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From Body Dissatisfaction to Obesity: How Virtual Reality May Improve Obesity Prevention and Treatment in Adolescents

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Abstract. Different studies, including longitudinal studies, suggest a link between body dissatisfaction, unhealthful weight-control behaviors and obesity in both male and female adolescents. In this paper we suggest that body dissatisfaction in obese adolescents may be driven by an allocentric negative body image that is no more updated by contrasting egocentric representations driven by perception. In other words, subjects are locked to an allocentric negative representation of their body (*allocentric lock hypothesis* - http://dx.doi.org/10.1016/j.mehy.2011.10.039) that their sensory inputs are no more able to update even after the dramatic body changes following a successful diet. More, the possible role of virtual reality in the prevention and treatment of this disorder is presented and detailed.

Keywords: Obesity, Adolescence, Body Dissatisfaction, Allocentric Lock Hypothesis

1. Introduction

Most clinicians and patients consider adolescent obesity just as a problem of energy balance: more energy input than expenditure. So the suggested ways to cope with it are quite simple: more physical exercize and healthier food. For example, the First Lady Michelle Obama, presenting her prevention program "Let's Move" underlines [1]:

> "Since we launched Let's Move!, we've made significant progress—from providing our kids with healthier food and greater opportunities for physical activity in school and in their communities, to getting families the information they need to make healthier decisions, to ensuring that more people have access to healthy, affordable food." (p. 1).

Neverheless, clinical practice presents a more complex picture of the problem. On one side, the typical prevention programmes based on these strategies are not successful in the long term. For example, in the same issue of the "Childhood Obesity" journal including the First Lady paper, Yin and colleagues discussed the impact of a 3-year after-school obesity prevention program in elementary school children [2]. Their conclusions is that the program, even if effective in the short term, was not able to modify permanently the behaviors of the children: "The rebound effect due to program discontinuity during the summer breaks, which has been shown by others, is

noteworthy. This implies that gains achieved in the 9 months of a school year can be lost during the 3 months of summer." (p. 67).

On the other side, longitudinal studies support a more complex view. In a 4-year longitudinal study on 496 adolescent girls, Stice and colleagues studied the psychological and behavioral risk factors able to predict the onset of obesity in adolescent girls. Their data show that participants who were on a weight-loss diet, or who used maladaptive compensatory behaviors for weight control at T1 of the study showed, 4 years later, an increased risk for obesity onset. A more recent 10-year longitudinal study confirmed this datum [3]. As stated by the authors:

> "Findings clearly indicate that dieting and unhealthy weight control behaviors, as reported by adolescents, predict significant weight gain over time." (p. 80).

Specifically, females using unhealthy weight control behaviors - fasting, trying to eat very little food, self-induced vomiting, and the use of diet pills, food substitutes, laxatives and diuretics - at two time points during the study period increased their BMI by 4.6 units as compared to 2.3 units among females not using these behaviors. Males increased their BMI by 7.0 units compared with 3.5 BMI units among nondieters. Finally the study underlined that dieting and unhealthy weight control behaviors were more prevalent in females: 37.8% of the female sample reported persistent dieting and 43.7% reported persistent use of unhealthy weight control behaviors. Instead, only 10.3% of the male sample reported persistent dieting.

These data have an important clinical implication: the evidence that adolescents practicing unhealthful weight-control behaviors are at higher risk for obesity implies that prevention and treatment interventions should also focus on the causes of these behaviors. In other words, why do adolescents decide to start radical weight-control behaviors?

2. Body Dissatisfaction and Obesity

In a recent letter to the *Yahoo Answer* site an adolescent girl wrote:

> "I hate my body so much. My top half (arms, stomach) is fine. I have a very flat stomach, my arms are great (my back is even bony looking) I wear a XS, S in shirts. but my lower half (butt, thighs) are huge, seriously I mean how can I loose weight there?"
> (online: http://answers.yahoo.com/question/index?qid=20120504232627AAPkxrl)

The words of the girl provide a clear explanation for her behavior: she wants to start a diet because she does not like her body [4]. A study by Kostanski and Gullone [5]with a sample of 431 Australian pre-adolescent children (7 to 10 years) confirms this interpretation: pre-adolescents as young as 7 years of age are unsatisfied with their body appearance and deliberately engage in restrictive eating behaviors. More, a recent study [6] showed that in adolescents frequent self-weighing is associated with lower body satisfaction and higher rates of unhealthy and extreme weight control behaviors.
But why does this happen? A possible explanation of this behavior is the phenomenon of *self-objectification* [7]: the tendence of Western culture to objectify the female body. On one side, in our culture it is impossible to avoid media contents depicting objectified images of women. On the other side, our culture suggest ideals of female beauty that are virtually unattainable making most women's bodies unadequate and in constant need of modification.

