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Virtual Reality–Based Multidimensional Therapy for the Treatment of Body Image Disturbances in Obesity: A Controlled Study

GIUSEPPE RIVA, Ph.D.,[1,2] MONICA BACCHETTA, Psy.D.,[1]
MARGHERITA BARUFFI, Psy.D.,[1] and ENRICO MOLINARI, Psy.D.[1,2]

ABSTRACT

The main goal of this paper is a preliminary evaluation of the efficacy of a virtual reality VR–based multidimensional approach to the treatment of body image attitudes and related constructs. The female obese patients (n = 28) involved in a residential weight control treatment, including low-calorie diet (1,200 kcal/day) and physical training, were randomly assigned either to the VR treatment or to psychonutritional groups based on the cognitive-behavior approach. Patients were administered a battery of outcome measures assessing eating disorders symptomatology, attitudes toward food, body dissatisfaction, level of anxiety, motivation for change, level of assertiveness, and general psychiatric symptoms. In the short-term, the VR treatment was more effective than the traditional cognitive-behavioral psychonutritional groups in improving the overall psychological state of the patients. In particular, it was more effective in improving body satisfaction, self-efficacy, and motivation for change. The improvement was associated with a reduction in problematic eating and social behaviors. The possibility of inducing a significant change in body image and its associated behaviors using a VR-based short-term therapy can improve body satisfaction in traditional weight reduction programs. However, given that this research that does not include a follow-up study, the obtained results are preliminary.

INTRODUCTION

In contrast to the efforts to document the physical consequences of obesity, much less is known about the psychological correlates of excess weight. Existing studies suggest several broad conclusions, the most important being that obesity is not associated with general psychological problems.[1,2] This conclusion, however, as noted by Friedman and Brownell[3] is "inimical to clinical impression, reports from overweight individuals, and a consistent literature showing strong cultural bias and negative attitudes toward obese persons." To investigate this issue, these authors used a meta-analysis study to examine the validity of previous conclusions in the field. In particular, they examined mean effect sizes across groups of studies measuring the relationship between obesity and a specific psychological variable.

[1] Applied Technology for Neuro-Psychology Laboratory, Istituto Auxologico Italiano, Verbania, Italy.
[2] Department of Psychology, Catholic University of Sacred Heart, Milan, Italy.

The most interesting result of that study is related to body image: "there is somewhat consistent body image disturbance in the form of body image distortion in obese individuals."[3] Moreover, although body image disparagement appears to vary across populations, "body image disparagement may in fact be high in obese individuals."[3]

It is also well known that the desire to improve body image is often the motivation to embark on weight reduction attempts.[4] However, one of the most intriguing lapses in research until the past few years is the lack of studies about the link between obesity and body image.[5] Standard weight reduction programs usually provide less therapy, and have a smaller treatment effect, for body image compared with eating behavior.[6,7] Moreover, few clinical trials with these patients have incorporated body image interventions and measurements.[5,6,8] Probably this situation can be explained by the common belief that the best way to improve one's body image is to lose weight. Indeed, weight reduction is probably the most used remedy for body image dissatisfaction. As reported by Rosen,[4] the most common reason for attempting to lose weight in women is the desire to improve physical appearance.

However, recent studies have questioned this belief: dietary intervention, even if accompanied by significant weight loss, may be ineffective in reducing total body dissatisfaction.[6–9] For instance, Cash et al.[10] found that obese subject who had lost weight were similar in appearance evaluation to a currently overweight sample and more distressed than a group of nonobese subjects.

Given the importance of body image satisfaction for the quality of life of obese persons, these findings argue for the potential benefits of treatment strategies for improving appearance satisfaction for obese individuals, regardless of the success of their weight-management efforts.[5] Unfortunately, obesity researchers have not added yet body image interventions in their programs. In a recent review on the behavioral obesity treatment literature, Rosen[4] didn't find any study including psychological techniques specifically designed to modify body image.

There are two different approaches to the treatment of body image disturbances that are actually used from leading researchers and clinicians: cognitive-behavioral and feminist methodologies.[5]

Cash and Rosen are the leading figure in the development of cognitive-behavioral strategies for the treatment of body image in eating disorders.[4,6,11,12] Their approach is based on assessment, education, exposure and modification of body image. The therapy both identify and challenge appearance assumptions, and modify self-defeating body image behaviors. Moreover, the approach involves the development of body image enhancement activities used to support relapse prevention and maintenance of changes, and the integration with weight reduction programs.[4,11,12]

