explores how personalization using AI can deepen users' sense of presence within VR

environments and serve as a foundation for future research into BED treatment.

Combined VR-CET and CBT protocol as Enhanced VR-CET

Building on published findings, we propose an enhanced Virtual Reality Cue Exposure Therapy (VR-CET) protocol for the clinical treatment of Binge Eating Disorder (BED). To complement this, integrating targeted cognitive-Behavioural therapy (CBT) strategies allows patients to confront food-related triggers in immersive environments while simultaneously strengthening adaptive coping mechanisms. This plan excludes avatar-based body image rescripting because as seen in the meta-analysis by Low et al.,(2021), there was no advantage of VR treatment in the reduction of body image dissatisfaction over traditional CBT.

The paper recommends the use of immersive reality as opposed to augmented reality as its most used by effective treatments in literature. The complete protocol of the treatment is recommended to be as follows:

Formative phase (1-2 sessions)

The first 1-2 sessions would comprise an in-depth evaluation and psychoeducation of the client. The client would be required to complete a psychological assessment detailing the severity of symptoms, food anxiety experienced and features of craving-inducing environments. (Crone et al., 2023; Engel et al., 2013,). Data from the assessment would be anonymized after the receipt of informed consent to further guide the characteristics of environments created by PsycReality.

Psychoeducation would involve educating the client on what psychological patterns directly fuel ED Behaviours. (**Fairburn et al., 2003).** This would include using a visual diagram to show the cycle (e.g., ED trigger -> overwhelming emotion -> ED Behaviour -> temporary relief -> shame/guilt -> reinforces ED Behaviour**).**This would effectively normalize the client's experience, reduce self-blame, and creates a shared understanding of the treatment targets.

Assessment Phase (2 sessions)

Following the approach of Nameth et al. (2021), participants are first asked to rank their cravings for 20 binges foods across four virtual environments. Patients will use a Visual Analog Scale (VAS; 0–100) which will be incorporated into the virtual reality environment.(Parker et al., 2004). These ratings are then used to generate a personalized 13-step exposure hierarchy for therapy, ordered by the intensity of food-related craving.

Intervention Phase (6 sessions): Adapted by (Nameth et al. 2021 ; Riva et al. 2000)

Phase 1 (2 sessions): Extinction

Patients undergo exposure to highly craved foods in VR environments without engaging in binge Behaviours, assisted by habituation and extinction of conditioned responses.

Phase 2 (4 sessions): Exposure with coping strategies

Patients continue exposure while also practicing adaptive skills. To begin CET, the progression through the 13-step hierarchy will start from the least anxiety provoking food/environment combinations, then patients advance only after reporting 40% reduction in craving or urge to binge. Each subsequent food item should be in a different virtual environment than the previous cue to increase variability (Weisman & Rodebaugh, 2018).

In Phase 2, *emotional priming* may also be incorporated to elicit distress-linked experiences, furthermore, increasing ecological validity and treatment engagement.

Each session follows a standardized structure:

- Agenda setting and homework review.
- Monitoring of binge frequency.
- 30-minute VR exposure session.
- Post-immersion reflection and debriefing.
- Coping skills training
- Assignment of new between-session tasks.

Cognitive Countering:

According to Riva et al. (2000), patients are to learn to identify distorted thoughts and beliefs associated with food, eating and control. They should be challenged to recognize the errors in their thinking and substitute them with more appropriate and realistic perceptions. Cognitive restructuring should be used to reinforce Behavioural learning achieved during VR exposure and consolidates long-term therapeutic gains.

Alternative Interpretation:

Before reacting to negative situations, patients should be taught to stop and generate multiple possible interpretations of a situation. Patients should work collaboratively with the therapist to identify which interpretation is supported by objective data. This approach reduces automatic reliance on maladaptive thought patterns and encourages more balanced cognitive processing.
Label Shifting:

Patients should identify and list the negative emotional labels they frequently apply to themselves. These labels are then to be replaced with more neutral and descriptive words which promotes more constructive self-evaluation.

Deactivating the Illness Belief:

The therapist supports patients list their beliefs about their eating disorder, identify how the "illness model" influences them, and re-frame Behaviours like binging and purging from a cognitive-Behavioural perspective. This shifts the perception of Behaviours such as binging and purging from being fixed “symptoms” to being modifiable and behaviourally driven.

Patients are guided in alternate responses during exposure (Weisman & Rodebaugh, 2018; Nameth et al., 2021). These include affect labelling**,** where individuals during exposure to food cues verbalize their present emotional state to engage prefrontal inhibition and dampen the amygdala's fear response, and goal shifting**,** which reframes exposure from avoiding cravings to actively overcoming them, in order to recruit the brain's reward system and establish new and non-threat associations.

Coping Skills Training:

Patients are equipped with structured coping strategies to strengthen resilience and reduce relapse risk, this includes:

Physiological regulation:
Paced breathing and sensory calming.

Behavioural expansion:
Substituting maladaptive eating Behaviours with alternative, adaptive activities or engaging in enjoyable pursuits.

