

Assessment of Emotional Reactivity Produced by Exposure to Virtual Environments in Patients with Eating Disorders

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ABSTRACT

The aim of this study was to assess the usefulness of virtual environments representing situations that are emotionally significant to subjects with eating disorders (ED). These environments may be applied with both evaluative and therapeutic aims and in simulation procedures to carry out a range of experimental studies. This paper is part of a wider research project analyzing the influence of the situation to which subjects are exposed on their performance on body image estimation tasks. Thirty female patients with eating disorders were exposed to six virtual environments: a living-room (neutral situation), a kitchen with high-calorie food, a kitchen with low-calorie food, a restaurant with high-calorie food, a restaurant with low-calorie food, and a swimming-pool. After exposure to each environment the STAI-S (a measurement of state anxiety) and the CDB (a measurement of depression) were administered to all subjects. The results show that virtual reality instruments are particularly useful for simulating everyday situations that may provoke emotional reactions such as anxiety and depression, in patients with ED. Virtual environments in which subjects are obliged to ingest high-calorie food provoke the highest levels of state anxiety and depression.

INTRODUCTION

HILDE BRUCH,¹ in 1962, was the first researcher to consider the dysfunctional experience of the body image as a central aspect in eating disorders (ED), in particular in anorexia nervosa. Since then, though the importance attributed to the concept has varied over recent years,² many studies have assessed individuals' experience of their own body image. Though it seems self-evident that there is a close relation between ED and altered body image, in the literature on the subject no clear association has been established. Indeed the results of the studies³⁻⁷ are often contradictory or inconclusive.

A number of hypotheses have been proposed to account for these results. Some authors have

stressed the fact that body image may be to a certain extent more a state than a trait^{2,4,8} and may change according to situational or emotional variables. Several studies have analyzed the possible impact of exposure to specific objects or situations on the stability of the body image.⁹⁻¹⁴ These studies suggest that body image, or some of its components, can indeed be understood as a state rather than as a trait.

In this study, we designed six virtual environments (VEs) that were emotionally significant for subjects with ED in order to generate different levels of anxiety and variations in mood. This paper describes the first stage of the project, in which we evaluate the effectiveness of these environments to elicit emotional responses in ED patients. For a

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VE to be effective as an exposure technique, it must produce responses of anxiety. However, most of the research carried out to date has only assessed whether an environment proves effective for the treatment of a particular disorder, overlooking the fact that its effectiveness is dependent on the ability of virtual reality (VR) to generate emotional responses. If the results of these trials are considered unsatisfactory, this does not necessarily mean that VR is not an effective technique for the treatment or assessment of a particular disorder, merely that the environments designed may not be able to trigger an emotional response from the patient. In future investigations, we will study whether exposure to these environments produces variations in the estimation of body image and whether anxiety exerts a mediating role in this relation.

Unlike conventional methods (real exposure to the situation, exposure to photographs, exposure via guided imagination, and so on), VR exposes subjects to interactive three-dimensional environments that simulate a real situation. These environments have ecological validity and also permit strict control over the variables and the recording of data. VR offers many of the advantages of the conventional methods mentioned above, and also overcomes many of their drawbacks.

Since patients with ED are known to show anxiety on seeing high-calorie food and in situations in which their body is displayed or in which they come into contact with other people,¹⁵ in our design of the environments we incorporated these two variables in the following conditions:

1. Presence of food: no food, a high-calorie meal, and a low-calorie meal
2. Presence of other people: no other people present/other people present

The combination of the two variables gives rise to a repeated measures design (2×3) with six experimental conditions (Table 1).

This study aims to assess the effectiveness of VEs to provoke emotional reactions (anxiety and de-

pressed mood) in patients with ED. We considered the following hypotheses:

Hypothesis 1. If food constitutes an aversive, anxiety-provoking stimulus for people with ED, exposure to virtual situations in which subjects must eat different types of food (high or low calorie) will increase their level of anxiety and depression.

Hypothesis 2. If subjects with ED experience higher levels of stress in social situations and situations that involve scrutiny by others, exposure to these types of situations will increase their level of anxiety and depression.

METHODS

Subjects

The sample comprised 30 women with a diagnosis of eating disorder (17 with anorexia nervosa, 11 with bulimia nervosa, and two with non-specific eating disorder) and with ages ranging from 16 to 32 (mean = 20.57; standard deviation = 4.15). The patients were from hospitals and private clinics in Barcelona: two from the Hospital Germans Trias i Pujol, six from the Hospital de Sant Juan de Déu, 10 from the Clinica Labor, and 12 from the Centro ABB. The first eight were hospitalized, and the others were on a day hospital program. Subjects were also classified according to their symptom severity as severe, moderate, or mild; the classification was made on the basis of their clinical history and the profile obtained on the EDI-2.