The feminist approach tries to help women to accept and celebrate the body they have.[13,14] However, feminist therapy, in general, varies from traditional forms of therapy in number of ways. Feminists believe that traditional therapy perpetuates the central role of men in the form of the doctor–patient relationship.[15] So, this approach place the therapist and client in equitable roles. Moreover, feminist therapists usually include more experiential techniques, such as guided imagery, movement exercises, and art and dance therapy.[15,16] Other experiential techniques include free-associative writing regarding a problematic body part, stage performance, or psychodrama.[15–17]

Even if both methods are actually used by many therapists, the treatment of body image disturbance is moving "in the area of multicomponent intervention methods."[5] A recent model proposed by Thompson and colleagues[5] underlines the complexity behind the development of body image disturbances. In the proposed model, self-esteem, and depression mediate among three formative influences (peers, parents, and media) and the frequency of comparison and internalization in the development of the disturbance. In this sense, this model suggests "that individuals low in self-esteem and high in depression are more vulnerable to factors that produce an awareness of appearance pressures and thus are more likely to engage in social comparison and internalization, leading to body dissatisfaction."[5]

In this study we proposed an integrated ap-

proach to the treatment of body image disturbances in obesity based on an exciting new technology: virtual reality (VR). Such choice of would make it possible to use the psychophysiological effects induced by the virtual experience on the body schema for therapeutical purposes.[18,19]

Previous studies have suggested that VR can be effective in clinical treatment.[20–24] One of the main advantages of a virtual environment (VE) for clinical psychologists is that it can be used in a medical facility, thus avoiding the need to venture into public situations. In fact, in most of the previous studies, VEs were used in order to simulate the real world.

However, it seems likely that VR can be more than a tool to provide exposure and desensitisation.[25] As noted by Glantz et al., "VR technology may create enough capabilities to profoundly influence the shape of therapy."[26] In particular, they expect that VR may enhance cognitive therapy.

In practically all VR systems the human operator's normal sensorimotor loops are altered by the presence of distortions, time delays, and noise.[27] Such alterations that are introduced unintentionally and usually degrade performance affect body perceptions, too. The somesthetic systems has a proprioceptive subsystem that senses the body's internal state, such the position of limbs and joints and the tension of the muscles and tendons. Mismatches between the signals from the proprioceptive system and the external signals of a virtual environments alter body perceptions and can cause discomfort or simulator sickness.[28] Perceptual distortions, leading to a few seconds of instability and a mild sense of confusion, were also observed in the period immediately following the virtual experience.

Such effects, attributable to the reorganisational and reconstructive mechanisms necessary to adapt the subjects to the qualitatively distorted world of VR, could be of great help during the course of a therapy aimed at influencing the way the body is experienced,[29] because they lead to a greater awareness of the perceptual and sensory/motorial processes associated with them. When a particular event or stimulus violates the information present in the body schema (as occurs during a virtual experience), the information itself becomes accessible at a conscious level.[30] This facilitates the process of modification and, by means of the mediation of the self (which tries to integrate and maintain the consistency of the different representations of the body), also makes it possible to influence body image.

In previous studies, a preliminary version of this approach (Virtual Environment for Body Image Modification [VEBIM]; for a detailed description, see Thompson and colleagues[5]) was tested on nonclinical subjects[18,19,31] and clinical subjects[32] in uncontrolled studies. The results indicated that the virtual experience induced in the subjects a significantly more realistic view of their body. Starting from these assumptions, this paper describes the characteristics and preliminary controlled clinical evaluation of the Virtual Reality for Eating Disorders Modification (VREDIM), a VR-based treatment to be used for body image therapy in obesity. The approach was developed to support an in-patient weight-reduction program.

SUBJECTS AND METHODS

Subjects

Subjects were consecutive patients seeking treatment at the Obesity Unit of the Istituto Auxologico Italiano, Verbania, Italy.

The individuals included were 28 women (mean weight, 110.86 ± 18.96 kg; mean height, 159 ± 5.86 cm; mean BMI, 43.97 ± 8.14) between the ages of 18 and 45 years. Potential participants were excluded if they were taking antidepressant medication or any medication that might influence weight, if they abused drugs or alcohol, if they had a current major psychiatric condition such as a psychosis, if there was a history of purging within the previous 6 months, or if their body mass index (BMI) was below 35.

The sample was randomly divided into two groups: the experimental group (mean age, 32.14 ± 8.73; mean weight, 112.50 ± 15.92 kg; mean height, 161 ± 4.50 cm; mean BMI, 43.50 ± 5.97) and the control group (mean age, 30.29 ± 12.62; mean weight, 109.21 ± 22.08 kg; mean height, 157 ± 6.61 cm; mean BMI, 44.44 ± 10.07).