Attentional control:
Redirecting focus using balanced thinking, guided visualization, and constructive self-talk.

Motivational strengthening:
Systematic evaluation of the advantages and disadvantages of potential actions to reinforce commitment to resilient choices.

Environments

Environments should be designed to maximize violation of expectation, which means they must be powerful enough to induce the anticipation of actual eating Behaviours (Schyns et al., 2020). Their effectiveness depends on three interrelated factors:

a) The likelihood of the patient to binge on the particular foods
b) The likelihood of binging in the environment
c) The sense of presence felt in the environment.

This paper proposes 32 binge foods distributed across 4 different virtual environments. During the assessment phase, participants select their triggering foods, from commonly reported binge foods such as high-calorie foods including sweets, junk foods, and snacks. (Pla-Sanjuanelo et al., 2015). Regional food preferences are also factored in to strengthen the relevance associated with the food and binging.

The 4 virtual environments identified as common binge-inducing settings are:

- Restaurant scenario
- Bedroom scenario
- Dining Room scenario

Kitchen scenario

Binging Behaviours were reported both during the day and night, with night-time binges being more common. It is recommended that environments incorporate both time settings, sequenced to patient patterns.

S.No.	**VR Environment**	Food Cues
1.	**Bedroom**	• Cookies • Ice Cream Tub • Chocolate • Potato chips • Cheese • Nachos • Crackers • Yogurt
2.	**Dining Room**	• Indulgent • Sandwiches • Fried Chicken • Kebabs • Mac & Cheese • Brownies • Dumplings • Pasta • Potato Wedges
3.	**Kitchen**	• Pizza • Lasagna • Donuts • Kunafa • Mandi • Ramen • Roll / Buns • Peanut Butter / Nutella • Cereal
4.	**Restaurant**	• Burger • French Fries • Chicken Biryani • Sundae • Cake • Waffles • Curry-rice Dish

Presence is essential for the ecological validity of VR treatment. One obstacle identified by Tal and Wansink (2011), is that VR environments might be visually realistic but psychologically inert if the users don't expect to act within them. The expectation of actual Behaviour is dependent on mental simulation, which is the brains automatic predictions about future experiences and Behaviours. It is only triggered if the virtual environment is perceived as actionable.

To ensure presence and validity, key design principles by Tal and Wansink (2011) include:

Embodiment:
The integration of the patient's real body into the virtual environment. For example, seeing their own hands in VR, this ensures alignment with their physical self rather than embodying an external avatar.

Multisensory Engagement:
Incorporating auditory, olfactory, haptic cues, and high-fidelity visuals strengthens authenticity.

Virtual environments should replicate the auditory features of real settings, and clinicians should be supplied with food-related scents that correspond to the cues presented during treatment, to reinforce immersion by spraying it in the room during therapy.

Perceptual Fidelity:
Distractions from equipment or headset weight must be minimized. Accordingly, the Oculus is recommended as a low-weight and comfortable headset for treatment.

Contextual Specificity:
Environments should replicate all components of the environment of binge-related cues, favouring immersive VR over AR.

Attentional Realism:
Virtual scenarios should guide focus naturally, also objects must be integrated seamlessly and avoid disproportionate emphasis.

Additional components for enhancing presence include:

Speed:
The potential between user action and system response. A delay of less than 20 milliseconds is recommended to preserve the illusion of direct manipulation and maintain the user's sense of agency. This effectively ensures there is no disruptive dissociation between action and outcome (Cummings & Bailenson, 2016).

Range:
The simulation must support a broad and nuanced spectrum of possible user interactions. A limited set of pre-defined actions can reduce immersion by constraining the user. A wide range of plausible responses reinforces the user's belief in the reality of the virtual world and their ability to influence it meaningfully (Skola & Liarokapis, 2016).

Narrative Coherence: All elements of the virtual environment must align with a coherent and logical storyline. This involves ensuring events unfold in a plausible sequence, character Behaviours should remain predictable, and the settings remain stable according to its own established rules (Bostan & Marsh, 2020).

AI Personalization

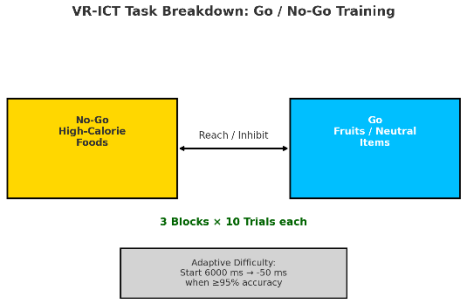
According to Singha and Singha (2025), the integration of artificial intelligence (AI) into VR treatment is an important avenue for increasing presence and engagement. Personalization through AI can benefit treatment outcomes and can be carried forward through the following methods:

Adaptive Task Difficulty:

AI algorithms can track patient task performance and adjust difficulty in real time and intensifies challenges when progress is strong or easier if the patient struggles. This maintains a therapeutic balance, ensuring tasks are neither too easy nor overwhelming.

