

Body Perception Treatment, a possible way to treat body image disturbance in eating disorders. A case-control efficacy study.

Preprint version

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Introduction

In recent years, researchers and clinicians have been increasingly interested in body awareness and disorders related to body perception [1, 2]. In particular, altered bodily self-perceptions are observed and described in psychiatric and neurological literature [3]. An altered perception of one's own body is a frequent symptom in eating disorders (E.D.) [4]. This symptom is often observed and described in Anorexia Nervosa (AN) and Bulimia Nervosa (B.N.) but recently in Binge Eating Disorder (BED) as well [5]. Scientific literature refers to this perceptual alteration in multiple ways: body image disturbance [1], body image discrepancy [6], body image self-discrepancy [7], body image distortion [8, 9], disturbed body image [10], disturbance in body estimation [11], body dissatisfaction [12]. The DSM-5 [13] describes it through the following definition: "disturbance in the way in which one's body weight or shape is experienced." Therefore, in this paper, the term "body image disturbance" (BID) is preferred to others, as it appears more in line with the DSM-5 description.

The Body Image Disturbance

Body image disturbance is usually described as a condition in which three different body-related components are disturbed: the affective, cognitive, and perceptual [14, 15]. The affective component includes feelings and emotions related to the body and bodily satisfaction/dissatisfaction [16, 17]. The cognitive component includes thoughts and beliefs about one's body and shape; it also consists of a conscious mental representation of one's body [15, 17, 18]. Finally, the perceptual one is characterized by alterations in the estimation of body shapes and sizes. It also includes misperceptions of one's own body, including visual, tactile, interoceptive, and proprioceptive perception [19].

Sometimes, the term "body dissatisfaction" is also used to refer to BID indiscriminately [12]. Here, we suggest using the expression "body dissatisfaction," referring it only to the cognitive and affective components of the BID. Therefore, we call to use the term "body image disturbance" when body dissatisfaction is accompanied by alterations in the perception of the body [20].

Body dissatisfaction and body image disturbance are closely related. Body dissatisfaction is influenced by personal, interpersonal, cultural, and ethnic variables [21–27], is a significant risk factor for E.D., and is a prodrome of BID [28–30]. BID is also related to unpleasant emotions such as shame, disgust, anxiety [31], and experiential avoidance behaviors [32]. Moreover, BID often persists in eating disorders after completing treatments [33–34], increasing the risk of relapse [35].

Finally, effective body image interventions could improve patients' prognosis in patients with E.D. [36], as Bruch [37] claimed.

Treatments for the body image disturbance

To date, most BID treatments are focused on the affective and cognitive components of the disturbance (e.g., CBT-E [39], Body Project [40], Body Wise [41]), but not on perceptual ones. Recently, other specific BID treatments focused on the perceptive component have been introduced (e.g., mirror exposure (M.E.) and virtual reality body swapping (VR-BS) [30, 42]). Mirror exposure is a cognitive-behavioral technique for the treatment of BID. However, as Griffen et al. underline (2018) [30], M.E. has a medium-small therapeutic effect on BID. Furthermore, ME focuses only on visual perception and does not involve multiple sensory modalities, as recently recommended by Engels et al. (2017) [34].

The VR-body swapping, a novel multi-perceptive treatment for the BID, improves one's body perception. The VR-BS uses virtual reality to promote a more realistic body perception and works within a neuroscientific theoretical framework. This treatment is promising but provides, at the moment, only a short-term effect [42]. Nowadays, significant developments for the treatment of BID are needed. In line with these data, a meta-analytic review (2015) found that current stand-alone body image interventions have small clinical effects in patients with E.D. [43]. Finally, a recent review has shown that evidence regarding additional effects of specific BID treatments added to standards E.D.s therapies are unclear [44].

Body Image and Body Schema

The idea of multiple mental representations of the body was born at the beginning of the last century [45]. Over the years, two concepts have found a significant consensus and diffusion in research: "body image" and "body schema" [46]. The term "body image" was officially introduced by Schilder [47–49], and his widely used definition is: *"body image is the picture of our own body we form in our mind, that is to say the way in which the body appears to ourselves."* With "body image," we currently refer to a conscious mental representation of one's own body, which involves affects, attitudes, and cognition [50 - 51]. Evidence, observed with the body size estimate (BSE) tasks, shows that patients with BID have an oversized body image [52].

