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EDITORIAL

Virtual Worlds versus Real Body: Virtual Reality Meets Eating and Weight Disorders

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THIS SPECIAL ISSUE PRESENTS and discusses a collection of authoritative studies suggesting that computer-generated graphic environments—virtual reality (VR) and augmented reality (AR)—can integrate and extend existing prevention, assessment, and treatment protocols for eating and weight disorders (EWDs).

The diffusion of EWDs is a worldwide problem. In the United States alone, 20 million women and 10 million men suffer from a clinically significant eating disorder during their lifetime.[1] For obesity, the situation is even worse. According to the data recently collected by the Gallup Organization in the Gallup-Healthways Well-Being Index (GHWBI), the U.S. adult obesity rate in 2013 was 27.2%.

EWDs have serious consequences for individuals and a significant economic impact on health systems. In addition to the direct consequences for the health of individuals, these disorders may contribute, directly or indirectly, to severe disability and premature death.

Apparently, both problems have a simple explanation: an imbalanced energy regulation. In obesity, energy intake exceeds energy expenditure; in anorexia, energy intake is lower than energy expenditure. However, their prevention and treatment is still an open challenge.

In its Weight Control Information Network, the U.S. National Institutes of Health discusses the etiology of obesity in this way: ''Energy balance is a fundamental principle of physics that regulates weight gain and loss. However, even when admitting that the main cause of obesity is an inadequacy between energy intake and expenditure, there remains a lot to be learned in order to properly manage the epidemic. Research is barely shedding light on the mysteries of this complex disorder'' (http://win.niddk.nih.gov/publications/understanding.htm#whatcausesobesity).

The situation is not so different for anorexia. As underlined by Fairburn and Harrison in their review article published in *The Lancet*: ''virtually nothing is known about the individual causal processes involved, or about how they interact and vary across the development and maintenance of the disorders.''[2(p409)] A similar view is expressed by Kaye et al. in their *Nature Review Neuroscience* article 6 years later: ''Anorexia nervosa is a disorder of unknown etiology.''[3(p573)]

The actual situation is pushing obesity and eating disorder researchers to begin a collaboration. In particular, their common effort is focused on the identification of risk factors that are shared between these disturbances[4]: apparently, stress and unhealthful weight-control behaviors—such as fasting (going without eating for 24 hours for weight control), vomiting, or laxative abuse—are the common antecedents of both obesity and eating disorders.[4–11]

More, an open challenge is the quest for improving the effectiveness of the available evidence-based interventions. This Special Issue will focus on the two leading virtual technologies—augmented reality (AR) and virtual reality (VR)—exploring their clinical potential for EWDs. As suggested by many studies, these technologies may have a big impact on clinical practice[12–15] for the high level of self-reflectiveness and personal efficacy induced by their emotional engagement and sense of presence[16,17]: if AR adds virtual information to the real world,[18] VR completely replaces the real environment with a virtual one.

Recent studies,[19–23] summarized in the review by Wiederhold et al.[24] opening this Special Issue, indicate that VR and AR can integrate and extend existing prevention,[25,26] assessment,[27,28] and treatment protocols[29–32] for EWDs.

The first section of the Special Issue showcases the potential of VR in supporting and improving health behavior change for the prevention and treatment of EWDs.

In their study, Behm et al.[33] present and discuss the potential of a social virtual world (Second Life) for increasing health self-efficacy (exercise and nutrition efficacy) among overweight adults. Their results suggest that for users who like video game VR are able to improve exercise efficacy and to support weight loss. A similar result is reported in the article by Kuo et al.[34]: compared with control participants, participants who viewed their weight-reduced avatars ate less ice cream in a taste test and were more likely to choose a sugar-free drink as a reward. These articles confirm the Proteus effect[35–37]—the behavior of an individual conforms to his/her digital self-representation—and underline the significant potential of VR in behavioral modeling. As underlined by Fox and Bailenson, using VR ''we have the capability to create ideal self-models that can motivate

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individuals to adopt new health practices or positively modify existing ones.''[38(p 20)]

The study by Ahn et al.[39] suggests that avatars that do not represent the user may also have an impact on health behavior: a virtual pet in the form of a mid-sized dog is able to improve the fruit and vegetable (F&V) consumption in children significantly. However, all roses have thorns, and this is true for the use of avatars, too. The article by Mountford et al.[40] underlines how virtual environments and avatars may have different efficacy according to their representational and behavioral fidelity.

The second section of the Special Issue includes different articles focusing on the use of VR and AR for assessing and improving attitudes, attention, and emotions. In their article, Tremblay et al.[41] explored the use of a haptic VR environment to interact physically with overweight virtual humans. Their results suggest that virtual touch is a promising method of measuring the attitudes, emotion, and social interactions that individuals have with overweight people.