To ensure the equivalence of the two groups,

we examined the differences among them on weight, BMI, and all the pretherapy assessment measures by using one-way analysis of variance. No significant differences between groups were obtained on any of the measures, and therefore it can be assumed that the two groups were equivalent at the beginning of the intervention.

Measures

Subjects were assessed by one of three independent assessment clinicians who were not involved in the direct clinical care of any subject. They were two M.A. level chartered psychologists and a Ph.D. level chartered psychotherapist. All the subjects were assessed at pretreatment and upon completion of the clinical trial.

The following psychometric tests were obtained at entry to the study:

- Italian version of the Minnesota Multiphasic Personality Inventory 2 (MMPI 2)[33]
- Italian version of the Eating Disorders Inventory 2 (EDI 2)[34]

In Table 1 are reported the mean EDI 2 and MMPI 2 scores obtained by the two groups.

Moreover, the following psychometric tests were administered at each assessment point (entry to the study, end of the treatment):

- Italian version[35] of the Dieter's Inventory of Eating Temptations.[36] The inventory has 30 items, each presenting a situational description along with a competent response. The subject rates the percentage of time he or she would behave as described in similar situations. A total score and six subscales are computed. The subscales are Resisting Temptation, Positive Social, Food Choice, Exercise, Overeating and Negative Emotions. The inventory was originally designed for use with obese individuals who are trying to lose weight in behavioral weight loss programs, but, according to the authors, it may be useful for identifying situations most likely to trigger loss of control by bulimic patients.[36]
- Italian version[37] of the State-Trait Anxiety Inventory (STAI)[38]

Table 1. Mean MMPI 2 and EDI 2 Scores in the Two Groups

Experimental group				*Control group*			
MMPI-2	*Score (T)*	*EDI-2*	*Score*	*MMPI-2*	*Score (T)*	*EDI-2*	*Score*
HS	60.21	DT	7.21	HS	60.10	DT	5.55
D	56.21	B	2.36	D	52.80	B	2.64
HY	55.79	BD	19.43	HY	58.50	BD	16.91
PD	58.29	I	4.50	PD	55.20	I	4.09
MF	46.64	P	4.36	MF	54.10	P	2.27
PA	54.86	ID	3.50	PA	53.60	ID	3.00
PT	56.57	IA	5.64	PT	55.30	IA	3.64
SC	58.21	MF	5.36	SC	58.50	MF	5.09
MA	53.50	A	5.07	MA	58.50	A	5.27
SI	50.21	IR	3.36	SI	48.60	IR	2.00
ANX	58.71	SI	3.71	ANX	55.30	SI	3.27
FRS	60.14			FRS	61.20		
OBS	53.29			OBS	55.90		
DEP	55.71			DEP	53.90		
HEA	60.29			HEA	61.30		
BIZ	56.71			BIZ	56.50		
ANG	52.78			ANG	46.90		
CYN	56.93			CYN	57.50		
ASP	52.14			ASP	53.40		
TPA	50.64			TPA	48.20		
LSE	52.50			LSE	52.60		
SOD	50.43			SOD	49.70		
FAM	52.43			FAM	51.50		
WRK	53.07			WRK	52.00		
TRT	53.50			TRT	56.40		

- Italian version[39] of the Assertion Inventory (AI)[40]
- Italian version[41] of the Weight Efficacy Life-Style Questionnaire (WELSQ).[42] The WELSQ is composed of 20 items that measure the confidence of the subjects about being able to successfully resist the desire to eat using a 10-point scale ranging from 0 (not confident) to 9 (very confident). The questionnaire was used to predict both acute change and long-term maintenance of weight loss across a range of ages in men and women.[42]
- Italian version[43] of the University of Rhode Island Change Assessment Scale (URICA).[44,45] The URICA consists of 32 items designed to measure four stages of change in psychotherapy: pre-contemplation, contemplation, action, and maintenance. Each item is scored using a five-point Likert-type format: higher scores indicate greater agreement with statements. The URICA was originally developed for use with clients in psychotherapy reporting on their problems.[45] However, the instrument is also used for measuring readiness to change across a wide range, including smoking cessation, alcohol use, and cocaine use.[44]
- Italian version[46] of the Body Satisfaction Scale (BSS).[47] The scale consists of a list of 16 body parts, half involving the head (above the neck) and the other half involving the body (below the head). The subjects rate their satisfaction with each of these body-parts on a seven-point scale: the higher the rating, the more dissatisfied the individual. A total score and three subscale scores are computed for head, torso, and limb items.[46] The scale was designed for work in health-related fields. In particular the scale was used by the authors to assess body dissatisfaction in eating disorders, to monitor changes in body satisfaction in subjects undergoing surgical treatment for breast cancer and to determine the psychological effects of either maxillary or mandibular joint surgery.[46]
- Italian version[48] of the Body Image Avoidance Questionnaire (BIAQ).[49] The BIAQ is 19-item self-report questionnaire on avoidance of situations that provoke concern about physical appearance, such avoidance of tight-fitting clothes, social outings, and physical intimacy. In particular the questionnaire measures the avoidance behaviors and grooming habits associated with negative body image.[49] The questionnaire uses a six-point scale to rate frequency of behavior: never, rarely, sometimes, often, usually, and always. A total score and four subscales are computed for: clothing, social activities, eating restraint and grooming/weighing.
- The Figure Rating Scale (FRS),[50] a set of nine male and female figures which vary in size from underweight to overweight
- The Contour Drawing Rating Scale (CDRS),[51] a set of nine male and female figures with precisely graduated increments between adjacent sizes