The term "body schema" was born in the early 1900s [53] and was initially used to describe a simplified map-like body mental representation. This map would allow the mind to be informed about the spatial arrangement of the different parts of the body. Nowadays, the definition of "body schema" varies from separate research areas [19, 54, 55] favoring terminological confusion. Keizer and colleagues (2013) suggest the following definition: "[body schema is] an unconscious, sensorimotor, representation of the body that is invoked in action" [56]. Following the current reference literature [54, 57], with the term "body schema," we refer to a fluid body representation, which is fundamental in sensory and motor processes [58] and tool-use [59]. This function integrates different perceptive inputs such as visual, proprioceptive, interoceptive, and vestibular inputs [57] to create updated body representations that allow coordinated movements [60] and also imagery motor simulations [54]. Evidence suggests that patients with BID show an overestimated body schema as well [61].

Besides "body image" and "body schema," other concepts were born to explain the subjective experience of one's own body. For instance, Riva has recently assumed (2017) the existence of six different body mental representations, all interacting with each other [46]. In light of this and other recent studies [58, 62], using only the terms "body schema" and "body image" to describe the different mental representations of the body appears simplistic. Moreover, various authors' use of such terms has shown terminological confusion over the years [50, 51, 63].

Tactile form

In addition to body image and body schema, a third body form representation was hypothesized [58, 62]. The "tactile form," a term proposed by Gadsby [57], is an additional higher-order representation of the body respect of primary somatosensory representation. This mental body map would allow the correct localization of tactile sensations on the skin surface [57], and it would be altered in patients with BID as well as body image and body schema [64]. Evidence showed that AN patients have an inappropriate mental image of their body and overestimate the distance between two tactile stimuli applied on their skin [65, 66]. Tactile perception plays a fundamental role in one's body perception, as described in the well-known "Rubber Hand Illusion" [67]. Finally, research shows that E.D. patients exhibit distortion in body image, body schema, and tactile form [65, 66, 67, 69].

Neuroscience and body image disturbance

The research focused on the perception of one's body has increased over the last years [14, 46, 70] and neuroscientists have been improving our knowledge on AN [1, 58, 62, 71]. A recent review (Gaudio, 2016) describes functional brain alterations related to body signal integration/processing, probably sustaining the BID in AN [72]. Furthermore, some of these neuroimaging studies are supporting [14, 73] an interesting hypothesis: the Allocentric Lock Hypothesis (ALH) [75]. Evidence indicates that our bodily experience involved two kinds of frames [75 - 76]: egocentric and allocentric. The egocentric frame is an integrated representation of the present state of the body constantly created by multiple perceptions. The allocentric frame is a long-term body memory that involves knowledge about the body and drives the third-person mental representation of one's own body. In healthy subjects, these two frames would influence each other [77]. However, what happens in the body image disturbance? ALH suggests that E.D. patients with BID are locked in an allocentric long-term negative "body memory." The egocentric representation of the body would not be able to update the allocentric representation, leading the patients to stay locked in a negative bodily representation [74].[\[3\]](#)

The idea of a "body memory" was proposed by Merleau-Ponty [78], revised by O'Shaughnessy [79, 80] in the "long term body memory," and has recently been taken up by several authors [46, 54, 57]. This idea is useful, we assume, to more deeply understand the body image disturbance [81]. In this way, the experience of being a body (and therefore the perception of this) is created by a constant processing of integration of multisensory bodily information [82]. This information is partially stored like body memories (i.e., as body images and bodily sensations) and partially obtained through the multisensory stimuli of the present moment (visual, tactile, proprioceptive, and interoceptive stimuli) [60]. Negative or altered body memories could therefore influence the body's perception in patients with BID. Moreover, negative emotions such as shame, [83] disgust, and anxiety related to the visual, proprioceptive, interoceptive, and tactile altered self-perception [30,

84] could reduce the somatosensorial bottom-up re-updating process through, we suppose, avoidance mechanisms [85] and top-down processes [86].

From this perspective, we have developed the Body Perception Treatment (BPT). We hypothesize that, through repeated egocentric exercises on proprioceptive, interoceptive, and tactile bodily self-perception, the allocentric "long term body memory" could gradually unlock and update with correct information about one's own body. This process would lead to a gradual reshaping of the shapes and dimensions of the body perceived and creates new bodily memories, thus reducing the body image disturbance.