The study by Pallavicini et al.[42] tested AR for cue exposure with response prevention in obese patients. The presented data show that AR food stimuli were perceived to be as palatable as real stimuli, and they also triggered a similar arousal response. The article by Baños et al.[43] analyzed the potential of VR to enhance attentional distraction in overweight children as they experience bodily sensations during exercise. Again, VR was useful to promote distraction and helped overweight and obese children to enjoy exercise.

The final section of the Special Issue explores in more detail the clinical use of VR in both assessment and treatment. First, Schroeder et al.[44] explored the use of a VR grasping task—taking both high-calorie food and neutral objects—for assessing EWDs. Their results underline that food objects were collected faster than control objects, and this difference correlated positively with both individual body mass index and diet-related attitudes. Then Serino et al.[45] investigated whether VR body-swapping—the embodiment in a virtual body—can be an effective tool for modifying the allocentric memory of the body. Findings revealed that after participants embodied a virtual body with a skinny belly, they reported a decrease in the ratio between estimated and actual body measures for most of the body parts considered. This result confirms the potential of VR multisensory bodily illusions for understanding of body image distortion and disturbance in those with eating disorders and obesity.[46–48] Manzoni et al.[49] tested the long-term efficacy of an enhanced cognitive–behavioral therapy (CBT) of obesity, including a specific VR module aimed at addressing the experience of the body and its behavioral and emotional correlates. In particular, the authors used a specific VR re-scripting protocol,[50] forcing the subject to re-experience the same negative body-related experience (e.g., teasing) from two different perspectives[51]: a first-person perspective (the patient does not see his/her full body) expressing and discussing his/her feelings; and a third-person perspective (the patient sees his/her full body as an external avatar) intervening to both calm and reassure his/her virtual avatar and to counter any negative evaluation. Findings support the hypothesis that the VR module addressing the negative experience of the body may enhance the long-term efficacy of standard CBT.

The final article by Gutiérrez-Maldonado et al.[52] tries to outline the future of VR in the assessment and treatment of EWDs. Specifically, the authors suggest that the growth of two types of VR interventions is likely in the coming years: the use of VR for altering in real time the experience of the body (embodiment), and VR as a cue exposure tool for reducing food craving.[26,53,54]

In conclusion, the contents of this Special Issue constitute a sound foundation and rationale for future research aimed at the design, development, and testing of computer-generated graphic environments—VR and AR—for integrating and extending existing methods for the prevention, assessment, and treatment of EWDs. In particular, this Special Issue provides strong preliminary evidence to justify future research to identify the most effective technological interventions, and the optimal amount of technological support needed, for supporting health behavior change, reducing body image and anti-fat attitudes, and extending existing cue-exposure and CBT protocols.

References

1. Wade TD, Keski-Rahkonen A, Hudson J. (2011) Epidemiology of eating disorders. In Tsuang M, Tohen M, eds. *Textbook in psychiatric epidemiology*. 3rd ed. New York: Wiley, pp. 343–360.
2. Fairburn CG, Harrison PJ. Eating disorders. The Lancet 2003; 361:407–416.
3. Kaye WH, Fudge JL, Paulus M. New insights into symptoms and neurocircuit function of anorexia nervosa. Nature Reviews Neuroscience 2009; 10:573–584.
4. Haines J, Neumark-Sztainer D. Prevention of obesity and eating disorders: a consideration of shared risk factors. Health Education Research 2006; 21:770–782.
5. Neumark-Sztainer D, Wall M, Guo J, et al. Obesity, disordered eating, and eating disorders in a longitudinal study of adolescents: how do dieters fare 5 years later? Journal of the American Dietetic Association 2006; 106:559–568.
6. Neumark-Sztainer D. Preventing obesity and eating disorders in adolescents: what can health care providers do? Journal of Adolescent Health 2009; 44:206–213.
7. Johnston JM. Eating disorders and childhood obesity: who are the real gluttons? Canadian Medical Association Journal 2004; 171:1459–1460.
8. Stice E, Presnell K, Shaw H, et al. Psychological and behavioral risk factors for obesity onset in adolescent girls: a prospective study. Journal of Consulting & Clinical Psychology 2005; 73:195–202.
9. Stice E, Davis K, Miller NP, et al. Fasting increases risk for onset of binge eating and bulimic pathology: a 5-year prospective study. Journal of Abnormal Psychology 2008; 117:941–946.
10. Sominsky L, Spencer SJ. Eating behavior and stress: a pathway to obesity. Frontiers in Psychology 2014; 5:434.
11. Torres SJ, Nowson CA. Relationship between stress, eating behavior, and obesity. Nutrition 2007; 23:887–894.
12. Riva G. Virtual reality: an experiential tool for clinical psychology. British Journal of Guidance & Counselling 2009; 37:337–345.
13. Riva G, Botella C, Baños R, et al. (2015) Presence-inducing media for mental health applications. In Lombard M, Biocca F, Freeman J, Ijsselsteijn W, Schaevitz RJ, eds. *Immersed in media*. New York: Springer, pp. 283–332.
14. Riva G, Molinari E, Vincelli F. Interaction and presence in the clinical relationship: virtual reality (VR) as communicative medium between patient and therapist. IEEE Transactions on Information Technology in Biomedicine. 2002; 6:198–205.