Instruments

- *EDI-2 (Eating Disorders Inventory-2)*¹⁶: D.M. Garner: self-report questionnaire for the evaluation of symptoms that normally accompany anorexia nervosa and bulimia nervosa
- *STAI (State-Trait Anxiety Inventory)*¹⁷: C.D. Spielberger, R.L. Gorsuch and R.E. Lushene: anxiety questionnaire

TABLE 1. DESIGN OF REPEATED MEASURES (2×3)

	<i>No food</i>	<i>Low-calorie food</i>	<i>High-calorie food</i>
No other people	Living-room	Kitchen with low-calorie food	Kitchen with high-calorie food
Other people present	Swimming-pool	Restaurant with low-calorie food	Restaurant with high-calorie food

- *CDB (The Barcelona Depression Questionnaire)*¹⁸: J. Gutierrez and M. Mora: self-report instrument for measuring variations in depressed mood
- *Presence Questionnaire*¹⁹: Slater, Steed, McCarthy, and Maringelli: a questionnaire that evaluates the degree to which the subject has experienced the “sense of being” in the virtual environment, how far the virtual environment is the dominant reality and how far it is recalled as a “place”

Scenarios

The living-room (neutral environment) has two functions: first, it accustoms subjects to moving around a VE and interacting with the items inside it; second, it provides a neutral, emotionally non-significant environment for use as the study’s baseline condition. The kitchen is one of the instrument’s five emotionally significant scenarios. There are two experimental conditions: a kitchen with low-calorie food (salad, apple, and water) and a kitchen with high-calorie food (hamburger, pizza and cola). The restaurant also has two experimental conditions: a restaurant with low-calorie food (salad, apple, and water) and a restaurant with high-calorie food (hamburger, pizza, and cola). In this environment, the presence of avatars representing attractive young people adds an extra element—social evaluation and comparison—alongside the effect of exposure to food. Finally, in the swimming-pool, the participants must expose their own body and at the same time be exposed to other people’s bodies. Figure 1 shows pictures of these environments.

Procedure

The psychological tests were administered in two stages. In the first stage, the self-report questionnaires EDI-2 and STAI-T were administered to all the participants in the sample. Each subject was then measured and weighed individually and their body mass index (BMI) calculated. The measurements were performed after the questionnaires were completed to avoid the possible influence on the test scores of the anxiety caused by the measuring and weighing. Finally, a form was filled out for each subject specifying their age, weight, height and BMI, type and course of the disorder and severity of symptoms.

In the second stage, the neutral environment (baseline) was administered and the subject filled in the STAI-S and the CDB (a depression scale). The five VEs (experimental conditions) were then randomly administered. In the interval between the presentations of each environment, the subject filled in the STAI-S and the CDB again. Both tests were computerized using a program that integrates them in the sequence of VEs and saves the data. After exposure to all the environments, the patients completed the Presence Questionnaire. The administration of all the tests took approximately 1.5 h.

Statistical analysis

Using repeated measures analysis, we compared subjects’ scores on the STAI-S and the CDB after visiting each of the five experimental environments, with the score obtained after visiting the neutral environment (the living-room). To assess interactions between the variables “food” and

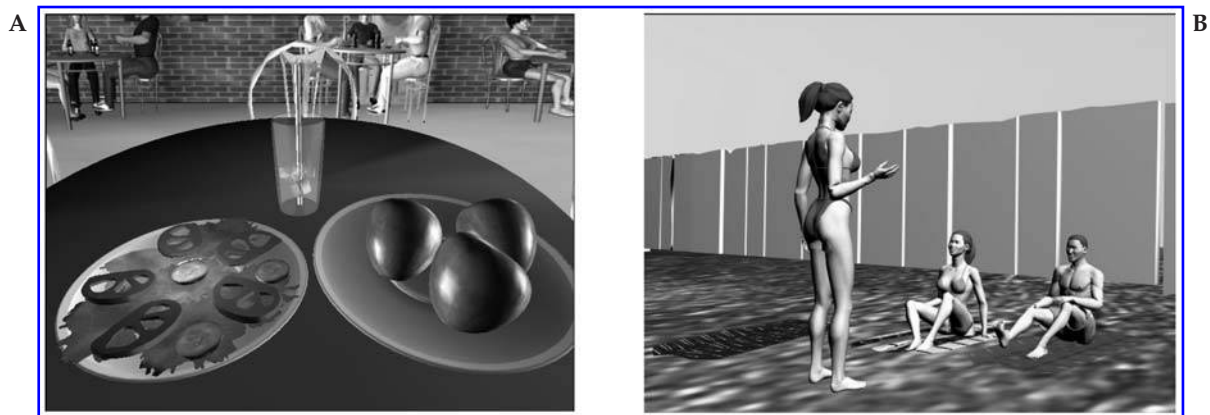


FIG. 1. Pictures of the virtual environments. **A:** Close-up of a table in the restaurant with low-calorie food. **B:** Close-up of a group of people in the swimming-pool.