In the last two tests, subjects rate the figures based on the following instructional protocol; (1) current size and (2) ideal size. The difference between the ratings is called the self-ideal discrepancy score and is considered to represent the individual's dissatisfaction.

The findings of Keeton et al.[52] support the usefulness of the self-ideal discrepancy score in the assessment of body image, as it was shown to relate to other body-image indices and other clinically relevant measures. All the scales have good test–retest reliability.[47–49]

Treatment

For the virtual reality sessions, VREDIM was used. VREDIM is an enhanced version of the original VEBIM immersive virtual environment, previously used in different preliminary studies on clinical[32] and nonclinical subjects.[18–31]

VREDIM is implemented on a Thunder 866/C virtual reality system by VRHealth.com, San Diego, CA (http://www.vrhealth.com). The Thunder 866/C is a Pentium III based immersive VR system (866mhz, 128 mega RAM, graphic engine: Matrox MGA 450 32Mb WRam) including a head mounted display (HMD) subsystem. The HMD used is the Glasstron from Sony Inc. The Glasstron uses

LCD technology (two active matrix colour LCD's) displaying 180000 pixels each. Sony has designed its Glasstron so that literally no optical adjustment at all is required, aside from tightening a two ratchet knobs to adjust for the size of the wearer's head. There's enough "eye relief" (distance from the eye to the nearest lens) that it's possible to wear glasses under the HMD.

The motion tracking is provided by Intersense through its InterTrax 30 gyroscopic tracker (azimuth, ±180 degrees; elevation, ±80 degrees; refresh rate, 256 Hz; latency time, 38 ± 2 msec).

We used a two-button joystick-type input device to provide a easy way of motion: pressing the upper button the operator moves forward, pressing the lower button the operator moves backwards. The direction of the movement is given by the rotation of operator's head.

The virtual environment is composed by seven 3D Healing Experiences™ (zones), each

Table 2. Therapeutical Methods Integrated in VREDIM

Methods	*Procedures*
Socratic style	The therapist uses different questions, usually hypothetical, inverse, and third-person ones to help patients synthesize information and reach conclusions on their own.
Miracle question	The therapist asks the patient to imagine what life would be like without her/his complaint. Answering to this question the patient constructs her/his own solution, which then guides the therapeutical process.
Cognitive	*Countering:* Once a list of distorted perceptions and cognitions is developed, the process of countering these thoughts and beliefs begins. In countering, the patient is taught to recognise the error in thinking, and substitute more appropriate perceptions and interpretations. *Alternative interpretation:* The patient learns to stop and consider other interpretations of a situation before proceeding to the decision-making stage. The patient develops a list of problem situations, evoked emotions, and interpretative beliefs. The therapist and patient discuss each interpretation and if possible identify the kind of objective data that would confirm one of them as correct. *Label shifting:* The patient first tries to identify the kinds of negative words she uses to interpret situations in her life, such as bad, terrible, obese, inferior, and hateful. The situations in which these labels are used are then listed. The patient and therapist replace each emotional label with two or more descriptive words. *Deactivating the illness belief:* The therapist first helps the client list her beliefs concerning eating disorders. The extent to which the illness model influences each belief is identified. The therapist then teaches the client a cognitive/behavioural approach to interpreting maladaptive behaviour and shows how bingeing, purging, and dieting can be understood from this framework.
Behavioral	*Temptation exposure with response prevention:* The rationale of temptation exposure with response prevention is to expose the individual to the environmental, cognitive, physiological, and affective stimuli that elicit abnormal behaviours and to prevent them from occurring. The TERP protocol is usually divided into three distinct phases: (1) comprehensive assessment of eliciting stimuli, (2) temptation exposure extinction sessions, and (3) temptation exposure sessions with training in alternative responses.
Visual motorial	*Awareness of the distortion:* The patients are instructed to develop an awareness of the distortion. This is approached by a number of techniques including the presentation of feedback regarding the patient's self-image. Videotape feedback is also usually used. Patients are videotaped engaging in a range of activities. *Modification of the body image:* The patients are instructed to imagine themselves as different in several aspects including size, race, and being larger or smaller in particular areas. They also are asked to imagine themselves as younger and older, and to imagine what they look and feel like before and after eating, as well as before and after academic-vocational and social successes and failures.

