The way we look at our own body really matters! Body-related attentional bias as a predictor of worse clinical outcomes after a virtual reality body exposure therapy

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Abstract: Body-related attentional bias (AB) experienced by anorexia nervosa (AN) patients has been associated with body image disturbances and other eating disorders (ED)-related symptoms. The aim of this study was to assess whether the body-related AB reported by AN patients before a virtual reality (VR)-based body exposure therapy predicted worse clinical outcomes after treatment. Thirteen AN outpatients participated in the study. AB was recorded using an eye-tracker incorporated in a VR-Head Mounted Display. Results showed that AN patients attended to their weight-related body parts for longer and more frequently than to their non-weight-related body parts. Statistically significant ($p<.05$) negative and positive correlations between pre-intervention body-related AB measures and the difference between pre- and post-assessment fear of gaining weight, body dissatisfaction, and body appreciation measures were also found. Showing higher body-related AB before the intervention marginally predicted a lower reduction of fear of gaining weight ($p =.08$ and $p=.07$) and body dissatisfaction ($p = .05$ and $p=.06$) at post-treatment, and significantly predicted a lower increase of body appreciation scores after the intervention ($p<.001$). Results suggest that body-related AB may reduce the efficacy of VR-based body exposure therapy in patients with AN.

Keywords: Anorexia Nervosa, Body-Related Attentional Bias, Virtual Reality, Eye-Tracking, Body Exposure Therapy, Treatment Outcomes

1. Introduction

Body-related attentional bias (AB), understood as the tendency to selectively attend to body appearance-related cues in preference to other information, is a phenomenon observed in Anorexia Nervosa (AN) patients [1]. Previous research found that body-related AB (i.e.

AB toward self-reported unattractive body parts) is strongly related to body image disturbances [2, 3]. However, more research is needed to explore the relationship between body-related AB and other core symptoms of AN such as fear of gaining weight.

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Based on the preliminary findings of a randomized clinical trial with AN patients [4], the objective of this study is to assess whether the body-related AB reported by AN patients before a virtual reality (VR)-based body exposure therapy predicts worse clinical outcomes after treatment. Specifically, patients showing higher body-related AB before the intervention were expected to report poorer outcomes (i.e., lower reduction of fear of gaining weight and body dissatisfaction, and lower increase of body appreciation) after the VR-based body exposure than patients showing lower body-related AB at pre-treatment.

2. Method

2.1. Sample

Thirteen AN outpatients (11 women and 2 men) receiving day-ward treatment at the Eating Disorders Units of the Hospital de Sant Joan de Déu and the Hospital de Bellvitge (Barcelona, Spain) participated in the study. The inclusion criteria were being 13 years or older and a body mass index over 19. The exclusion criteria were serious mental disorders with psychotic or manic symptoms (e.g., schizophrenia or bipolar disorders), sensory complications that precluded exposure (e.g., visual, tactile, or auditory deficits), epilepsy, clinical cardiac arrhythmia, and pregnancy.

2.2. Measures

Fear of gaining weight (FGW), body appreciation (BA), and body dissatisfaction (BD) were assessed before and after the intervention. Self-reported FGW levels were assessed using a visual analog scale (VAS) ranging from 0 (not at all) to 100 (completely). Body image-related measures were assessed using the Body Appreciation Scale (BAS) [5], and the Body Dissatisfaction scale (BD) of the Eating Disorder Inventory (EDI-3) [6].

AB measures included the number of fixations and the complete fixation time on weight-related body parts (Weight-related areas of interest, W-AOIs) and on non-weight-related body parts (Non-weight-related areas of interest, NW-AOIs). In accordance with the *Physical Appearance State and Trait Anxiety Scale* (PASTAS) [7], weight-related areas included thighs, buttocks, hips, stomach, legs, and waist, and non-weight related areas included the remaining body parts (i.e., head, shoulders, arms, décolletage, neck, and chest). The number of fixations and the complete fixation time are considered reliable measures for the assessment of body-related AB and have been widely applied in previous studies using eye tracker (ET) technology [8].

2.3. Technical Features

Patients were exposed to an immersive virtual environment using a VR head-mounted display (HMD-HTC-VIVE). The virtual scenario was designed with the Unity 3D 5.6.1 software and consisted of a small room with a large mirror on the wall placed 1.5 m in front of the patient's avatar, so that patients could see their whole virtual body reflected in it. The avatars (male and female versions) were designed using the software Blender v.2.78. They wore standard clothes (a white t-shirt, blue jeans, and black trainers) and their hair was covered by a gray hat to reduce any influence of hairstyle. The avatars also wore an HMD as the patients did, and their height and size could be adjusted based on the patient's measures. In addition to the two controllers of HTC-VIVE, three additional body trackers were used to achieve full body motion tracking of the avatar. The VR HMD-FOVE-Eye Tracking was used to detect and register the participant's eye movements while looking at the avatar in the mirror.