“people,” we then performed a repeated measures analysis of variance (2×2) with the scores obtained on the STAI-S and another with the CDB.

RESULTS

The results showed significantly higher levels of state anxiety in the kitchen with high-calorie food ($F = 13.120$; $p = 0.001$), the restaurant with high-calorie food ($F = 14.954$; $p = 0.001$), and the swimming-pool ($F = 4.230$; $p = 0.049$) than in the neutral environment. Analyzing the scores for depression obtained on the CDB, significant differences again appeared between the high-calorie food environments ($F = 7.187$, $p = 0.012$ in the kitchen; and $F = 5.933$, $p = 0.021$ in the restaurant) and the neutral environment. In the high-calorie food situations, patients with ED had more depressed mood. Table 2 shows the means and standard deviations of STAI-S and CDB scores.

There were significant differences only on the level of state anxiety comparing low-calorie and high-calorie food environments ($F = 15.262$; $p = 0.001$). No differences were found between environments with people and those without, or when analyzing the combined effect of these two variables. The same pattern of results appeared on analyzing the results of the CDB: an effect was exerted by food but not by people, and there was no interaction between the two variables.

We also studied whether the presence of possible modulating variables influenced the results. We analyzed the following inter-subject variables: diagnosis, symptom severity, level of trait anxiety, and degree of presence experienced in the VEs. First, we analyzed the possible existence of differences in the emotional reactivity to the VEs according to diagnosis, using repeated measures analysis of variance (2×6) with diagnosis as the inter-subjects variable. The results showed that there were no significant differences in the levels of state anxiety either in the mood between patients with

anorexia and patients with bulimia across the various situations.

We analyzed the influence of symptom severity on the emotional reactivity experienced in the VEs using repeated measures analysis of variance (3×6). Symptom severity was the inter-subjects variable, and three values were specified: mild, moderate, and severe. The STAI-S scores showed an interaction between the situation and symptom severity in the high-calorie food environments ($F = 5.336$, $p = 0.011$ in the kitchen; and $F = 4.509$, $p = 0.020$ in the restaurant) and in the swimming-pool ($F = 3.560$; $p = 0.042$) compared with the neutral environment. The severe symptoms group showed the greatest disparity between these situations and the neutral environment. The simple effect of the symptom severity variable was significant ($F = 14.568$; $p < 0.001$). The analysis of the CDB results did not show an interaction between symptom severity and the situation to which the subject is exposed: that is, their effects were additive. The simple effect of symptom severity, however, was significant ($F = 11.621$; $p < 0.001$).

We found no interaction between trait anxiety and the situation: that is, their effects were additive. However, the simple effect of the trait anxiety variable was significant ($F = 12.001$, $p = 0.002$ on the STAI-S; and $F = 15.927$, $p = 0.001$ on the CDB), indicating that the subjects' level of trait anxiety influenced overall levels of state anxiety and mood manifested in the VEs.

Finally, to establish whether there was a relation between the level of emotional reactivity shown by the patients in the various environments and the degree of the sense of “being there,” we divided the sample into quartiles and selected the first (25% with the lowest scores on the presence questionnaire) and the fourth (25% with the highest scores). According to the repeated measures variance analysis (2×6), the STAI-S results did not show an interaction between the degree of presence in the VEs and the situations. The simple effect of the degree of presence was not significant either. The

TABLE 2. MEANS AND STANDARD DEVIATIONS OF STAI-S AND CDB SCORES

	<i>Living-room</i>	<i>Kitchen with low-calorie food</i>	<i>Kitchen with high-calorie food</i>	<i>Restaurant with low-calorie food</i>	<i>Restaurant with high-calorie food</i>	<i>Swimming-pool</i>
STAI-S	23.53 (10.615)	26.53 (15.024)	32.70 (14.932)	27.80 (14.370)	33.83 (15.450)	28.10 (14.907)
CDB	4.2357 (3.14554)	4.5567 (3.27086)	5.5537 (3.93844)	4.5177 (3.15932)	5.4733 (3.86078)	5.1800 (3.91454)

same applied when analyzing the mood manifested by subjects (CDB).

