Eye-tracking and virtual reality-based attentional bias modification training to improve mirror exposure therapy: preliminary findings from a multiple case study with anorexia nervosa patients

Ascione M.1, Carulla-Roig M.2, Miquel-Nabau H.1, Meschberger-Annweiler F.A.1, Serrano-Troncoso E.2, Ferrer-Garcia M.1, Gutierrez-Maldonado J.1

1Department of Clinical Psychology and Psychobiology, University of Barcelona, Barcelona, Spain.
2Department of Child and Adolescent Psychiatry and Psychology, Hospital Sant Joan de Déu, Barcelona, Spain.
The authors declare that they have no conflict of interest.
Patients with anorexia nervosa show dysfunctional body-related attentional bias.

Body-related attentional bias is associated with higher levels of body dissatisfaction, which in turn interferes with the effectiveness of body exposure-based treatments.

The Physical Appearance State and Trait Anxiety Scale (PASTAS; Thompson, 1999) assesses these aspects.
Body exposure-based therapies:

**Mirror exposure therapy (MET)**

MET is an effective treatment for anorexia nervosa to reduce the anxiety experienced by patients about their bodies and fear of gaining weight through a habituation process.

Patients are exposed to their real bodies over a prolonged period expressing their emotions and thoughts about their body.

Looking at or avoiding looking at the most anxiety-producing body parts could interfere with the extinction of the anxiety response.
ATTENTIONAL BIAS MODIFICATION TRAINING (ABMT) can reduce attentional biases

- Improve anorexia nervosa symptomatology, such as body dissatisfaction
- Increase the efficacy of body exposure therapies
Increasing the efficacy of MET by incorporating ABMT into MET in the treatment of 4 adolescent females with anorexia nervosa

Will the mirror exposure treatment’s efficacy increase by previously reducing the attentional bias?
Attentional Bias Modification Training & Mirror Exposure Therapy

Eye-tracking + Virtual reality
The treatment at the ED Unit consisted of individual and group cognitive-behavioral therapy, nutritional rehabilitation and individual and group parent counseling.

### Cases description
**4 females**
**Diagnosis: restrictive anorexia nervosa**

<table>
<thead>
<tr>
<th></th>
<th>Patient 1</th>
<th>Patient 2</th>
<th>Patient 3</th>
<th>Patient 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>14 y.o.</td>
<td>16 y.o.</td>
<td>17 y.o.</td>
<td>17 y.o.</td>
</tr>
<tr>
<td><strong>Comorbidity</strong></td>
<td>Adjustment disorder with anxiety</td>
<td>no</td>
<td>Major depressive disorder and anxiety disorder</td>
<td>Major depressive disorder</td>
</tr>
<tr>
<td><strong>Pharmacological treatment</strong></td>
<td>Antidepressants and antipsychotics</td>
<td>no</td>
<td>Antidepressants and occasional anxiolytics</td>
<td>Anxiolytics and antidepressants</td>
</tr>
<tr>
<td><strong>Program treatment</strong></td>
<td>Intensive day-patient treatment (11h)</td>
<td>Day-patient treatment (5h)</td>
<td>Intensive day-patient treatment (11h)</td>
<td>Outpatient program treatment</td>
</tr>
</tbody>
</table>

* The treatment consisted of individual and group cognitive-behavioral therapy, nutritional rehabilitation and individual and group parent counseling.

### Procedure

1. **Pre-treatment assessment session**
2. **5 experimental sessions**
   - Attentional bias modification training
   - Mirror exposure therapy
3. **Post-treatment assessment session**
The virtual avatar was created by taking a patient’s frontal photo which was manually overlapped on the silhouette of the virtual body by adapting the avatar’s body parts to the patient's silhouette.
In each clinical session, the following treatments are used:

1. Immersion in the virtual environment
2. Full body ownership illusion
3. Attentional bias modification training
4. Mirror exposure therapy
5. Exposure to a relaxing environment
Full Body Motion Tracking

Virtual reality environment
In each clinical session:

1. Immersion in the virtual environment
2. Full body ownership illusion
3. Attentional bias modification training
4. Mirror exposure therapy
5. Exposure to a relaxing environment
**VISUO-MOTOR STIMULATION PROCEDURE**

synchronizing the movements of the participant with the movements of the avatar using motion capture sensors placed on the hands and feet → participant could see how the virtual body was doing the same movements as the real body.