one individually used by the therapist during a 50-min session with the patient. A detailed description of the clinical approach used in the different 3D Healing Experiences™ is reported in Table 2.

The first 3D Healing Experience™ is used to assess any stimuli that could elicit abnormal eating behavior. In particular, attention is focused on the patient's concerns about food, eating, shape, and weight. This assessment is normally part of the Temptation Exposure with Response Prevention protocol.[53] At the end of the first 3D Healing Experience,™ the therapist uses the miracle question, a typical approach used by the solution-focused brief therapy.[54,55] According to this approach, the therapist asks the patient to imagine what life would be like without her or his complaint. Answering to this question in writing the patient constructs her or his own solution, which then guides the therapeutical process.[56] According to deShazer,[56] this approach is useful for helping patients establish goals, that can be used to verify the results of the therapy. Using VR to experience the effects of the miracle, the patient is more likely not only to gain an awareness of her need to do something to create change but also to experience a greater sense of personal efficacy (Figs. 1 and 2).

The next 3D Healing Experiences™ are used to assess and modify:

- *The symptoms of anxiety related to food exposure*: This is done by integrating different cognitive-behavioral methods (Table 2): Countering, Alternative Interpretation, Label Shifting, Deactivating the Illness Belief, and Temptation Exposure with Response Prevention.[19–53]
- *The body experience of the subject*: To do this the virtual environment integrated the therapeutic methods (Table 2) used by

FIG. 1. Screen shoot from the VREDIM zone 2.

FIG. 2. Screen shoot from the VREDIM zone 5.

Butter and Cash[57] and Wooley and Wooley.[16] In particular in VREDIM, we used the virtual environment in the same way as guided imagery[58] is used in the cognitive and visual/motorial approach.

In all the sessions, the therapists follow the Socratic style: they use a series of questions, related to the contents of the virtual environment, to help clients synthesize information and reach conclusions on their own.

The experimental group received seven sessions of VREDIM plus a low-calorie diet (1,200 kcal/day) and physical training (30 min of walking two times a week as a minimum).

For the control group, the inpatient treatment consisted of the same low-calorie diet (1,200 kcal/day) and physical training as the experimental group, plus psychonutritional groups (three times a week) aimed at helping the patients to understand the importance of their life-style and to modify unhealthy and destructive behavior patterns. The psychonutritional groups were based on the cognitive-behavior approach[59] and focused on teaching patients methods for improving their stress management, problem-solving and eating.

The treatment for both group lasted approximately 6.5 weeks (mean length for the experimental group, 6.7 ± 0.3 weeks; mean length for control group, 6.5 ± 0.4 weeks).

The study received ethical approval by Ethical Committee of the Istituto Auxologico Italiano. Before starting the trial, the nature of the treatment was explained to the patients and her written informed consent was obtained.

Statistical analysis

A power calculation was made to verify the possibility of obtaining statistically significant differences both between the two groups (independent measures), and the pre- and post-treatment scores (repeated measures). Given the low/medium statistical power, due to the relatively small number of subjects and the high standard deviation, we decided to use the exact methods, a series of nonparametric statistical algorithms developed by the Harvard

School of Public Health, that enable researchers to make reliable inferences when data are small, sparse, heavily tied or unbalanced.[60]

The exact method used to compare the mean scores—both for repeated and independent measures—was the marginal homogeneity test.[61]

RESULTS

In Table 3 are reported the means and standard deviations for the tests' scores obtained by the experimental group before and after the therapy. The marginal homogeneity test reported significant ($p < 0.07$) differences in the BSS Torso and Limbs scores, in the DIET Overeating score, in the STAI Total score, in the AI Anxiety and Ability scores and in the WELSQ Total score.

