Assessing User Experience of a virtual reality training in patients with anorexia nervosa: insigths from a pilot study

Marta MATAMALA-GOMEZ[a,1], Eleonora BRIVIO[b], Alice CHIRICO[b], Clelia MALIGHETTI[b], Olivia REALDON[a], Silvia SERINO[b], Antonios DAKANALIS[d,e] Giulia CORNO[f], Nicoletta POLLI[g,h], Chiara CACCIATORE[g], Giuseppe RIVA,[b,i] Fabrizia MANTOVANI[a]

[a] *Center for Studies in Communication Sciences "Luigi Anolli" (CESCOM).University of Milano-Bicocca, "Riccardo Massa" Department of Human Sciences for Education, Milan, Italy.*
[b]*Università Cattolica del Sacro Cuore, Department of Psychology, Milan, Italy.*
[d]*Department of Medicine and Surgery, University of Milano Bicocca, Milan, Italy.*
[e]*Department of Brain and Behavioral Sciences, University of Pavia, Pavia, Italy.*
[f]*Université du Québec en Outaouais • Département de psychoéducation et de psychologie, Québec, Canada.*
[g]*'Istituto Auxologico Italiano (IRCCS), 'UO di Endocrinologia e Malattie Metaboliche', Milan, Italy.*
[h]*University of Milan, 'Dipartimento di Scienze Cliniche e di Comunità', Milan, Italy.*
[i] *Applied Technology for Neuro-Psychology Laboratory, Istituto Auxologico Italiano, IRCCS, Milan, Italy.*

Abstract. VR effectiveness has been tested before in Anorexia Nervosa (AN) with full-body illusion. The embodiment of patients with AN into a different virtual body to modify their long-term memory of the body is a crucial factor for the onset and maintenance of this disorder. In this pilot study, we aimed to test the usability and User Experience (UX) of this VR-based protocol. Five Italian women with AN were embodied in a virtual body resembling their perceived body size from an ego- and an allocentric perspective while remembering episodes of their life related to their body. High levels of embodiment were reported while embodied in a virtual body resembling their real perceived body size for ownership ($p<0.0001$), agency ($p<0.01$), and self-location ($p<0.01$). Results from UX in terms of embodiment and personal opinion collected by the think aloud and patient's interviews show that patients with AN can benefit from using VR as a driver for assessing and modulating body image distortions in patients with eating disorders.

Keywords. Virtual reality, anorexia nervosa, user experience

1. Introduction

Virtual reality (VR) have been widely used for modulating the internal body perception in clinical populations [1,2] , and particularly in patients with eating disorders (ED) [3,

[1] Corresponding Author: marta.matamala10@gmail.com.

In this regard, a recent study showed that VR can act as a driver for assessing and modulating body image distortion in patients with AN through a full virtual body swapping illusion [5]. Regarding VR experiences, a large number of studies on VR environments have focused on the ability that this kind of environments have to influence peoples' perception [6]. Indeed, elements like these make up the criteria for effectiveness of the system that is if the users can reach their aim with an adequate level of accuracy and completeness within the system[1]. More recently, another criterion of appropriateness when using virtual reality systems emerged: User Experience (UX) [7]. UX is considered to be a multi-dimensional construct [8] that includes "a person's perceptions and responses that result from the use or anticipated use of a product, system or service". In fact, UX occurs as a consequence of the interaction between a user and a product within a physical, social and cultural context, determining the users' experience of a system [9] before, during, and after the interaction, as indicated by the International Standard Organisation[1.] The present pilot study aims to test the user experience of a body-swapping VR-based system in terms of embodiment and user experience scores, and personal opinion regarding the VR experience in patients with AN.

2. Materials and methods

2.1. Participants

Five young women diagnosed with AN participated in this study (age = 17±1,87; BMI= 15,95±0,61). Inclusion criteria envisaged to meet the diagnostic criteria for AN based-on DSM 5, a BMI not under 15 and a normal or correct-to normal visual and hearing. Exclusion criteria included current or prior history of a neurological illness, brain damage or head injuries and psychiatric comorbidity. All participants were informed about the purpose of the research and provided written informed consent. The study was approved by the local ethical committee of the Istituto Auxologico Italiano.