**VISUO-TACTILE STIMULATION PROCEDURE**

synchronizing the participant’s visual and tactile stimulation using a tactile controller → participant could see how her virtual body was touched by a virtual controller on the same areas of the real body touched by a real controller.
In each clinical session:

1. Immersion in the virtual environment
2. Full body ownership illusion
3. Attentional bias modification training
4. Mirror exposure therapy
5. Exposure to a relaxing environment
The attentional bias modification training goal was to balance the attention between weight and non-weight-related body parts. The task is based on a virtual reality adaptation of the attentional bias induction procedure proposed by Smeets et al. 2011.

150 figures divided into two blocks of 75 figure

10-15 minutes task

The patient was asked to be staring for 4 seconds at the figures that appeared on a specific body part of the avatar, while it was progressively illuminated until the end of the 4 seconds, and then to move on to the next figure presentation.
In each clinical session

1. Immersion in the virtual environment
2. Full body ownership illusion
3. Attentional bias modification training
4. Mirror exposure therapy
5. Exposure to a relaxing environment
The patient was asked to focus on different parts of the virtual body and to orally report her thoughts and feelings.

The level of experienced anxiety was evaluated every 120 seconds.
VR technology offers the possibility of performing ABMT and MET by allowing the patient to experience the illusion of ownership of a virtual body that progressively increases weight until reaching a healthy body mass index.

---

<table>
<thead>
<tr>
<th>Session I</th>
<th>Session II</th>
<th>Session III</th>
<th>Session IV</th>
<th>Session V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real BMI</td>
<td>Real BMI</td>
<td>Real BMI</td>
<td>Real BMI</td>
<td>Real BMI</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**INCREMENTS OF BMI**

To progress in the hierarchy, anxiety must decrease by 40% in the previous session.
In each clinical session:

1. Immersion in the virtual environment
2. Full body ownership illusion
3. Attentional bias modification training
4. Mirror exposure therapy
5. Exposure to a relaxing environment
## Pre-Post Treatment & Within-Treatment Sessions Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Body Ownership Illusion (FBOI)</td>
<td>Visual Analogue Scales (VAS) from 0 to 100</td>
</tr>
<tr>
<td>Fear of Gaining Weight Anxiety</td>
<td></td>
</tr>
<tr>
<td>Body weight</td>
<td>Body Mass Index (BMI)</td>
</tr>
<tr>
<td>Body dissatisfaction</td>
<td>Spanish version of the Body Dissatisfaction subscale of the Eating Disorder Inventory-3 (EDI-BD)</td>
</tr>
<tr>
<td>Drive for thinness</td>
<td>Spanish version of the Drive for Thinness subscale of the Eating Disorder Inventory-3 (EDI-DT)</td>
</tr>
<tr>
<td>State weight-related body parts anxiety</td>
<td>Physical Appearance State and Trait Anxiety Scale (PASTAS)</td>
</tr>
<tr>
<td>Body-checking behaviors</td>
<td>Body Checking Questionnaire (BCQ)</td>
</tr>
<tr>
<td>Body appreciation</td>
<td>Body Appreciation Scale (BAS)</td>
</tr>
</tbody>
</table>
**RESULTS: body mass index**

BMI increased slightly at post-treatment assessment (except for patient 1) without reaching the minimum healthy weight.
The RELIABLE CHANGES INDEX (RCI) for single cases was calculated for the post-assessment measurements only for the measures with clinical and community means and standard deviations.

**RESULTS: Patient 1**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Pre</th>
<th>Post</th>
<th>RCI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Dissatisfaction</td>
<td>29</td>
<td>14</td>
<td>2.97*</td>
</tr>
<tr>
<td>Drive for Thinness</td>
<td>25</td>
<td>3</td>
<td>5.68*</td>
</tr>
<tr>
<td>Body Anxiety</td>
<td>22</td>
<td>5</td>
<td>9.64*</td>
</tr>
<tr>
<td>Body Checking Behaviour</td>
<td>76</td>
<td>46</td>
<td>3.27*</td>
</tr>
<tr>
<td>Body Appreciation</td>
<td>18</td>
<td>48</td>
<td>-6.82*</td>
</tr>
</tbody>
</table>