Aim of the study

The present study aims at verifying additional effects of BPT added to a standard in-patients protocol for eating disorders, previously described [87, 88]. More specifically, the study aims at verifying whether there was a more remarkable and statistically significant improvement in the experimental group that participated in BPT activities compared to the control group. Furthermore, the study compared a highly individualized in-patients protocol for eating disorders (TAU) vs. the same protocol added with BPT activities (TAU+BPT). We will focus on the psychological traits strictly related to eating disorders, body uneasiness, and the global psychological symptoms using the following psychometric instruments: The Global Psychological Maladjustment (GPM) of the Eating Disorder Inventory-3 (EDI-3) [89 - 92], the Global Severity Index of the Body Uneasiness Test (BUT) [93 - 94], and the Global Severity Index of the Symptom Check List Questionnaire-90 (SCL-90) [95].

Methods

SETTING AND PARTECIPANTS

We conducted this study in the ward to treat Eating Disorders of the Private-Accredited Hospital "Maria Luigia" in Monticelli Terme (Emilia Romagna, Italy). Previous research has already described the therapeutic-rehabilitation program for the E.D. treatment used in the ward [87, 88]. It is a highly individualized and flexible protocol inspired by the bio-psycho-social paradigm, implemented with specific cognitive-behavioral techniques. The treatment is integrated and provided by a multidisciplinary team that includes: neurologists, psychiatrists, nutritionists-dietitians, internists, psychologists, psychiatric rehabilitators, psychomotor therapists, psychiatric nurses, and a social worker [96]. The program deals with both primary (food restriction, binge eating, purging, and weight control) and secondary (low self-esteem, clinical perfectionism, mood intolerance, body uneasiness, and interpersonal problems) aspects of E.D.s. Additionally, the treatment aims at improving autonomy in the management of relationships and favors patients' return to their homes and living places. A weekly 60-minute Cognitive Behavioral Body Image Therapy group was performed [97]. This group was inspired by the manualized Cash's treatment "The Body Image Workbook" [98]. All the sample (N=182) participate in the "Body Image" group for 12 weeks. Only the experimental group (N=91) participated in the Body Perception Treatment protocol.

Body Perception Treatment (BPT)

The BPT is a specific body-oriented rehabilitation treatment for body image disturbance. In comparison to other specific treatments [30, 39 - 42], BPT is mainly focused on the perceptive component of body image disturbance [81] and more specifically on proprioceptive, interoceptive [99], and tactile self-perception [100]. BPT protocol involves patients in two weekly groups: "body

schema" and "body perception." The treatment was applied every week for the entire duration of the hospitalization (MEAN=89.20 days SD=±33.77; 12 weeks).

The "body schema" intervention (60-minute sessions), focused on interoceptive and proprioceptive perception, is inspired by Jacobson's progressive muscle relaxation [101]. The exercise is improved by breath control [102] and focused attention techniques [103 - 104]. The "body schema" intervention aims to become aware of the different parts of the body in movement and subject to muscle contraction and relaxation. Besides, patients are invited to perceive muscle tension, heartbeat, breath flow, and other possible internal bodily sensations. The gradual state of induced relaxation facilitates proprioceptive and interoceptive experiences in a supine position with eyes closed. At the end of the exercise, a debriefing phase is scheduled. Patients are invited to share in the group the body sensations and any difficulties experienced.

The "body perception" intervention (90-minute sessions) aims at leading patients to become aware of their bodily sensations and misperceptions [105 - 106], promoting a more realistic body image and reducing avoidance behaviors related to bodily sensations [107 - 108]. The intervention is focused on proprioceptive and tactile perception. At the beginning of each session, a brief psychoeducational introduction (about 10 minutes) is scheduled. This brief session aims to prevent experiential avoidance related to the body self-perception, promote a climate of confidence, anticipate and normalize possible negative perceptive experiences, and explain the aims of the intervention. Then, a light relaxation through breath control techniques and focused attention is induced. After this step, patients are guided into a self-perception body-oriented experience. The psychiatric rehabilitator invites patients to lie down on their backs in the supine position and close their eyes. Then he guides patients to selectively focus attention on the different body parts in contact with the floor [100]. In order: feet, calves, thighs, back, shoulders, hands, arms, head. Finally, the body in its entirety. In addition, patients are invited to pay attention to skin sensations in contact with clothes. At the end of this body perception experience, patients are invited to: draw their own body, evaluate the level of general and specific distress for the different parts of the body and describe the perceptual experience in written narrative form. The next step is a debriefing phase lasting 20 minutes, during which patients can share their experiences. Besides, cognitive and behavioral aspects related to the BID are examined and more in-depth discussed in the group. [19, 109 – 112].

