Virtual reality-based attentional bias modification training to improve the efficacy of mirror exposure therapies. User experience optimization with healthy women and preliminary results with patients with anorexia nervosa.

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Patients with anorexia nervosa show dysfunctional body-related attentional bias.

Body-related attentional bias

Association with higher levels of body dissatisfaction

Interference with the effectiveness of the body exposure-based treatments

Physical Appearance State and Trait Anxiety Scale (PASTAS; Thompson, 1999)
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
Virtual reality (VR) enables researchers and therapists to:

- create highly realistic simulations of real-life settings and situations associated with body and weight concerns.

- design 3D avatars that reproduce the patients’ silhouettes based on their own body size, height, skin tone and clothes and capable of moving the same way as the individuals (full-body motion tracking) [1].
Creating a personalized avatar: photo procedure

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.
Using a VR embodiment-based procedure allows individuals to realistically experience a virtual body as their own body, eliciting the same sensorial responses or activating the same implicit or explicit multisensory representations of their own body.

**New transdisciplinary research field:** the “embodied medicine”, aiming to use advanced technologies to alter the experience of being in a body in order to improve the health and wellbeing [2-5].
Combined use of Virtual Reality and Eye-Tracking

Eye-Tracking feature integrated in the VR Head Mounted Displays (HMD) enables researchers to:
- **directly and continuously** record participants' saccades toward visual stimuli in **real time** [6].
- get a **detailed, direct and objective assessment** of the attentional patterns, bringing out avoidance and engagement with stimuli over time (e.g., with food-cue or specific body parts of participants).

ET-based methods are **ecologically valid**, as they can be used to study the attentional patterns on a more naturalistic visual array in comparison with other methods (stroop task or dot probe) [7].

First VR-based Attentional Bias Modification Task

- Adapted to VR from Smeets et al. (2011) [8].
- Projection of geometric figures in a balanced way between weight and non-weight related body areas (defined from PASTAS questionnaire) [9].

Areas Of Interest*


Project purpose

Increasing the efficacy of Mirror Exposure Therapies (MET) by incorporating Attentional Bias Modification Task (ABMT) into MET in the treatment of women with anorexia nervosa (AN)

Will the mirror exposure treatment’s efficacy increase by previously reducing the attentional bias?
OBJECTIVE: Optimize the Attentional Bias Modification Task duration and the user experience

First step: pilot study
Participants: 58 college women, divided into two groups depending on baseline AB (non-weight related predominant vs. weight-related Attentional Bias predominant).

Study allowed us to determine that **150 trials (2 series of 75 trials)** of figures’ projection onto the avatar were sufficient to produce a significant reduction in Attentional Bias measures (both Complete Fixation Time and Number of Fixations) [10].

Also, we checked that the user experience was acceptable.

OBJECTIVE: 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?
The treatment at the ED Unit consisted of individual and group cognitive-behavioral therapy, nutritional rehabilitation and individual and group parent counseling.

Cases description

**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>Age</td>
<td>14 y.o.</td>
<td>16 y.o.</td>
<td>17 y.o.</td>
<td>17 y.o.</td>
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<tr>
<td>Comorbidity</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>Pharmacological treatment</td>
<td>Antidepressants and antipsychotics</td>
<td>no</td>
<td>Antidepressants and occasional anxiolytics</td>
<td>Anxiolytics and antidepressants</td>
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<tr>
<td>Program treatment*</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
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
Virtual reality environment

Full Body Motion Tracking

HTC Vive HMD
Hand Controller
Foot Tracker
<table>
<thead>
<tr>
<th></th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Immersion in the virtual environment</td>
</tr>
<tr>
<td>2</td>
<td>Full body ownership illusion</td>
</tr>
<tr>
<td>3</td>
<td>Attentional bias modification training</td>
</tr>
<tr>
<td>4</td>
<td>Mirror exposure therapy</td>
</tr>
<tr>
<td>5</td>
<td>Exposure to a relaxing environment</td>
</tr>
</tbody>
</table>
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
Attentional bias modification training
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.

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>
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</thead>
<tbody>
<tr>
<td><strong>Body weight</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Body Mass Index (BMI)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Body dissatisfaction</strong></td>
<td>Spanish version of the <strong>Body Dissatisfaction subscale</strong> of the Eating Disorder Inventory-3 (EDI-BD)</td>
</tr>
<tr>
<td><strong>Drive for thinness</strong></td>
<td>Spanish version of the <strong>Drive for Thinness subscale</strong> of the Eating Disorder Inventory-3 (EDI-DT)</td>
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<tr>
<td><strong>State weight-related body parts anxiety</strong></td>
<td><strong>Physical Appearance State and Trait Anxiety Scale (PASTAS)</strong></td>
</tr>
<tr>
<td><strong>Body-checking behaviors</strong></td>
<td><strong>Body Checking Questionnaire (BCQ)</strong></td>
</tr>
<tr>
<td><strong>Body appreciation</strong></td>
<td><strong>Body Appreciation Scale (BAS)</strong></td>
</tr>
</tbody>
</table>

**Full Body Ownership Illusion (FBOI)**: Visual Analogue Scales (VAS) from 0 to 100

**Fear of Gaining Weight**: Anxiety
**RESULTS:** body mass index

BMI increased slightly at post-treatment assessment (except for patient 1) without reaching the minimum healthy weight.
**RESULTS: Patient 1**

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.

*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.

**RESULTS: Patient 2**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Pre</th>
<th>Post</th>
<th>RCI: 0.59</th>
<th>RCI: 0</th>
<th>RCI: 5.1*</th>
<th>RCI: 1.31</th>
<th>RCI: -0.68</th>
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<tbody>
<tr>
<td>Body Dissatisfaction</td>
<td>34</td>
<td>31</td>
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<tr>
<td>Drive for Thinness</td>
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<td>28</td>
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<tr>
<td>Body Anxiety</td>
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<td>11</td>
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<td>Body Checking Behaviour</td>
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<td>90</td>
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<tr>
<td>Body Appreciation</td>
<td>15</td>
<td>18</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*Significant difference RCI > 1.96

**FEAR OF GAINING WEIGHT**

**ANXIETY**

**FBOI**

*VISUAL ANALOGUE SCALES*
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.

*Significant difference RCI >1.96*
**RESULTS:** Patient 4

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:** 2.18*  
- **RCI:** 2.32*  
- **RCI:** -1.7  
- **RCI:** 1.42  
- **RCI:** -5*  

*Significant difference RCI >1.96

**VISUAL ANALOGUE SCALES**

**FEAR OF GAINING WEIGHT**

**ANXIETY**

**FBOI**
Discussion

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
OBJECTIVE: Increasing the efficacy of MET by incorporating ABMT into MET in controlled randomized clinical study

Will the mirror exposure treatment’s efficacy increase by previously reducing the attentional bias?
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
Conclusions

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.

VR and ET technologies might improve research and clinical practice in AN by providing new tools to help patients confront their core fears (i.e., food- or weight-related cues) and improve their emotional, cognitive, and behavioral responses to their body image.
Thank you!

Questions?

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