The results show that the therapy was able improve the overall psychological status of the patients. In particular, the therapy reduced both the level of body dissatisfaction and the level of anxiety in the patients. Moreover, it increased their self-efficacy. This reflected also on the eating behavior of the subjects who reduced overeating. At the end of the therapy the experimental group experienced a mean weight

Table 3. Mean BIAQ, BSS, CDRS, FRS, DIET, STAI, AI, WELSQ, and URICA Scores Before and After Treatment (ECT Group)

	Before treatment	*After treatment*	p
BIAQ			
Total score	30.79	29.14	—
Eating Restraint	5.86	5.50	—
Clothing	12.29	11.79	—
Grooming/Weighing	5.14	5.00	—
Social Activities	7.50	6.86	—
BSS			
Total score	50.07	46.36	—
Head	11.07	11.64	—
Torso	19.21	17.50	0.056
Limbs	19.79	17.21	0.026
CDRS			
Real Body	8.36	7.93	—
Ideal Body	5.21	5.14	—
Body Satisfaction Index	1.68	1.59	—
FRS			
Real Body	6.50	6.29	—
Ideal Body	4.29	4.21	—
Body Satisfaction Index	1.56	1.52	—
DIET			
Total score	43.36	41.38	—
Positive Social	45.20	38.78	—
Overeating	39.29	31.55	0.065
Negative Emotions	43.85	40.43	—
Resisting Temptations	43.21	50.54	—
Exercise	42.14	44.64	—
Food Choice	38.39	36.79	—
STAI			
Total score	39.64	39.93	0.025
AI			
Anxiety	89.43	75.71	0.035
Ability	89.93	68.93	0.014
WELSQ			
Total score	129.50	152.21	0.029
URICA			
Total score	105.00	105.50	—
Precontemplation	12.64	11.93	—
Contemplation	33.64	34.50	—
Action	31.93	32.21	—
Maintenance	26.79	26.86	—

reduction of 11.33 kg. No subjects experienced simulation sickness.

In Table 4 are reported the means and standard deviations for the tests' scores obtained by the control group before and after the therapy. The only significant changes were in the DIET Exercise score and in the AI Ability and Anxiety score. However, the reduction in the anxiety level was not confirmed by the STAI score. The mean weight reduction for the control group was 7.58 kg.

Then we compared the differences pre/post therapy in the mean BIAQ, BSS, CDRS, FRS, DIET, STAI, AI, WELSQ, and URICA scores between the two groups (Table 5). The statistical tests showed significantly ($p < 0.07$) higher differences in the ECT group for the following scales: BSS Total score, DIET Positive Social score, AI Ability, and Anxiety score. No significant differences were found in the self-efficacy and motivation for changes scores. However, at least for the WELSQ Total score and for the URICA Maintenance score the experimental group showed a marked difference in relation to the control group.

These data showed that experimental was more effective than the traditional low-calorie diet plus cognitive-behavioral nutritional

TABLE 4. MEAN BIAQ, BSS, CDRS, FRS, DIET, STAI, AI, WELSQ, AND URICA SCORES BEFORE AND AFTER TREATMENT (CONTROL GROUP)

	Before treatment	*After treatment*	p
BIAQ			
Total score	24.14	22.64	—
Eating Restraint	3.14	2.29	—
Clothing	10.50	10.21	—
Grooming/Weighing	5.00	4.71	—
Social Activities	5.50	5.43	—
BSS			
Total score	42.50	41.86	—
Head	8.43	8.71	—
Torso	16.93	16.57	—
Limbs	17.14	16.57	—
CDRS			
Real Body	7.86	7.71	—
Ideal Body	4.57	4.64	—
Body Satisfaction Index	1.79	1.74	—
FRS			
Real Body	6.07	6.00	—
Ideal Body	3.79	3.79	—
Body Satisfaction Index	1.63	1.61	—
DIET			
Total score	40.76	43.50	—
Positive Social	37.65	40.71	—
Overeating	41.07	41.43	—
Negative Emotions	41.29	44.00	—
Resisting Temptations	40.54	47.86	—
Exercise	43.04	47.68	0.035
Food Choice	34.82	33.57	—
STAI			
Total score	34.86	36.43	—
AI			
Anxiety	84.07	85.71	0.051
Ability	93.29	95.29	0.026
WELSQ			
Total score	142.00	143.07	—
URICA			
Total score	110.29	109.07	—
Precontemplation	15.64	16.86	—
Contemplation	33.71	33.00	—
Action	33.36	32.21	—
Maintenance	27.57	27.00	—

Table 5. Mean Differences in the BIAQ, BSS, CDRS, FRS, DIET, STAI, AI, WELSQ, and URICA Scores (Before and After Treatment)