Sampling

Considering a 95% confidence interval ($z = 1.96$), a standard deviation of 0.5 (worst hypothesis), and an error probability of $\pm 5\%$ ($\alpha = 0.05$), we obtain that each arm of the trial required at least 75 patients. In the control group (TAU), we included the last 91 patients who completed their therapeutic admission before introducing the BPT. In the experimental group (TAU+BPT), the first 91 patients were added since the introduction of the BPT. We identified three inclusion criteria: to be 14 years of age or older, have an E.D.s diagnosis (AN, B.N., BED or EDNOS/OSFED) according to the DSM-IV-TR [113] for TAU, and DSM-5 [13] for TAU+BPT, and hospitalized for not less than 30 days. BPT activities were introduced in mid-2013. The TAU group was made up of E.D. patients admitted in the hospital ward from the end of 2009 to the first half of 2013. The TAU+BPT group of E.D. patients was admitted between mid-2013 and mid-2017. Both groups (TAU and TAU+BPT) participated in the activities described by the rehabilitative therapeutic protocol used by the hospital. However, TAU did not be involved in Body Perception Treatment activity. Instead, in the TAU+BPT group, the BPT treatment lasted for the entire duration of the hospitalization. All patients (AN, B.N., BED, or EDNOS/OSFED patients) admitted to the hospital's ward who met inclusion criteria in the period considered (end 2009 – mid-2017) were recruited in the study.

Sample

The entire sample consists of 182 patients admitted with a diagnosis of eating disorders (AN, B.N., BED, or EDNOS/OSFED) at the "Maria Luigia" Hospital. Diagnosis in TAU (N=91) was performed according to DSM-IV-TR. Instead, in TAU+BPT (N=91), DSM-5 diagnostic criteria were used. The mean age of the TAU group was 32.29 years (SD=±12.55), and only eight patients (8.69%) are males. In the TAU+BPT group, the mean age was 30.83 years (SD=±13.21), and only six patients (N=6.52%) are males. There are no statistically significant differences for age ($Z=1.19$; $p=0.12$) and sex ($X^2=0.31$; $df=1$; $p=0.58$) in the two groups. The mean duration of hospitalization is 107.97 days (SD=±35.9) for TAU and 89.20 days (SD=±35.9) for TAU+BPT. This difference is statistically significant ($Z=2.30$; $p<0.001$). The TAU group was more composed of nonspecific ED diagnoses (EDNOS = 64.83%) than TAU + BPT (OSFED = 42.86%). The differences between the diagnoses in the two groups are significant ($X^2=9.51$; $df=3$; $p=0.02$). The pre-post analysis's means and standard deviations are in Table 3, the incidence of the diagnoses in the two groups, and all other sample data are in Table 1.

Information collection

We collected the following information through a sociodemographic sheet and analysis of medical records:

Interval variables: Age, Duration of hospitalization (days), Duration of amenorrhea (days), Weight at the appearance of amenorrhea (in kilograms), Weight at admission (in kilograms), Height at admission (in meters), BMI at admission, Premorbid Weight (in kilograms), Minimum Weight achieved in life (in kilograms), Heaviest Weight in life (in kilograms), time passed since an eating disorder was diagnosed (in days), Age of the first diet, Weight at the beginning of the first diet (in kilograms), psychometric instruments (EDI-3, BUT and SCL-90) score at admission and discharge;

Categorical and ordinal variables: Sex, Diagnosis of Eating Disorder, Frequency of menstruation, Presence of another psychiatric disorder in comorbidity. Patients were also asked whether they ever had psychotherapy after diagnosing eating disorders and whether they were sexually abused.