15. Riva G, Wiederhold BK. The new dawn of virtual reality in health care: medical simulation and experiential interface. Annual Review of CyberTherapy & Telemedicine 2015;13: 3–6.
16. Botella C, Quero S, Banos RM, et al. Virtual reality and psychotherapy. Studies in Health Technology & Informatics 2004; 99:37–54.
17. Wiederhold BK, Riva G. Positive change: connecting the virtual and the real. Annual Review of CyberTherapy & Telemedicine 2014;12.
18. Gamberini L, Orso V, Beretta A, et al. Evaluating user experience of augmented reality eyeglasses. Annual Review of CyberTherapy & Telemedicine 2015;13:28–32.
19. Ferrer-Garcia M, Gutierrez-Maldonado J. The use of virtual reality in the study, assessment, and treatment of body image in eating disorders and nonclinical samples: a review of the literature. Body Image 2012; 9:1–11.
20. Ferrer-Garcia M, Gutiérrez-Maldonado J, Riva G. Virtual reality based treatments in eating disorders and obesity: a review. Journal of Contemporary Psychology 2013; 43:207–221.
21. Riva G, Gaudio S, Dakanalis A. The neuropsychology of self objectification. European Psychologist 2015; 20:34–43.
22. Riva G. (2015) Embodied medicine: what human–computer confluence can offer to health care. In Gaggioli A, Ferscha A, Riva G, Dunne S, Viaud-Delmon I, eds. *Human computer confluence: transforming human experience through symbiotic technologies*. Warsaw: De Gruyter Open, pp. 55–79.
23. Riva G. Out of my real body: cognitive neuroscience meets eating disorders. Frontiers in Human Neuroscience 2014; 8:236.
24. Wiederhold BK, Riva G, Gutiérrez-Maldonado J. Virtual reality in the assessment and treatment of weight-related disorders. Cyberpsychology, Behavior, & Social Networking 2016; 19:67–73.
25. Ferrer-Garcia M, Gutierrez-Maldonado J, Caqueo-Urizar A, et al. The validity of virtual environments for eliciting emotional responses in patients with eating disorders and in controls. Behavior Modification 2009; 33:830–854.
26. Pla-Sanjuanelo J, Ferrer-Garcia M, Gutierrez-Maldonado J, et al. Identifying specific cues and contexts related to bingeing behavior for the development of effective virtual environments. Appetite 2015; 87:81–89.
27. Gorini A, Griez E, Petrova A, et al. Assessment of the emotional responses produced by exposure to real food, virtual food and photographs of food in patients affected by eating disorders. Annals of General Psychiatry 2010; 9:30.
28. Riva G. Virtual reality in psychological assessment: the Body Image Virtual Reality Scale. CyberPsychology & Behavior 1998; 1:37–44.
29. Manzoni GM, Pagnini F, Gorini A, et al. Can relaxation training reduce emotional eating in women with obesity? An exploratory study with 3 months of follow-up. Journal of the American Dietetic Association 2009; 109:1427–1432.
30. Marco JH, Perpina C, Botella C. Effectiveness of cognitive behavioral therapy supported by virtual reality in the treatment of body image in eating disorders: one year follow-up. Psychiatry Research 2013; 209:619–625.
31. Ferrer-Garcia M, Gutierrez-Maldonado J, Pla J, et al. Development of a VR application for binge eating treatment: identification of contexts and cues related to bingeing behavior in Spanish Italian patients. Studies in Health Technology & Informatics 2014; 199:71–75.
32. Cesa GL, Manzoni GM, Bacchetta M, et al. Virtual reality for enhancing the cognitive behavioral treatment of obesity with binge eating disorder: randomized controlled study with one-year follow-up. Journal of Medical Internet Research 2013; 15:e113.
33. Behm-Morawitz E, Lewallen J, Choi G. A second chance at health: how a 3D virtual world can improve health self-efficacy for weight loss management among adults. Cyberpsychology, Behavior, & Social Networking 2016; 19:74–79.
34. Kuo H-C, Lee C-C, Chiou W-B. The power of the virtual ideal self in weight control: weight-reduced avatars can enhance the tendency to delay gratification and regulate dietary practices. Cyberpsychology, Behavior, & Social Networking 2016; 19:80–85.
35. Fox J, Bailenson JN, Tricase L. The embodiment of sexualized virtual selves: the Proteus effect and experiences of self-objectification via avatars. Computers in Human Behavior 2013; 29:930–938.
36. Yee N, Bailenson JN, Ducheneaut N. The Proteus effect implications of transformed digital self-representation on online and offline behavior. Communication Research 2009; 36:285–312.
37. Yee N, Bailenson J. The Proteus effect: the effect of transformed self-representation on behavior. Human Communication Research 2007; 33:271–290.
38. Fox J, Bailenson JN. Virtual self-modeling: the effects of vicarious reinforcement and identification on exercise behaviors. Media Psychology 2009; 12:1–25.
39. Ahn SJ, Johnsen K, Moore J, et al. Using virtual pets to increase fruit and vegetable consumption in children: a technology-assisted social cognitive theory approach. Cyberpsychology, Behavior, & Social Networking 2016; 19:86–92.
40. Mountford VA, Tchanturia K, Valmaggia L. ''What are you thinking when you look at me?''a pilot study of the use of virtual reality in body image. Cyberpsychology, Behavior, & Social Networking 2016; 19: 93–99.
41. Tremblay L, Roy-Vaillancourt M, Chebbi B, et al. Body image and anti-fat attitudes: an experimental study using a haptic virtual reality environment to replicate human touch. Cyberpsychology, Behavior, & Social Networking 2016; 19:100–106.
42. Pallavicini F, Serino S, Cipresso P, et al. Testing augmented reality for cue exposure in obese patients: an exploratory study. Cyberpsychology, Behavior, & Social Networking 2016; 19:107–114.
43. Baños RM, Escobar P, Cebolla A, et al. Using virtual reality to distract overweight children from bodily sensations during exercise. Cyberpsychology, Behavior, & Social Networking 2016; 19:115–119.
44. Schroeder PA, Lohmann J, Butz MV, et al. Behavioral bias for food reflected in hand movements: a preliminary study with healthy subjects. Cyberpsychology, Behavior, & Social Networking 2016; 19:120–126.
45. Serino S, Keizer A, Triberti S, et al. Virtual reality body-swapping: a tool for modifying the allocentric memory of the body. Cyberpsychology, Behavior, & Social Networking 2016; 19:127–133.
46. Preston C, Ehrsson HH. Illusory changes in body size modulate body satisfaction in a way that is related to non-clinical eating disorder psychopathology. PLOS ONE 2014; 9.
47. Slater M, Spanlang B, Sanchez-Vives MV, et al. First person experience of body transfer in virtual reality. PLoS ONE 2010; 5:e10564.