As noted by Calogero and colleagues [7],

> "self-objectification leads to anumber of negative behavioral and experiential consequences… which in turn accumulate to put women at increased risk of three particular mental health disorders: eating disorders, depression, and sexual dysfunction." (p. 139).

Nevertheless males, too, experience obesity in adolescence [8]: in US, the prevalence of obesity among male children and adolescents aged 2 through 19 years (18.6%) is significantly higher than among female children and adolescents (15.0%).
A recent study by Mond and colleagues [9] provides a critical path for solving this problem: in both male and female overweight adolescents, the impairment in emotional well-being is primarily due to dissatisfaction with body size and shape. The authors conclude:

> "In conclusion, the present findings suggest that associations between obesity and impairment in emotional well-being, where these occur, are likely due to the effects of weight-related body dissatisfaction. This appears to be the case for both boys and girls and during both early and late adolescence. The findings are consistent with the view that body dissatisfaction is central to the health and well-being of children and adolescents who are overweight and suggest that psychological distress associated with negative body image may warrant greater attention in developing programs to reduce the individual and community health burden of obesity." (p. 377)

But what is the link between body dissatisfaction and obesity? We will discuss this point in the next paragraph. In particular we will introduce the "allocentric lock theory" [10-13] suggesting that obese adolescent may have an allocentric negative body image that is no more updated by contrasting egocentric representations driven by perception [14]. In other words, these patients are locked to an allocentric (*observer view*) negative representation of their body that their sensory inputs are no more able to update even after dramatic body changes, including the ones following a successful diet.

2. The Allocentric Lock Hypothesis

Psychology and neuroscience indicates that our spatial experience, including the experience of the body, involves the integration of different sensory inputs within two different reference frames: *egocentric* and *allocentric* [15; 16]:

- *egocentric frame*: it is referred to the body of the observer and allows him/her to locate objects relative to the body centre. When we adopt an egocentric stance we represent the object relative to ourselves
- *allocentric frame*: it is referred to space external to the perceiver. When we adopt an allocentric stance the object is represented independently of our own current relation with it.

As suggested by Byrne and Becker [17] the transformation from egocentric to allocentric representations of space is done by neurons in different medial temporal lobe structures. If, for some reasons, this transformation is impaired, the subjects cannot use anymore the sensory inputs to update the contents of the allocentric representation of their body. This is what may be behind the body dissatisfaction experienced by many obese patients even after a significant weight loss: an altered somatorepresentation - that is not updated by contrasting egocentric parietal representations driven by perception - priming the processing of any further body-

related experience [14]. In simpler words, the egocentric perception-driven experience of the real body does not modify the allocentric memory-driven experience of a negative body: these patients are locked to an allocentric negative representation of their body [18]. However, the impossibility of using sensory inputs for updating the allocentric representation of the body – patients hate their body even after the surgery or significant weight loss - locks the patients into an unsatisfying body that may explain their depression and low quality of life [19; 20].

3. Unlocking the virtual body using virtual reality

The evolution of technology is providing new tools and methods for health care [21]. Between them, an emerging trend is the use of virtual reality (VR) [22-24].

VR consists of a three-dimensional (3D) graphical environment where a user can interface with the environment through a variety of computer peripheral devices. Using visual, aural or haptic devices, the user can experience the environment as if it were a part of the real world [25].

In clinical psychology VR is used to offer a new human-computer interaction paradigm in which patients are no longer simply external observers of images on a computer screen but are active participants within a computer-generated three-dimensional virtual world [26]. Moreover, VR can be considered an "embodied technology" for its effects on body perceptions [27]: it is possible the use of VR for inducing controlled changes to the experience of the body [28-31].

On one side, different authors showed that is possible to use VR both to induce illusory perceptions – e.g. a fake limb [32] - by altering the normal association between touch and its visual correlate. On the other side, it is also possible to use VR to improve body image [33; 34], even in patients with eating disorders [35-37] or obesity [28; 38]. As noted by Gallagher [39]

> "[different] studies indicate that changes in various aspects of body schemata have an effect on the way subjects perceive their own body." (p. 237)

Following this vision it is possible the use of VR to induce a controlled sensory rearrangement that facilitates an update of the locked allocentric representation of the body. A possible strategy towards this goal is the adaptation to virtual reality of the imagery rescripting method developed for the treatment of post-traumatic stress disorders [14; 40]. Specifically Riva developed a specific body image rescripting protocol based on VR [14] that is presented in Table 1.