	ECT group	*Control group*	p
BIAQ			
Total score	1.64	1.50	—
Eating Restraint	0.36	0.86	—
Clothing	0.50	0.29	—
Grooming/Weighing	0.14	0.29	—
Social Activities	0.64	7.14	—
BSS			
Total score	3.71	0.64	0.056
Head	−0.57	−0.28	—
Torso	1.71	0.36	—
Limbs	2.57	0.57	—
CDRS			
Real Body	0.43	0.14	—
Ideal Body	7.14	−7.10	—
Body Satisfaction Index	8.64	4.79	—
FRS			
Real Body	0.21	7.14	—
Ideal Body	7.14	0.00	—
Body Satisfaction Index	3.71	1.79	—
DIET			
Total score	1.98	−2.74	—
Positive Social	6.43	−3.06	0.031
Overeating	7.74	−0.36	—
Negative Emotions	3.43	−2.71	—
Resisting Temptations	−7.32	−7.32	—
Exercise	−2.50	−4.64	—
Food Choice	1.61	1.25	—
STAI			
Total score	6.71	−1.57	0.004
AI			
Anxiety	13.71	−1.64	0.002
Ability	21.00	−2.00	0.000
WELSQ			
Total score	−22.71	−1.07	—
URICA			
Total score	−0.50	1.21	—
Precontemplation	0.71	−1.21	—
Contemplation	−0.86	0.71	—
Action	−0.29	1.14	—
Maintenance	−7.10	0.57	—

groups in reducing body dissatisfaction and the anxiety level of the patients. Moreover experimental patients experienced an higher, even if not significant, weight reduction: 11.33 versus 7.58 kg.

DISCUSSION

Although there is much potential for the use of immersive virtual reality environments in clinical psychology, some problems have limited their application in this field. Some users have experienced side effects, during and after exposure to virtual reality environments.[62] The symptoms experienced by these users are similar to those which have been reported during and after exposures to simulators with wide field-of-view displays.[63] These side effects have been collectively referred to as "simulator sickness"[64] and are characterized by three classes of symptoms: ocular problems, such as eyestrain, blurred vision and fatigue; disorientation and balance disturbances; and nausea. Exposure duration of less than 10 min to immersive virtual reality environments has

been shown to result in significant incidences of nausea, disorientation, and ocular problems.[65]

The first interesting result of this study is the lack of side effects and simulation sickness in our samples after the experience in the virtual environment, confirming the possibility of using VREDIM for body image treatment.

This result is even more interesting given the sample used. In fact, females tend to be more susceptible to motion sickness than males.[66]

Next, our experience with the use of VREDIM suggests that this treatment was more effective than the traditional low-calorie diet plus cognitive-behavioral nutritional groups in improving body satisfaction and in reducing overeating and the anxiety level of the patients. Finally, VREDIM induced an improved level of self-efficacy in the patients associated to an higher motivation for change.

Its multidisciplinary approach seems to be suitable to the peculiar characteristics of body image disturbances in obesity. In particular, VREDIM was effective in dealing with two key features of these disturbances not always adequately addressed by cognitive-behavioral therapy: body experience disturbances and self-efficacy.

First, VREDIM allows the integration of different methods (cognitive, behavioral, and visual-motorial) commonly used in the treatment of body experience disturbances within a virtual environment.[29] In particular, VREDIM integrates the cognitive methods of Countering, Alternative Interpretation, Label Shifting and Deactivating, the behavioural method of Temptation Exposure with Response Prevention and the visual motorial approach (Table 2) using the virtual environment in the same way as images in the well-known method of guided imagery.[58] According to this method the therapist, after introducing a selected image, encourages the patient to associate to it in pictures, rather than in word, and to give a detailed description of them.

A choice of this type makes it possible both to evoke latent feelings, and to use the psychophysiological effects provoked by the experience for therapeutic purposes.[29–31] In practically all VR systems, the human operator's normal sensorimotor loops are altered by the presence of distortions, time delays, and noise.[27] Such effects, attributable to the reorganisational and reconstructive mechanisms necessary to adapt the subjects to the qualitatively distorted world of VR, could be of great help during the course of a therapy aimed at influencing the way the body is experienced,[29] because they lead to a greater awareness of the perceptual and sensory/motorial processes associated with them.

As noted by Glantz,[26] one of the main reasons it is so difficult to modify patients' attitudes towards their body is that change often requires a prior step—recognizing the distinction between an assumption and a perception: "Until revealed to be fallacious, assumptions constitute the world; they seem like perceptions, and as long as they do, they are resistant to change. We anticipate using VR to help people in distress make the distinction between assumptions and perceptions."