2.4. Procedure

The study was approved by the ethics committees of the University of Barcelona (Institutional Review Board IRB00003099) and the hospitals that participated in the study. During the first session (pre-assessment), and once the patient signed the informed consent, an avatar (i.e., virtual body) with the same measures of the patient was created and FWG, BAS, and EDI-3-BD questionnaires were administered. Then, the patient was exposed to the virtual environment and full body illusion (FBI) was induced over the virtual body using visuo-motor and visuo-tactile stimulations. Once the FBI was induced, the patient's gaze was tracked while they were asked to observe their virtual body in the mirror for 30 seconds to assess body-related AB. A more detailed description of the avatar development, the visuo-motor and visuo-tactile stimulations, and the eye tracker assessment task procedures are provided elsewhere [9, 10].

Treatment consisted of standard cognitive-behavioral therapy plus five sessions of VR-based body exposure therapy. During exposure sessions, patients were exposed (in the first-person perspective and on a mirror) to an avatar simulating their own body. In the first exposure session, the virtual body had the real-size silhouette and body mass index (BMI) of the participant. Throughout subsequent sessions (maximum 60 minutes, once a week), the virtual body progressively increased its size until showing a healthy weight. Once participants finished the fifth (and last) exposure session, the assessment questionnaires were administrated again.

2.5. Statistical analyses

The OGAMA (Open Gaze and Mouse Analyzer) software was used to transform the raw eye-tracking data into suitable quantitative data. In addition, the difference between weight-related and non-weight-related AOIs was calculated so that a positive outcome meant that the patient had been looking more at the weight-related body parts than at the non-weight-related body parts, and a negative outcome meant the opposite. On the other hand, a difference close to zero indicated that the patient had attended to both the weight-related and the non-weight-related body parts (i.e., there is no attentional bias).

Pearson correlation and linear regression analyses were conducted to assess the association between the attentional bias showed by the patients before the treatment and the outcomes of the intervention (differences between pre- and post-treatment scores in FGW, BD scale of the EDI-3, and BAS). Assumptions were partially met, as some variables were not normally distributed [11]. Analyses were conducted with the software IBM SPSS Statistics v.25.

3. Results

Prior to the treatment, the mean of complete fixation time of patients was 5,197 ms (SD=9,368.79) and the mean number of fixations was 18,77 (SD=15.87), indicating that participants showed an attentional bias to weight-related body parts (i.e. when looking at their avatar, they attended to their W-AOIs for longer and more frequently than to their NW-AOIs).

Furthermore, Pearson correlation analyses showed statistically significant (p<.05) negative and positive correlations between pre-intervention body-related AB measures and the difference between pre- and post-assessment fear of gaining weight, body dissatisfaction and body appreciation (Table 1).

Table 1. Pearson correlations between attentional bias measures at pre-treatment and the difference between scores of fear of gaining weight, body dissatisfaction, and body appreciation before and after treatment.

Measures	**FGW (pre-post treatment) *r* (*p*)**	**EDI-3-BD (pre-post treatment) *r* (*p*)**	**BAS (pre-post treatment) *r* (*p*)**
Number of fixations at pre-treatment	-.541* (.043)	-.575* (.025)	.777** (.001)
Complete fixation time at pre-treatment	-.562* (.036)	-.552* (.031)	.720**(.004)

***Note*:** FGW (Fear of Gaining Weight), EDI-3-BD (Body dissatisfaction scale of the Eating Disorder Inventory 3, BAS (Body Appreciation Scale).
** = statistically significant at p<.05 level*
*** = statistically significant at p<.01 level*

Finally, linear regression analyses (Table 2) showed that having higher body related AB levels before the intervention marginally predicted a lower reduction of fear of gaining weight (p=.086 and p=.072) and body dissatisfaction (p=.050 and p =.063) after the intervention. In addition, having higher body related AB levels before the intervention also significantly predicted a lower increase of body appreciation scores after the intervention (p<.001).

Table 2. Summary of linear regression analyses for attentional bias measures (number of fixations and complete time of fixation) predicting VR-based body exposure therapy outcomes.

Predictors	**Dependent variables**	**Beta**	***t***	***p***	**R^2**	**R^2 adj.**	***F***	***p***
Number of fixations at pre-treatment	FGW	-.541	-.1.929	.086	.292	.214	3.721	.086
	EDI-3-BD	-.575	-2.224	.050	.331	.264	4.945	.050
	BAS	.777	3.898	.003	.603	.563	15.194	.003**
Complete time of fixation at pre-treatment	FGW	-.562	-2.037	.072	.316	.240	4.151	.072
	EDI-3-BD	-.552	-2.094	.063	.305	.235	4.384	.063
	BAS	.720	3.278	.008	.518	.470	10,744	.008**

***Note*:** FGW (Fear of Gaining Weight), EDI-3-BD (Body dissatisfaction scale of the Eating Disorder Inventory 3 (EDI-3 BD), BAS (Body Appreciation Scale).

* = *statistically significant at p<.05 level*

** = *statistically significant at p<.01 level*

4. Conclusion

As expected and consistent with previous research [2, 3], higher levels of body-related AB at pre-treatment were strongly associated with poorer outcomes (i.e., lower reduction of fear of gaining weight and body dissatisfaction, and lower increase of body appreciation) after the intervention. Consequently, despite a promising reduction in eating disorder symptomatology after the VR-based body exposure therapy [4], our results suggest that body-related AB may have reduced the efficacy of the intervention in some ED measures. The combination of VR and eye-tracking technology could make it possible to control, and even reduce, body-related AB, and thus represents a useful way to improve body exposure therapies in AN.

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