The VR sessions are based on the free NeuroVR software (http://www.neurovr.org). NeuroVR is an enhanced version of the original Virtual Reality for Body Image Modification (VEBIM) immersive virtual environment, previously used in different preliminary studies on non-clinical subjects [29; 33].

Through the VR experience, the patients practice both eating/emotional/relational management and general decision-making and problem-solving skills. By directly practicing these skills within the VR environment, the patient is helped in developing specific strategies for avoiding and/or coping with these.

NeuroVR is composed of 14 virtual environments, used by the therapist within a 60-minute session with the patient. The environments present critical situations related to

the maintaining/relapse mechanisms (e.g., Home, Supermarket, Pub, Restaurant, Swimming Pool, Beach, Gymnasium) and two body image comparison areas.

Phase 1: Interview	During a clinical interview the patient is asked to relive the contents of the allocentric negative body image and the situation/s in which it was created and/or reinforced (e.g. being teased by my boyfriend at home) in as much detail as possible. The meaning of the experience for the patient was also elicited.
Phase 2: Developmentof the VR scene	The clinician reproduces the setting of the identified situation (e.g. the corridor of the classroom where my boyfriend teased me) using one of the different scenes available in the free NeuroVR software (http://www.neurovr.org),
Phase 3: Egocentric Experience of the VR scene	The patient is asked to reexperience the event in VR from a first person perspective (the patient does not see his/her body in the scene) expressing and discussing his/her feelings. The patient is then asked what was needed to happen change the feelings in a positive direction. The main cognitive techniques used in this phase, if needed, are: Countering: Once a list of distorted perceptions and cognitions is developed, the process of countering these thoughts and beliefs begins. 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.
Phase 4: Allocentric Experience of the VR scene	The patient is asked to reexperience the event in VR from a third person perspective (the patient sees his/her body in the scene) intervening both to calm and reassuring his/her virtual avatar and to counter any negative evaluation. The therapist follows the Socratic approach, for example ‘‘What would need to happen for you to feel better? How does it look through the eyes of a third person? Is there anything you as a third person like to do? How do the other people respond?’’ The main cognitive techniques used in this phase, if needed, are: Alternative Interpretation: The patient learns to stop and consider other interpretations of a situation before proceeding to the decision-making stage. Deactivating the Illness Belief: The therapist first helps the client list her beliefs concerning weight and eating.

Table 1: The VR body image rescripting protocol (Adapted from Riva, 2011).

Specifically, in the VR sessions the therapist uses the “20/20/20 rule”. During the first 20 minutes, the therapist focuses on getting a clear understanding of the patient's current concerns and level of general functioning. This part of the session tends to be characterized by patients doing most of the talking, although therapist guides with questions and reflection to get a sense of the patient's current status. The second 20 minutes is devoted to the virtual reality experience. During this part of the session the patient enters the virtual environment and faces a specific critical situation. Here the patient is helped in developing specific strategies for avoiding and/or coping with it. In the final 20 minutes the therapist explores the patient’s understanding of what happened in VR and the specific reactions – emotional and behavioral - to the different situations experienced. If needed, some new strategies for coping with the VR situations are presented and discussed.

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1. Conclusions

Most clinicians and patients consider obesity just as a problem of energy input and expenditure: more energy input than expenditure. However, the clinical practice and epidemiological data clearly show that obesity is more complex than expected by this simple equation. In particular this chapter underlined the possible role of negative body image in the etiology of this disturbance.

Specifically, we suggested that body dissatisfaction in obese adolescents may be produced by an allocentric negative body image that is no more updated by contrasting egocentric representations driven by perception. In other words, these subjects are locked to an allocentric (*observer view*) negative representation of their body that their sensory inputs are no more able to update even after dramatic body changes. The impossibility of using sensory inputs for updating the allocentric representation of the body – patients hate their body even after a significant weight loss - locks the patients into an unsatisfying body that may explain their depression, low quality of life and difficulty in maintaining an effective eating behavior [19; 20].

How can we unlock this virtual body? The paper suggested as possible answer an exciting new technology: virtual reality (VR). VR is well known by surgeons: it is used in surgical training and allows the surgeon to interact efficiently with 3D computerized databases of medical images in real time using his natural senses and skills. However, VR can be considered an "embodied technology" for its effects on body perceptions: VR can be used for inducing controlled changes to the experience of the body. In sum, it is possible the use of VR to induce a controlled sensory rearrangement that facilitates an update of the locked allocentric representation of the body.

Longer follow-up data and multi-centric trials are required to investigate the possible effects of the behavioral and body image changes on the long-term maintenance of the weight loss.

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