RESEARCH ARTICLE

The Use of a Nonimmersive Virtual Reality Programme in Anorexia Nervosa: A Single Case-Report†

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Abstract

Objective: People with anorexia nervosa (AN) experience high levels of fear and anxiety related to eating. The aim of this case report was to describe the use of a virtual reality (VR) programme developed to facilitate exposure to food as a supplement to treatment for a person with AN.
Method: A 21-year-old patient with AN was given the VR module in addition to the Maudsley Model of Treatment for Adults with Anorexia Nervosa. Weight, eating disorder symptomatology (EDE-Q) and general psychopathology (DASS) were assessed before and after the module was delivered.
Results: At the end of the module, the patient reported lower levels of anxiety, safety behaviours and fears related to food. Both eating disorder symptoms and distress were reduced. Body mass index increased from 15 to 16.8 kg/m^2 during the module.
Conclusion: The VR exposure module was associated with a beneficial change in the relationship to food and was perceived to be helpful by the individual.

Keywords
anorexia nervosa; virtual reality; exposure to food

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Introduction

People with anorexia nervosa (AN) avoid food and associate it with negative emotions, thoughts and imagery (Treasure, Cardi, & Kan, Early view). This pattern of response may arise from learned negative associations with food, developed through a variety of processes including vicarious learning and cognitive conditioning by threatening information about food, weight and health (Treasure, et al., Early view). Treatment to overcome the avoidance associated with fear includes gradual exposure to a feared object or situation in a clinical setting experienced as safe and supporting (Marks, 1987). Steinglass and colleagues have developed an exposure-based protocol to reduce food fears in people with eating disorders (EDs) and have found it to be acceptable and feasible (Steinglass et al., 2007; Steinglass et al., 2011).

Virtual reality exposure (VRE) is considered an alternative to exposure in reality (Riva, 2009). It offers the advantages of tailoring treatment to the patient's needs in a relatively safe context (Ferrer-Garcia, Gutierrez-Maldonado, Caqueo-Urizar, & Moreno, 2009; Gorini, Griez, Petrova & Riva, 2010), which may ameliorate the high rejection and attrition rates that have been reported for *in vivo* exposures in the treatment of anxiety disorders (Choy, Fyer & Lipsitz, 2007; Olatunji, Cisler & Deacon, 2010). A recent meta-analysis of studies using VRE for the treatment of anxiety disorders concluded that its efficacy might be higher (Powers & Emmelkamp, 2008) and its acceptance was greater (Garcia-Palacios, Botella, Hoffman & Fabregat, 2007) than *in vivo* exposure.

In people with EDs, virtual reality (VR) programmes used as part of cognitive behavioural treatments have been found to be effective in decreasing body dissatisfaction and improving motivation (Perpina et al., 1999; Perpiñá, Marco, Botella & Baños, 2004; Riva, Bacchetta, Baruffi, Rinaldi & Molinari, 1998, 1999; Riva et al., 2000; Riva, Bacchetta, Cesa, Conti & Molinari, 2004). Virtual food is as effective as real food in eliciting emotional responses in patients with EDs (Ferrer-Garcia, et al., 2009; Gorini, et al., 2010).

One of the authors of the paper has developed a VR programme designed to help patients normalize their eating pattern (Perpiñá, 2008). The programme is still under experimentation and validation,[1]

[1]For further information or questions about the VR programme, please contact perpinya@uv.es.

and the preliminary results regarding the emotional impact and sense of presence in the virtual environment are promising (Perpiñá et al., 2010).

The aim of this case report was to examine the effectiveness and acceptability of this VR programme to supplement treatment with the Maudsley Model of Treatment for Adults with Anorexia Nervosa (MANTRA).

Precedents

T. is a 21-year-old female diagnosed with AN, restricting subtype (*Diagnostic and Statistical Manual of Mental Disorders—Fourth Edition*) (American Psychiatric Association, 1994). The onset began at age 16 years, and she was referred to our centre because she had continued to deteriorate despite 7 months of cognitive behavioural therapy, pharmacological treatment (amitryptiline and chlorpromazine) and a recovery group.