This is particularly true for body experience. When a particular event or stimulus violates the information present in the body schema (as occurs during a virtual experience), the information itself becomes accessible at a conscious level.[30] This facilitates the process of modification and, by means of the mediation of the self (which tries to integrate and maintain the consistency of the different representations of the body), also makes it possible to influence body image.

Second, using VREDIM therapists can improve the self-efficacy and motivation for change in their patients. According to Prochaska and DiClemente,[67] it is possible to identify five stages of change that people face in altering problematic behaviour. These stages can be considered predictable and stable subprocesses within the therapeutic process. The five stages are: precontemplation, contemplation, determination, action, and maintenance/relapse.

In particular, a stage of change is critical for the therapy of body image disturbances: contemplation. Contemplation is a paradoxical stage of change, since the patient is open to the possibility of change but is stopped by ambivalence. The characteristic style of the contemplator is, "yes, but . . . " Two key techniques are usually in facilitating a shift from the con-

templation stage to the determination stage of change.[55] The first technique is the use of the miracle question, a typical approach used by the solution-focused brief therapy.[54,55] The miracle question is used to help the client identify how her life would be different if her eating disorder were miraculously gone. The second technique is the search for exceptions: situations in which the patient has been able to manage the problematic eating behaviors more successfully.

Using the VR sessions to experience the effects of the miracle and the successful situations, the patient is more likely not only to gain an awareness of her need to do something to create change but also to experience a greater sense of personal efficacy.

According to Vitousek et al.,[68] another well-suited approach to face denial and to support self-efficacy is the Socratic method. In this method, the therapist uses different questions to help patients synthesize information and reach conclusions on their own. Usually the therapist poses hypothetical, inverse, and third-person questions[68]: for example, would the significance of body shape change if the obese patient became stranded on a desert island? Would a patient swallow a magic potion that could remove her fear of normal weight?

VR is well suited to this approach, for its ability of immersing the patient in a life-like situation that she or he is forced to face. In fact, the key characteristic of VR is the high level of control of the interaction with the environment without the constrains usually found in real life. VR is highly flexible and programmable. It enables the therapist to present a wide variety of controlled stimuli and to measure and monitor a wide variety of responses made by the user.[69] Both the synthetic environment itself and the manner in which this environment is modified by the user's responses can be tailored to the needs of each client and/or therapeutic application. Moreover, VR is highly immersive and can cause the participant to feel "present" in the virtual rather than real environment. It is also possible for the psychologist to follow the user into the synthesised world.

The advantages of a VR-based Socratic method are clear. It minimizes distortion in self-report, since there is no script for conforming clients to parrot or oppositional clients to reject; a typical behavior of anorexic individuals.

Moreover, it circumvents power struggles because the therapist can be invisible to the patient and presents no direct arguments to oppose. Finally, evidence is more convincing and conclusions better remembered because they are one's own. As noted by Miller and Rollnick,[70] people are "more persuaded by what they hear themselves say than by what other people tell them."

As we have seen before, change often requires the recognition of the distinction between an assumption and a perception.[25] By using VR, the therapist can actually demonstrate that what looks like a perception doesn't really exist. This gets across the idea that a person can have a false perception. Once this has been understood, individual maladaptive assumptions can then be challenged more easily.

Usually the traditional body-image treatment involves a cognitive/behavioural or a feminist therapy that require many sessions. The possibility of inducing a significant change in body image and its associated behaviors using a VR-based short-term therapy (seven biweekly sessions) can be useful to improve the body satisfaction in traditional weight reduction programs.

As such, VREDIM can be considered as a multifactorial treatment package aimed at breaking through the "resistance" to treatment in clinical subjects.[71,72] Nevertheless, an alteration of the body image toward a more realistic "proportion" might also be decisive for the long-term outcome of the weight reduction therapy.

Of course, given the nature of this research that does not include a follow-up study, the obtained results are preliminary only. Moreover, the cost of the VR system used in the study is about $7,000. This price, even if affordable for departments or hospitals, is still high for a single therapist, especially without a clear cost/benefit ratio. From a clinical view point the main issues that we have to address in a systematic way in the future are:

- Further testing of ECT in controlled clinical trials by comparing it with different approaches (e.g., interpersonal therapy)

- A follow-up study to check the long-term efficacy of the therapy

We have already planned an extention of the study as a part of the Telemedicine and Portable Virtual Environments for Clinical Psychology European Community–funded research project (IST-2000-25323).

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Address reprint requests to:
Dr. Giuseppe Riva
Applied Technology for Neuro-Psychology Laboratory
Istituto Auxologico Italiano
P.O. Box 1
28900 Verbania, Italy

E-mail: auxo.psylab@auxologico.it