2.2. Measures

In order to evaluate the usability and user experience of this VR-based system, during the VR experimental session the following techniques and tests were used: The think-aloud protocol [10], which consist in semi-directed and undisturbed users' verbalization while using and interacting with the VR set-up, providing useful information for interpreting and determining verbal data to identify system deficiencies; Embodiment assessment [11], during the experimental session after the exposure of each virtual body condition the level of embodiment, (sense of body ownership, self-location, and agency toward the virtual body) was assessed by using three different questions in which patients had to indicate how much they agreed or disagreed with each statement in a 7-point Likert scale, from -3= totally disagree to +3=totally agree. User experience was assessed with the User Experience Questionnaire (UEQ-S) seven-point Liker type from -3 (horribly bad) to +3 (extremely good) for each of the 26 items of the questionnaire [12]. User experience after the VR exposure was assessed in session 1 and session 4. A 4-week follow-up qualitative interview was conducted to verify the final user experience evaluation and the overall experience of the proposed protocol.

2.3 Procedures

In order to participate in the study, each participant carries the informed consent form signed by the parents. The VR-based intervention consisted in four sessions in which participants were embodied in an avatar from an egocentric view (first person perspective) and from an allocentric view (third person perspective). The VR procedure included an HDM, oculus rift connected to a laptop computer and a Kinect Sensor to track motion. Through the motion tracker device, the virtual body was visuomotor synchronized with participants' real body

and reproduced the real movements of the participants simultaneously. Once the patients observed the virtual body through the HMD, the experimenter asked them to start the think-aloud phase while slowly moving their arms upwards, in order to experiment with their virtual body, and to visually explore the virtual environment. Finally, patients were asked to co-locate their real body aligned with the virtual one in order to encourage the embodiment. At this point, patients were asked to verbally express what they felt and their sensations. All patients' responses were audio recorded by the experimenters (this part was always conducted from a body first-person perspective). Once the think-aloud was concluded VR experimental session started. Each VR experimental session was composed of four different parts: (1) Embodiment phase, in which the embodiment toward the virtual body was induced by means of synchronous visuo-motor correlations; (2) Virtual body perspective, in which an allocentric or egocentric perspective of the virtual body was provided depending of the session; (3) Modification of the BMI, where the body mass index (BMI) of the virtual body was increased throughout the VR sessions until arrives to a healthy BMI (18.5); and (4) Autobiographical recall, following a classical autobiographical recall procedure [see 13 for further details].

2.4. Data handling

Statistical tests for the repeated measures of the study (embodiment questions) were performed in Stata 13 (StataCorp LP, College Station, TX, USA), using the Friedman test for non-parametrical data. The distribution of the data was tested with the Shapiro-Wilk test. Effect sizes based on mean comparison were also calculated (Cohen's d).

2.5. Results

2.5.1. Embodiment questionnaire scores

Patients reported significantly higher levels of ownership ($Q=30.03$, $p<0.0001$, CI(95) =0.65-1.40, $d=1.02$), location ($Q= 7.63$, $p<0.01$, CI(95)=0.12-0.83, $d=0.47$), and agency ($Q=7.61$, $p<0.01$, CI(95)=0.60-0.77, $d=0.41$) toward the virtual body when they were embodied in a virtual body with their perceived real BMI, than when they were embodied in a virtual body with their desired BMI. However, no differences were found for ownership, location, and agency while observing the virtual body form an egocentric (1PP) or allocentric point of view (3PP). **Figure 1.I.**

2.5.2. User experience questionnaire scores

The results obtained in the UEQ showed that patients perceived the system as more attractive after the VR exposure in session 1 (0,53±0,46) than after session 4 (0 ±0,59). On the other hand, patients perceived the system more familiar and easier to use after session 4 (1,13±0,72) than after session 1 (0,95±0,60). Average scoring for novelty were higher after session 4 (1,69±0,94) than after session 1 (1,56±1,23). **Figure 1.II.**

2.5.3. Think aloud

The thinking aloud technique revealed that no element in the virtual environment gained more attention than the others: two patients first focused on the virtual body and two on the virtual environment. The virtual environment is described by most patients in details, giving attention especially to the interior of the room. The virtual world outside the window is not given much consideration. The description of the virtual body is more critical. The patients used personal nouns and pronouns when describing the virtual body, which indicates a good level of identification with the virtual body ("I saw myself reflected in a mirror").

2.5.4. Patients interview

All five patients appreciated the contextual features of the VR room, which was deemed clear and detailed. However, the virtual body generated contrasting feelings: while the patients could tell that it was meant to be them, the virtual body was usually perceived as unfamiliar and not similar enough to their own body. The body similarity between the virtual body and the real body of the patients emerged as particularly relevant especially in the two youngest interviewees, who expressed frustration in not being able to control the body of the avatar body completely, in its physical aspects. This fixation on the body is on par with the AN pathology. The interviewees said they would continue/re-attend the program as they found it is very innovative and they like the VR aspect of it, and they would suggest others to try it. The VR systems' novelty and innovation is the main driver for continued use.