Exploration

At the intake assessment, T.'s body mass index (BMI) was 15 kg/m². Although she lived at home with her parents and sisters, she ate alone. She had a restrictive and rigid eating pattern and exercised four times a week. She reported intense fears and anxiety related to food, and she was obsessed with intrusive thoughts of being contaminated by calories. T. had the following additional symptoms: amenorrhea for 2 years, heightened sensitivity to cold, sleep problems, hair loss, general weakness, emotional dysregulation, low mood, irritability and social isolation.

Treatment plan

The deterioration in T.'s symptoms and health despite specialist outpatient care led the clinician to consider the use of inpatient care or day patient care in which there would be exposure to food in order to remediate the increasing problems of malnutrition. T. and her family were reluctant to choose this option. Therefore, we decided to supplement the standard treatment available in our clinic, the Maudsley Model (MANTRA), with the food exposure VR programme. The VR intervention was delivered before the MANTRA treatment.

Maudsley model of treatment for adults with anorexia nervosa

The model underpinning this treatment is that four broad maintaining factors prevent recovery from AN: perfectionism and obsessive–compulsive personality traits, avoidance, pro-anorectic beliefs and the responses of close others (Schmidt & Treasure, 2006). Moreover, the symptom (poor nutrition) exacerbates pre-existing traits [anxious/avoidant and obsessional traits (rigidity, detail focus)] leading to additional impairments in the socio-emotional domain (such as avoidance) and interpersonal domains (an over sensitivity to criticism and reduced attention to warmth). The MANTRA includes a module to improve nutrition, which is based on motivational intervening and behaviour change principles. However, exposure to food is not part of the MANTRA protocol within sessions.

Methods

Assessment

The 'Eating Disorders Examination Questionnaire' (EDE-Q) (Fairburn & Beglin, 1994) and the 'Depression, Anxiety and Stress Scale' (DASS) (Lovibond & Lovibond, 1995) were administered at baseline and after the VR exposure programme to assess ED symptomatology and general psychopathology.

Virtual reality exposure module

The VR software displays a virtual kitchen, which can be explored by using the mouse. Food items of different caloric contents (e.g. fruit, salad, yoghurt, chicken, lasagna and cake) are stored in a refrigerator or cupboards. These food items may be used to prepare a meal, which is eaten at a table using plates and cutlery. Each bite is associated with sounds of chewing and swallowing. The VR programme used a 'nonimmersive' technology (e.g. it did not require the use of a head-mounted display) (Perpina et al., 1999; Perpiñá, Botella & Banos, 2003; Riva, et al., 1998, 1999).

The VR intervention module consisted of seven weekly sessions, each of which lasted approximately 60 minutes. The protocol consisted of a gradual exposure to food items. Sessions were run in a quiet room by a trained psychologist. During each session, intrusive thoughts and negative emotions were elicited and rated on a Likert scale ranging from 1 (not experiencing this thought/emotion at all) to 10 (experiencing this thought/emotion very much). A flexible and explorative approach was adopted and no *a priori* emotion labels were used. T. was weighed at the end of each session. At the end of the study, a feedback form was given to evaluate on a 5-point Likert scale ranging from 1 (not at all) to 5 (very much) the acceptability, enjoyment and usefulness of the VR programme.

Results

Virtual reality exposure sessions

Session 1

The aim of the first session was to explain the rationale of the intervention and to give T. the opportunity to become familiar with the computerized tool. T. explored the virtual kitchen, and she was asked to rate the thoughts and feelings that she was experiencing on a graduated scale. T. focused her attention on the fear eliciting food items (she referred to them as 'forbidden foods'), which included cake, pizza and lasagna. T. commented that she would not be able to eat these foods virtually. She believed that they were extremely unhealthy, and this is why she avoided them. T.'s description of her attitudes toward each item in the fridge was extremely detailed, which probably reflected her perfectionist nature. She described intrusive thoughts and images related to the need to check how food was prepared. She had magical thinking related to contamination (calories in the air), which forced her to avoid specific situations and household electrical appliances.

In the first session, T. was asked to build up a hierarchy of feared food (from the least to the most frightening). Then, she was asked to eat a portion of salad, the less feared food. She

consumed this without any difficulties in a short amount of time. T. agreed to challenge her fears and anxiety towards the next food items on the hierarchy during the following sessions.