*Significant difference RCI >1.96

**VISUAL ANALOGUE SCALES**

**FEAR OF GAINING WEIGHT**

- Pre: 100, 100, 100, 100, 100, 100
- Post: 100

**ANXIETY**

- Pre: 100, 100, 82, 100, 95, 95, 92

**FBOI**

- Pre: 55, 15, 75, 57, 50, 80, 65
- Post: 65
RESULTS: Patient 2

The RELIABLE CHANGES INDEX (RCI) for single cases was calculated for the post-assessment measurements only for the measures with clinical and community means and standard deviations.

RCI: 0.59
RCI: 0
RCI: 5.1*
RCI: 1.31
RCI: -0.68

*Significant difference RCI >1.96

FEAR OF GAINING WEIGHT

ANXIETY

FBOI
RESULTS: Patient 3

The RELIABLE CHANGES INDEX (RCI) for single cases was calculated for the post-assessment measurements only for the measures with clinical and community means and standard deviations.

**Fear of Gaining Weight**

<table>
<thead>
<tr>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>62</td>
<td>12</td>
</tr>
<tr>
<td>80</td>
<td>0</td>
</tr>
<tr>
<td>80</td>
<td>0</td>
</tr>
<tr>
<td>67</td>
<td>2</td>
</tr>
</tbody>
</table>

**Index of FBOI**

<table>
<thead>
<tr>
<th>Pre</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>0</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

**Anxiety**

<table>
<thead>
<tr>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>73</td>
</tr>
</tbody>
</table>

**Body Dissatisfaction**

<table>
<thead>
<tr>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>34</td>
<td>30</td>
</tr>
</tbody>
</table>

**Drive for Thinness**

<table>
<thead>
<tr>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>25</td>
</tr>
</tbody>
</table>

**Body Anxiety**

<table>
<thead>
<tr>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>21</td>
</tr>
</tbody>
</table>

**Body Checking Behaviour**

<table>
<thead>
<tr>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>90</td>
<td>73</td>
</tr>
</tbody>
</table>

**Body Appreciation**

<table>
<thead>
<tr>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>28</td>
</tr>
</tbody>
</table>

RCI: 0.79  RCI: 0.77  RCI: 1.13  RCI: 1.85  RCI: -0.91

*Significant difference RCI >1.96
The RELIABLE CHANGES INDEX (RCI) for single cases was calculated for the post-assessment measurements only for the measures with clinical and community means and standard deviations.

**VISUAL ANALOGUE SCALES**

**FEAR OF GAINING WEIGHT**

- Pre 45
- 1 57
- 2 57
- 3 55
- 4 25
- 5 25
- Post 17

**ANXIETY**

- Pre 0
- Post 0

**FBOI**

- Pre 75
- 1 75
- 2 75
- 3 60
- 4 60
- 5 55
- Post 75

*Significant difference RCI > 1.96*
Patients 1

The treatment has been effective

1. High level of anxiety → Anxiety disorder
2. No reduction in fear of gaining weight
3. High level of full body ownership illusion and identification with the avatar

Patient 3

Lack of effect of the treatment

3. Absence of full body ownership illusion and no identification with the avatar
Incorporate a pioneering ABMT into MET

Take advantage of virtual reality and eye-tracking technologies
To advance this preliminary study and evaluate the effectiveness of incorporating ABMT into MET, a controlled clinical trial is necessary.

Our group is now conducting a randomized controlled clinical trial*

Control group I
Cognitive behavioral therapy

Control group II
Cognitive behavioral therapy
+ Virtual-reality-based Mirror Exposure Therapy

Experimental group
Cognitive behavioral therapy
+ Virtual-reality & Eye-tracking-based attentional bias modification training
+ Virtual-reality-based Mirror Exposure Therapy

*Clinicaltrials.gov, NCT 04786951
This augmentation of MET through ABMT based on virtual reality and eye-tracking could open up a wide range of possibilities for new interventions to improve the symptomatology of patients with anorexia nervosa.
Thank you!

Questions?

Contacts
Mariarca Ascione: ascione.m@ub.edu
José Gutiérrez-Maldonado: jgutierrezm@ub.edu