PSYCHOMETRIC INSTRUMENTS

The Eating Disorder Inventory 3 (EDI-3) represents an expansion and improvement of the earlier versions of the EDI, a self-report questionnaire widely used in research and clinical settings to assess eating disorders' symptoms and psychological features [89 - 90]. It consists of 91 questions, and items are rated on a 6-point Likert-type scale (always, usually, often, sometimes, rarely, never) with higher scores representing more severe symptoms [91 - 92]. For this study, we used the Global Psychological Maladjustment (GPM) of EDI-3. GPM consists of the summed T-scores of all nine psychological subscales (low self-esteem, personal alienation, interpersonal insecurity, interpersonal alienation, interoceptive deficits, emotional dysregulation, perfectionism, asceticism, maturity fears) EDI-3. These scales represent personality traits often related to patients with eating disorders. Regarding the psychometric characteristics described in the scientific literature, these EDI-3 subscales discriminated significantly and strongly between patients and non-clinical controls; the internal consistency of the item scores was satisfactory, showing an α value > 0.80 . Thus, the reliability of these EDI-3's psychological scales is excellent (Cronbach's $\alpha=.90-.97$; test-retest $r=.98$) [114 – 134]. Furthermore, research suggests that the GPM index we used is related to a higher risk for developing an eating disorder [135].

The Body Uneasiness Test (BUT) is a self-administered questionnaire specifically designed to explore several areas in clinical and non-clinical populations: body shape and weight dissatisfaction, avoidance, compulsive control behaviors, detachment and estrangement feelings toward one's own body, specific worries about particular body parts, shapes or functions. Higher scores indicate more considerable body uneasiness [94]. For our study, we used the Global Severity Index of the BUT (B-GSI). The validation of the questionnaire [93] highlighted a satisfactory internal consistency for all the subscales (Cronbach's $\alpha=.69-.90$) and, for the Global Severity Index, a significant test-retest correlation coefficient ($r=.90$) for E.D. subjects.

The Symptom Checklist-90 (SCL-90) [95] is a brief self-report questionnaire. It consists of 90 items describing nine symptom dimensions: Somatization; Obsessive-Compulsive; Interpersonal Sensitivity; Depression; Anxiety; Hostility; Phobic Anxiety; Paranoid Ideation; and Psychoticism. We used the subscale Global Severity Index of SCL-90 (GSI) for our study, which measures the general psychopathological state.

Statistical Analysis

Normal distribution was calculated using the Kolmogorov-Smirnov Test. Variables were described as frequencies or mean values and standard deviations. In comparing different sub-populations, χ^2 and t-test or Kolmogorov-Smirnov test were used to analyze categorical and non-categorical variables, respectively, with significance levels of $p<.05$. The pre/post analysis of the EDI-3, BUT, and SCL-90 questionnaires scores for the entire population and the two subgroups was performed using the student t (for normal distribution) and the Wilcoxon test (for not normal distribution). The analysis to verify the presence of statistically significant differences between the delta (Δ) of the score of the three questionnaires ($\Delta =$ assessment at discharge - assessment at the entrance) between the two subpopulations was calculated using t (for normal distribution) and the Wilcoxon test (for not normal distribution). All statistical analyses were performed using SPSS 22

Results

The comparison between the two subpopulations (TAU vs. TAU+BPT) shows a substantial homogeneity of the groups. Only three variables emerge with statistically significant differences: the duration of the average hospitalization (measured in days) is more significant in TAU (107.97; $SD=\pm 35.90$ vs. 89.20; $SD=\pm 33.77$; $p<.001$), unlike the average score at the entrance to the EDI-3, which is greater in TAU+BPT (117.873; $SD=\pm 40.72$ vs. 78.24; $SD=\pm 39.88$; $p<.001$). Even the distribution of the different types of eating disorder is not homogeneous: the TAU+BPT group is characterized by higher percentages of patients with AN (16.48% vs. 10.99%), B.N. (31.87% vs. 21.98%), and BED (7.69% vs. 2.20%) while the control group has a greater percentage of EDNOS/OSFED (64.83% vs. 42.86%). In addition, the proportions of patients with AN, B.N., BED and EDNOS/OSFED are significantly different ($p=.02$).

The pre/post analysis (evaluation at admission and demission, Table 2) showed a statistically significant improvement in the scores of all three questionnaires in TAU+BPT: BUT ($t=7.55$, $df=78$, $p<.001$), SCL-90 ($Z=-6.57$, $p<.001$), and EDI-3 ($t=-6.50$, $p<.001$). Improvements were observed in TAU for the SCL-90 ($Z=-2.05$, $p=.04$) and EDI-3 scores ($Z=-3.36$, $p=.001$). No significant improvements ($t=1.42$, $df=90$, $p=.158$) were observed for the TAU group's body uneasiness (BUT). Deltas analysis ($\Delta =$ assessment at discharge - assessment at admission) showed statistically significant differences (Table 3). In fact TAU+BPT was superior for all the three variables studied in relation to TAU: BUT ($t=6.15$, $df=168$, $p<.001$), SCL-90 ($Z=-5.45$; $p<.001$) and EDI-3 ($Z=-4.50$, $p<.001$).