Sessions 2–4

From the second session onwards, T. was gradually exposed to the 'forbidden food' items. She chose to be exposed to virtual pizza first. When exposed to pizza, T. reported the maximum score for anxiety, fears and intrusive thoughts (getting fat and losing control). T. commented that, to her, the slice of pizza in the VR software seemed bigger than in reality. T. indicated that in order to fight against her intrusive thoughts (fear of losing control and getting fat), she had to eat the slice very quickly. The more T. thought of the pizza, the more her anxiety increased. Exposure to this item and the encouragement to try to eat was repeated for three consecutive sessions. The therapist took a compassionate stance, reminding T. about the importance and the rationale of the extinction process. In session 2, T. gradually started to eat the virtual pizza but did not finish the whole portion. She discussed with the experimenter the difficulties of eating without using safety behaviours (e.g. cutting food into small pieces and use of distracters while eating). At the end of the third session, T. ate at a normal pace and was able to finish the whole piece on the plate. Anxiety and fear related to pizza dropped to a score of 4. At the end of session 4, T. reported that she was able to be in proximity to a range of forbidden food items. Furthermore, her intrusive thoughts dropped to a score of 6, and her fear of contamination and the need to check food preparation also decreased significantly. Throughout these sessions, T. was encouraged to adopt the same attitudes and behaviours used during the sessions at home and to repeat the exposure to the same food item in a variety of different settings and with different people.

Sessions 5–7

From session 5 onwards, T. was asked to try to eat different food combinations. During sessions 5 and 6 she was asked to eat a combination of one threatening food (virtual lasagna) and one safe food (virtual apple). During session 7, T. was asked to eat a combination of two threatening caloric items (sausages and beer). When confronted with the first task (lasagna and apple), T. felt especially anxious (score of 7) and reported unpleasant emotions, such as fear of getting fat and guilt (score of 10). T. was scared of feeling too full. She was frightened of eating without any distracters (television, internet surfing or reading newspapers) (both scored a 10). She said that she was confused about portion sizes (score of 10) and still found it difficult to finish the portion. During session 5, T. refused to eat more than one food item because her intention was to reduce her feelings of guilt (score of 7). However, she was nevertheless able to finish the most threatening food portion (virtual lasagna). During the following session, T. was exposed to the same food combination (virtual lasagna and apple). She started to eat the two different food items but was not able to finish the portions. Nevertheless, her anxiety level decreased from 10 to 4 at the end of the session. During the last session, T. was asked to try a combination of two threatening food items (sausages and beer). When first exposed to sausages and beer, her anxiety and guilt went up (score of 10) but she was able to finish the portions after only a few minutes. T. enjoyed eating these food items (score of 7), and at the end of the sessions, her anxiety and guilt dropped (a score of 3 and 7 was reported, respectively). She judged the virtual portions adequately and was able to eat slowly and to focus on the food rather than searching for distracters. Fears of getting fat and feeling guilty were still reported, even though at lower levels (score of 4). After session 5, T. was able to introduce a larger variety of different real foods into her diet. Her mother helped her with food preparation and portion sizes. At the end of the VR exposure programme, T. started to eat the same foods as her family, albeit smaller portions.

Outcome measures

During the VR component, T. reduced the number of safety behaviours and did not report any contamination thoughts or fear of losing control. Anxiety, fear and guilt related to eating also dropped significantly. T. augmented the number of food choices in real life. Her family relationships and social life also improved considerably. Finally, her mood improved, and her self-esteem and confidence to change increased. Both eating symptoms (EDE-Q) and depression and anxiety (DASS) were reduced at the end of the programme (EDE-Q Restriction: from 3.8 to 3; EDE-Q Eating Concern: from 4.6 to 3.8; EDE-Q Weight Concern: from 3 to 2.4; EDE-Q Shape Concern: from 4.6 to 3.1; EDE-Q Global Score: from 4 to 3; DASS Anxiety: from 24 to 18; DASS Depression: 20; DASS Stress: from 32 to 22). At the end of the VR programme, T.'s BMI had increased to16.8 kg/m2. Figure 1 shows T.'s weight increase during the VR sessions.

On the feedback form (assessed at the end of session 7), T. provided a maximum score of 5 to the enjoyment and helpfulness of the VR programme. She commented that the programme felt real and helped her to be actively involved in eating. The eating sounds in the programme made the virtual context more real. She recommended that increasing the availability of different foods and having the option to eat with other people might improve the programme. Figure 2 shows some examples of the responses of the patient to the VR component.