48. Normand JM, Giannopoulos E, Spanlang B, et al. Multisensory stimulation can induce an illusion of larger belly size in immersive virtual reality. PLoS ONE 2011; 6.
49. Manzoni GM, Cesa GL, Bacchetta M, et al. Virtual reality-enhanced cognitive-behavioral therapy for morbid obesity: a randomized controlled study with 1 year follow-up. Cyberpsychology, Behavior, & Social Networking 2016; 19:134–140.
50. Riva G. The key to unlocking the virtual body: virtual reality in the treatment of obesity and eating disorders. Journal of Diabetes Science & Technology 2011; 5:283–292.
51. Serino S, Mestre D, Mallet P, et al. Being present in space: the role of allocentric and egocentric reference frames. Annual Review of CyberTherapy & Telemedicine 2015;13: 64–68.
52. Gutiérrez-Maldonado J, Wiederhold BK, Riva G. Future directions: how virtual reality can further improve the assessment and treatment of eating disorders and obesity. Cyberpsychology, Behavior, & Social Networking 2016; 19:148–153.
53. Pla-Sanjuanelo J, Ferrer-Garcia M, Gutiérrez-Maldonado J, et al. Trait and state craving as indicators of validity of VR-based software for binge eating treatment. Annual Review of CyberTherapy & Telemedicine 2015;13: 141–146.
54. Ferrer-Garcia M, Gutiérrez-Maldonado J, Pla-Sanjuanelo J, et al. External eating as a predictor of cue-reactivity to food-related virtual environments. Annual Review of CyberTherapy & Telemedicine 2015;13:117–122.