Limitations

Our study has some limits. First of all, it is not a Randomized Control Trial (RCT). Therefore, sampling occurred on a time basis and not by randomization. Furthermore, the diagnostic criteria used to describe the TAU group refer to the DSM-IV-TR, those used for TAU+BPT refer to the DSM-5. However, no significant changes, except the introduction of BPT for the trial, have been introduced in Maria Luigia Hospital's E.D.s protocol in the observed period. Furthermore, it was impossible to calculate reliability indices (e.g., Cronbach's alpha) of EDI-3, SCL-90, and BUT on our sample. The reliability indices indicated are taken from the psychometric validation articles of the tests [90, 93, 95].

Other limitations concern some non-homogeneous variables. The two groups, at the entrance, were not homogeneous for three of all the variables considered (Table 1): duration of hospitalization ($Z=2.30$; $p<0.001$), frequency in diagnoses of eating disorder ($X^2=9.51$; $df=3$; $p=0.02$) and EDI-3's score at admission ($Z=-5.77$; $p<0.001$). The length of hospitalization, shorter in TAU+BPT, is explained by political choices of the national and regional health systems that reduced accredited days of hospitalization for eating disorders. As a result, the average number of days of hospitalization decreased from 107.97 ($SD=\pm 35.90$) for TAU to 89.20 ($SD=\pm 33.77$) for TAU+BPT.

Data show differences in the frequency of E.D.s diagnoses in the two groups. In TAU+BPT, specific diagnoses increased (AN, B.N., and BED), and EDNOS/OSFED cases are reduced. The DSM-5 introduction in 2013 may explain this data. The new edition of the DSM has modified the diagnostic criteria used for E.D., effectively reducing the EDNOS/OSFED prevalence (from 64.83% to 42.86%), thus increasing the incidence of specific E.D.s diagnoses. This result, related to the introduction of the DSM-5, is in line with previous research [115].

Another difference concerns the EDI-3 score at admission. In particular, the TAU+BPT group shows higher admission scores than those in TAU. This finding suggests that, at admission, TAU+BPT showed more severe psychological traits (measured with the GPM scale of EDI-3) than TAU. This data could be explained by an increase, over time, in personality psychopathological characteristics in the type of patients admitted to the Maria Luigia Hospital. Moreover, no follow-up data were analyzed. The analysis of the medium-long term effects of the BPT will be the subject of future studies. Further limitations regard the BPT protocol administration. We studied the BPT in a hospital ward, so it is impossible to generalize results to outpatient. Finally, we did not perform intergroup analyses.

Discussion

The current research aimed to evaluate additional effects of Body Perception Treatment on a therapeutic-rehabilitation protocol for in-patients with E.D. For this study, we compared two clinical sub-populations (TAU vs. TAU+BPT). We studied the sample with three psychometric instruments (SCL-90, EDI-3, and BUT) at hospital admission and discharge. We also analyzed some sociodemographic and anamnestic variables (Table 2). The TAU group performed the treatment, as usual, TAU+BPT group performed BPT activities. The whole sample participated in a weekly cognitive-behavioral group for the body image disturbance for 12 weeks, inspired by Cash's "The body image workbook" [98]. The results presented in Table 1 show that the TAU and TAU+BPT groups were homogeneous for all the variables considered except the three previously described: duration of hospitalization, frequency in eating disorder diagnoses, and EDI-3's GPM score at admission. The homogeneity of groups allows us to affirm that the controlled variables considered (e.g., age, age of the first amenorrhea, BMI at the entrance, premorbid Weight, etc.) have no influence on the additional effects observed in the BPT group and that we are now going to describe. We wondered whether a possible higher frequency of chronic patients in the control group

could have altered the results. Hypothesis testing through analysis of the sociodemographic and anamnestic variables of the two groups suggests excluding this possibility. The homogeneity for all the temporary variables in the two groups (in particular age, age of first amenorrhea, how long have you been diagnosed with eating disorders, etc.) describes a homogeneous distribution also for the chronicity of the eating disorder. So then, the observed results do not seem to be influenced by the possible greater chronicity of the disease in one of the two groups.