T. continued with the Maudsley Model of Individual Therapy over the next 6 months. This involved joint sessions with family members in order to reduce the inadvertent pattern of behaviours, which were reinforcing ED symptoms (overprotection, accommodation to ED behaviours) (Treasure et al., 2008). T. was encouraged to increase reward and positive emotions through connection with others. She started to eat meals with the family. She reduced her running and gym attendance. She gradually reduced her medication. She continued to have residual problems with anxiety such as the dread that one of her three sisters might develop an ED. At 6 months, her BMI had increased to 17.2 kg/m^2 (Figure 1). She was promoted at work and started a new relationship.

At follow-up, T. commented on the use of the VR with a written feedback (Table 1).

Discussion

To conclude, the addition of this short programme mainly focused on eating symptoms to MANTRA helped T. to reduce fear of food and to increase the variety of food and to develop a more normal eating pattern. At the end of the module, she was able to

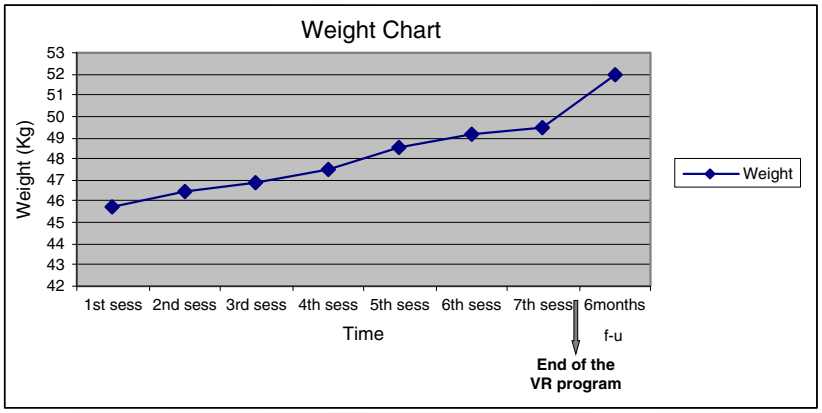

Figure 1 Weight chart of weight gain progression through the virtual reality (VR) sessions and at 6 months follow-up (f-u)

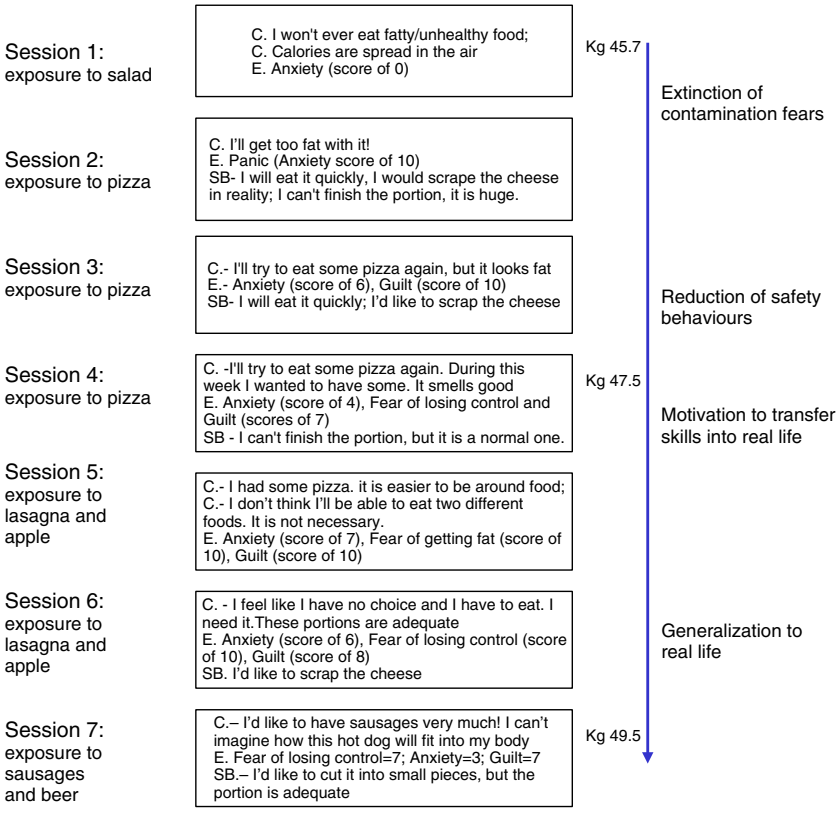

Figure 2 Examples of cognitions (C), emotions (E) and safety behaviours (SB) reported during the sessions

eat foods socially and to prepare food for others. Her ED and mood symptoms decreased. Self-esteem, family and social life also improved significantly.