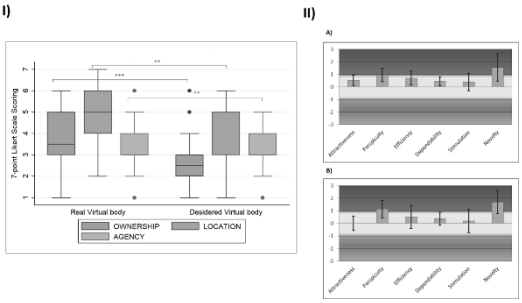

Figure 1. Embodiment and user experience questionnaire scores

3. Discussion and conclusion

The present manuscript shows the preliminary data from the results obtained in a pilot study conducted with five patients with AN to explore user experience in terms of embodiment and user experience scores, and personal opinion regarding the VR body-swapping illusion experience. The results show that the VR-system was able to induce the sense of embodiment toward a virtual body while being embodied in a virtual body with a real perceived BMI (figure 1). Regarding the UX of the system, the results from the UEQ revealed that users found the VR-system familiar and easy to use after the last session (session 4), and novelty compared with conventional rehabilitation training (session 1 and session 4). This result was supported with the high scores obtained in terms of the perspicuity of the system, which indicates the clearness in following the VR protocol throughout the 4-sessions period. Results from UX assessments (embodiment scores, think aloud, and patient's interviews) show that patients with AN can benefit from using VR as an easy to use an innovative technological solution. However, future studies with a higher sample size and a control group have to be done to support the preliminary results of this study.

References

[1] Matamala-Gomez M, Malighetti C, Cipresso P, Pedroli E, Realdon O, Mantovani F, et al. Changing Body Representation Through Full Body Ownership Illusions Might Foster Motor Rehabilitation Outcome in Patients With Stroke. Front Psychol. 2020;11.

[2] 2.Matamala-Gomez M, De Icco R, Avenali M, Balsamo F. Multisensory integration techniques in neurorehabilitation: The use of virtual reality as a rehabilitation tool. Confin Cephalalgica. 2018;28(2):81–5.

[3] Riva G, Bacchetta M, Baruffi M, Rinaldi S, Vincelli F, Molinari E. Virtual Reality-Based Experiential Cognitive Treatment of Obesity and Binge-Eating Disorders. Clin Psychol Psychother. 2000;7(3):209–19.

[4] Malighetti C, Serino S, Riva G, Cipolletta S. Inside and outside the self. Virtual reality and repertory grids in the spatial analysis of anorexic patients' meanings. Annu Rev CyberTherapy Telemed. 2016;14:78–83.

[5] Serino S, Polli N, Riva G. From avatars to body swapping: The use of virtual reality for assessing and treating body-size distortion in individuals with anorexia. J Clin Psychol [Internet]. 2019;75(2):313–22. Available from: http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L625944049

[6] Tuena C, Pedroli E, Trimarchi PD, Gallucci A, Chiappini M, Goulene K, et al. Usability issues of clinical and research applications of virtual reality in older people: A systematic review. Front Hum Neurosci. 2020;14.
[7] Kuliga SF, Thrash T, Dalton RC, Hölscher C. Virtual reality as an empirical research tool - Exploring user experience in a real building and a corresponding virtual model. Comput Environ Urban Syst. 2015;54:363–75.
[8] Hinderks A, Schrepp M, Domínguez Mayo FJ, Escalona MJ, Thomaschewski J. Developing a UX KPI based on the user experience questionnaire. Comput Stand Interfaces. 2019;65:38–44.
[9] Rebelo F, Noriega P, Duarte E, Soares M. Using virtual reality to assess user experience. In: Human Factors. 2012. p. 964–82.
[10] Boren MT, Ramey J. Thinking aloud: Reconciling theory and practice. IEEE Trans Prof Commun. 2000;43(3):261–78.
[11] Longo MR, Schüür F, Kammers MPM, Tsakiris M, Haggard P. What is embodiment? A psychometric approach. Cognition [Internet]. 2008 [cited 2017 Apr 10];107(3):978–98. Available from: http://www.sciencedirect.com/science/article/pii/S0010027708000061
[12] Schrepp M, Hinderks A, Thomaschewski J. Design and Evaluation of a Short Version of the User Experience Questionnaire (UEQ-S). Int J Interact Multimed Artif Intell. 2017;4(6):103.
[13] Chirico A, Cipresso P, Gaggioli A. Psychophysiological Specificity of Four Basic Emotions Through Autobiographical Recall and Videos. In: Lecture Notes of the Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering, LNICST. 2018.