DISCUSSION

In accordance with our first hypothesis, VEs in which subjects had to eat high-calorie food (the kitchen and restaurant with high-calorie food) caused significant increases in the levels of anxiety and more depressed mood compared with the neutral situation (the living-room). Subjects with ED showed negative reactivity to high-calorie foods due to their fear of gaining weight. Some authors¹⁵ have noted that patients with ED show anxiety on seeing high-calorie foods and stress the aversive effect that food has on these subjects.¹²

In reference to the second hypothesis, we aimed to determine whether exposure to VEs that simulate social situations increased the level of state anxiety and produced more depressed mood in people with ED. Only the swimming-pool situation significantly increased the level of anxiety compared with the neutral environment. The high level of anxiety shown after visiting this VE reflects the importance that patients with eating disorders attribute to their body image and to the other people's possible evaluations of it. In this environment, subjects wear bathing-suits and are exposed to attractive young people also wearing bathing-suits, so aspects such as body dissatisfaction and negative social comparison contribute to raise their level of anxiety. Thompson and Chad²⁰ affirm that subjects with negative perception and thoughts regarding their body shape are usually worried about how others see them; this is clearly the case of patients with ED. The authors add that these subjects may try to avoid situations in which their body is exposed to others, as in the case of swimming-pools or gymnasiums.

There was no interaction between food and people either in eliciting different levels of state anxiety or in producing variations in mood. In fact, one of the aims of the design of the VEs was to make the effects of food and people additive. We expected the restaurant with high-calorie food environment to provoke the highest levels of reactivity in subjects, due to the distress generated by having to eat high-calorie food, and by doing so under the scrutiny of others. However, though there was no interaction between the variables; the presence or absence of people had no significant effect. Food was the only effect that was significant in all situations, for both anxiety and depression, and for both the complete sample and

for diagnostic groups assessed individually. This means that only the subject's exposure to a situation with low- or high-calorie food does indeed produce substantial changes in their level of anxiety and their mood.

We also analyzed the influence of possible modulating variables on emotional reactivity to the different situations. Specifically, we analyzed subjects' diagnosis, their symptom severity, their level of trait anxiety, and their degree of presence experienced in the VEs. As far as diagnosis was concerned, patients with anorexia and patients with bulimia responded with similar levels of emotional intensity to the different situations.

As regards symptom severity, patients with more severe symptoms showed a significant increase in the level of state anxiety in the high-calorie situations and in the environment in which the body is exposed (the swimming-pool). In contrast, though more severe patients showed more depressed mood in general, symptom severity did not seem to influence the effect produced by the various situations on subjects' mood. It is reasonable to think that only the subjects who still present acute symptoms will show high levels of stress on seeing high-calorie food. Indeed, one of the first steps in the treatment of ED is the normalization of eating patterns; probably, patients with moderate symptoms (and even more, those with mild symptoms) are more used to eating these "forbidden" foods. The more severe patients would also be expected to show more alterations of the body image and therefore be more affected by environments in which the body is exposed to others.

We also analyzed levels of trait anxiety and its influence on the results. As expected, the patients with the highest levels of trait anxiety presented the highest levels of anxiety and more depressed mood in all the environments. The effects of trait anxiety and the exposure to stressful environments are additive.

Finally, we evaluated the influence of subjects' degree of presence experienced in the environments on the impact that the different situations exerted on them. Presence is defined as the sensation a person has on entering a virtual environment of "being there."²¹ For this to occur, two factors are necessary: immersion and interaction. Immersion is achieved via technological devices that make users feel they are physically present in the virtual world. Interaction is achieved by enabling users to interact with the virtual world in real time, that is, to experience the virtual environment as real or very near to real. A higher degree of presence reflects a more realistic and intense experience of the

virtual situations, and consequently a higher level of reaction of the subjects.

Even though our results do not demonstrate an interaction between the degree of presence experienced by the subjects and the situations, and though the effect of the degree of presence did not reach significance, the mean scores for state anxiety and depressed mood obtained by the high presence group were above those of the low presence group. Higher degrees of presence could be achieved by increasing the levels of immersion and interaction of the subjects with the environment. One way of increasing the immersion would be to use head-mounted displays (HMDs). Interaction could be increased, especially with regard to the avatars representing human figures in some of the environments. In contrast to the food stimuli, which the subject can eat, in none of the environments was there any interaction between the subject and the other people present. This is probably why the presence or absence of other people only produced high levels of emotional reactivity in patients with severe symptoms, who are more sensitive to this type of situation.

In conclusion, VR is a good way for simulating situations from everyday life that are able to provoke emotional reactions in patients with ED. VEs in which subjects are obliged to ingest high-calorie food provoke the highest levels of state anxiety and depression. VEs with people only produce significant mood changes when they induce feelings of body image dissatisfaction and negative social comparison. Other studies have already shown the capacity of VR to elicit states of anxiety in patients with other pathologies.²²⁻²⁴

ACKNOWLEDGMENTS

This study was supported by a scholarship from the Department of Universities, Research and Information's Society of the Generalitat de Catalunya and the European Social Fund, granted to the second author.

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