Clinical implications

This study adds to the evidence that suggests that VR may be a useful adjunction to the treatment of AN (Perpiñá, et al., 2003; Riva, et al., 1998, 1999). This case report describes the process of exposure to virtual food in AN using a VR programme. The virtual environment allows for a high flexibility, with measurement and monitoring of the wide variety of patient's responses in real time. An advantage is that food choice can be adjusted in the moment and tailored to the patients needs. Aside from these practical advantages to the use of VR, there may also be theoretical advantages. For example, Riva has proposed an intriguing hypothesis about the mechanism underpinning the effectiveness of VR programmes. He suggests that they induce a sensory rearrangement of disturbed perceptual experiences and assumptions about the relationship between self and the world (Riva, 2010, 2011).

Table 1 Comments that T. made, 6 months after the onset of treatment about her experiences before, during and after the use of the virtual reality programme

	T.'s thoughts
Assessment	My situation at this stage was quite desperate and I was in despair at how I would manage to get over the torment and put my Eating disorder (Anorexia Nervosa) behind me. I knew the recovery was up to me, however, to do this alone was a tremendous amount of pressure, particularly as I had tried almost every remedy and listened to every bit of advice I was given and I couldn't manage to get over my fear of food. I had crazy thoughts (which I see clearly now) like I couldn't have my food in the same basket as others, I had to have a separate fridge, junk food could not be eaten near me, all for fear of some of the particles escaping and lapping into my food or my body. . . of course, my overall fear was of gaining much weight and losing control.
Session 1	I remember when I first sat there with Isabel and Valentina my facial expression said it all, I found the food disgusting and never imagined being able to virtually eat the chocolate cake and pizza, let alone in real life. Having said this, the longer I sat there, the more it calmed my nerves about high content foods being in the fridge with lower calorie salads etc. . .That day I ate the salad and I think so the fish or fruit from the fridge, I had not reservations about this as I d been living on that for a while now and for some reason the idea of it being in a fridge with chocolate cake extra did not faze me too much. That weekend I diminished my own fridge at home and me and mum went shopping with the same basket to buy are foods – an immediate difference noticed by my mum.
Sessions 2–7	Over time and repeated visits to Guys to try out more of the foods in the fridge, I began to try these foods in small quantities at home in real life cases. I built up an immunity to the voice, I wasn't gaining all the weight like I was told by the eating disorder, I wasn't dragging each day, in fact I was getting compliments for my energy by the people in my work and was not finding it as hard as anticipated to resist the urge to fill my face.
Feedback on the virtual reality experience	The virtual food was a gentle way of easing me back into being around high calorie and high content foods. The more I was around these foods, the more I became accustomed to seeing them in everyday life – it has become more normal to me nowadays and this definitely helped me with going to supermarkets and just being in kitchens with normal food around. I guess the understanding that these foods will always be around is now more of a comfort to me. I try to remember that its not imperative to finish a meal if your full and this keeps me more grounded, so I don't over-indulge. My current state is now much improved. I have tried various maudsley methods at overcoming my demons; however, stand by the fact that I believe the virtual fridge was of the most help. It got me back in touch with food again and made me more at ease with all foods and being around different types of healthy and non healthy indulgences.

This is a single case-report in which the VR programme was added to MANTRA for an individual who had failed to respond to standard outpatient treatment. There is therefore uncertainty about what component of treatment was effective in this case. However, both the objective and subjective changes in relationship to food, which occurred during the VR module, suggest that there was a specific benefit gained. Further studies are needed in a larger sample with a controlled design in which possible mediators of change are measured such as the sense of presence elicited by the VR programme and how much experience generalized to exposure to real food. Other VR programmes have been developed and are currently tested: Neuro-VR (Riva, 2009, 2011).

In summary, these findings support the use of VR also as a valid and useful adjunct to the treatment of fears and anxiety related to food in people with EDs.

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