Real-Time Feedback & Adaptation:

During VR exposure sessions, AI could analyze physiological and Behavioural responses (stress levels and reaction times), it could then modify the VR environment instantly. For example, if the patient is too distressed, AI could reduce the intensity of triggers, or if the patient is coping well, the AI can increase exposure. This effectively create a dynamic therapy loop where treatment evolves in sync with the patient's reactions.



Data-Driven Insights for Clinicians:
AI can process and analyze large datasets (e.g., performance scores, emotional responses, biometrics) to reveal recurrent patterns.

Clinicians can use these insights to:

Figu

a) Identify triggers for anxiety or binge episodes and tailor VR scenarios accordingly
b) Track recovery trends to identify effective interventions
c) Adjust long-term treatment plans more accurately
d) Enhanced Engagement

Gamification

AI can gamify therapy by rewarding progress or adding motivational elements. This keeps patients engaged longer compared to static therapy methods.

VR-ICT protocol as adjunct treatment

VR-ICT can prospectively enhance the Enhanced-CBT treatment. Protocol can either comprise twice-weekly sessions carried out in the practitioner's clinic or as validated by Manasse et al. (2021), through daily at-home sessions.
A restaurant-based VR environment will present high-calorie foods on yellow plates ("no-go" signal) and low-calorie or non-food stimuli on blue plates ("go" signal). Participants must inhibit reaching

during no-go cues and grasp virtual food during "go cues". Game performance should be visible in the VR screen, and gameplay initiate only when the participant is in the correct position in space. The food cues should constitute 3 blocks of 10 trials (i.e., 30 total trials) of stimuli, with 33% of the stimuli comprising binge foods (i.e. pizza, French fries, brownie, cake, chocolate chip cookie), 33% fruits and vegetables (i.e. apple, orange, green bell pepper, banana, carrot) and 33% neutral items (i.e. cup, bowl, knife, fork, spoon). To optimize training efficacy, the task to adapt to performance- beginning with a 6000 ms response window, which decreases by 50 ms whenever 95% accuracy or higher is achieved within a block, progressively increasing inhibitory control demands (Vinogradov et al., 2012)

Ethical Considerations

The utmost priority of this treatment is the well-being of participants. The VR protocol is designed to be therapeutic and helpful in reducing binge eating Behaviour. However, we acknowledge that exposure to food stimuli and immersive VR settings may temporarily increase anxiety, craving, or distress. To ensure safety, all sessions will be conducted under the immediate supervision of a licensed clinical practitioner trained to monitor adverse effects and provide immediate support. Sessions may be paused or terminated at any time if a participant is experiencing intense psychological discomfort. Importantly, participation remains entirely voluntary.

Informed Consent:

Before enrolment, all prospective participants will undergo a detailed informed consent process before enrolling. This would include a clear explanation of the treatment aims, procedures, duration, potential risks and expected benefits. Participants would receive a clear notice that they are free to withdraw from the treatment at any point without penalty or impact on their future care. The VR technology will also be explained in detail, including what participants will see, hear and experience, this is to prevent any anxiety about the medium. Participants will be given sufficient time to ask questions and sign the informed consent is crucial confirming participant understanding and agreement, which will be obtained prior to initiating any treatment procedure.

Practitioner Training:

All interventions of therapy, including administration and instruction of VR exposure sessions, will only be conducted by certified clinical practitioners who have received special training in:

a) Evidence-based treatments for eating disorders
b) Principles of Exposure and Response Prevention (ERP)
c) The safe and effective use of the VR software and hardware utilized in this protocol.

Data Security and Confidentiality

All collected data (questionnaire responses, demographic information, physiological measurements, and VR performance metrics) will be securely stored on encrypted, password-protected servers with access limited to authorized clinicians. All information for AI analysis would be anonymized with all identifiable information being discarded.

Future Directions

Building on the proposed protocol, future iterations should assess the efficacy of VR-Enhanced CBT in more diverse populations to evaluate generalizability. Long term outcomes should be evaluated using further longitudinal studies. Further research could also explore the integration of augmented reality with BED treatment. The use of augmented reality could be used to facilitate contextual retention by simulating virtual food cues within the patient's home environment, possibly enhancing ecological validity and generalization. The method of emotional priming could be made more engaging and realistic, through its elicitation by interactive conversation with virtual friends. Emotional stressors from memory could be made accessible in the presence of food cues by a virtual friend who asks the patient conversational primers such as "How are you? What has been stressing you out recently?" The method could also be used to incorporate and enhance affect labelling through improvement of ecological

validity. Longitudanal studies and studies on different demographics should also be conducted to confirm long-term efficacy and generalizability

Conclusion

BED continues to be a priority public health concern, particularly in regions such as the UAE where rates of prevalence are substantial and current treatments leave important gaps. VR specifically through the PsycReality model and enhanced VR-CET algorithm represent a scalable, engaging and patient-centered solution. With AI personalization and ethical safeguards, VR must complement but not replace established evidence-based therapies to improve outcomes and accessibility for individuals with binge eating disorder.

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