The pre/post analysis (Table 2) shows statistically significant improvements for both groups. More specifically, in TAU, we observed improvements at the discharge in the personality traits related to eating disorders and measured with the EDI-3's GPM ($Z=-3.36$, $p=0.001$), and in the general psychopathological state measured with the SCL-90 ($Z=-2.05$, $p=0.04$). No significant improvements in body uneasiness (measured with BUT) were observed in the control group ($t=1.42$, $df=90$, $p=0.158$). Otherwise, TAU+BPT data show improvements for all the three variables considered: EDI-3 ($Z=-6.50$, $p<.001$), SCL-90 ($Z=-6.57$, $p<.001$), and BUT ($t=7.55$, $df=78$, $p<.001$). This lack of improvement in BUT score was unexpected and appeared to be not in line with what was observed in the previous research on Cash's manualized treatment group (Nye, 2006) [116]. A possible explanation concerns the type of patients in the sample. Nye's sample consisted of outpatients, while ours consisted of in-patients. Anyway, this result suggests future insights. However, these data seem to align with recent research showing that BID persists after recovery from eating disorders and is hard to treat [33 - 34]. To confirm that, Alleva et al. (2015) found small-to-medium effects in their Review of stand-alone interventions for improving body image [43]. Furthermore, Ziser et al. (2018) have recently concluded that evidence regarding additional effects of current BID treatments added to standard E.D. protocol is not clear [44]. The partial effectiveness of the treatments available today could be explained by two facts: the first could be that most treatments are focused on the affective and cognitive components of the BID, excluding the perceptual one. As claimed by Dakanalis et al. (2016), "it is now time to consider the development of intervention strategies that target the [body image disturbance's] perceptive component" [81]. The second could be that the current treatments focused on the perceptive component of the BID use visual perception exclusively (e.g., mirror exposure [117 - 118] or video confrontation [119]) and do not involve multiple sensory modalities as the recent research suggests [38, 42, 45, 120, 121]. In fact, a recent review on the effectiveness of mirror exposure (Griffen et al., 2018) found evidence regarding a significant therapeutic enhancement using M.E., but with a small-medium magnitude effect [30]. In line with Engel et al. (2017), we suggest that integrating different sensory stimuli during visual exposure treatment could improve clinical effects [34]. Anyway, further research in this direction is needed.

Returning to data, we analyzed the results to look for additional effects of the BPT on all three psychometric instruments. Table 3 shows statistically significant differences between the Δ of the score of the three questionnaires (Δ = assessment at discharge - assessment at admission) between the two subpopulations. The comparison of the Δ of the BUT, considering the lack of improvement in the control group, was in favor of the BPT group. BPT group shows a significant difference (Δ Mean = 0.90, $SD = \pm 1.07$, $p<0.001$) unlike the control group, which shows non-significant values (Δ Mean = 0.09, $SD = \pm 0.63$, $p=1.158$). Therefore, we observed an additional effect of BPT activities on treatment as usual. These data suggest that BPT effectively reduces body image uneasiness, improving the degree of body satisfaction and the related emotional, cognitive, and behavioral aspects linked to body image and measured with BUT. Anyway, the lack of more specific instruments in our study (e.g., instruments to measure the degree of body misperception, more in-depth questionnaires about self-perception experience and so forth) prevents us from better understanding and describing what has led to BUT improvement. Is it something related to the acceptance of the body [122], improved sense of ownership [123], reduced avoidance behaviors [107], drop in the intensity of negative emotions related to the body, or something else? Clinical observation suggests all these elements and perhaps others. In our opinion, BPT treatment also reduces bodily misperception and leads to a more realistic body perception through repeated

perceptive egocentric experiences. The gradual state of relaxation induced in the BPT exercises could facilitate body awareness through multi-perceptive experiences. These experiences could gradually re-update the allocentric mental representations of the body [74], reducing the body misperception and thus improving the BUT score. However, more in-depth studies are necessary to verify this hypothesis.

Moreover, continuing the discussion and analyzing the general psychopathological state (measured with the GSI of SCL-90), both TAU ($\Delta\text{Mean} = -0.13$, $\text{SD} \pm 0.49$, $p=.04$) and TAU+BPT ($\Delta\text{Mean} = -0.70$, $\text{SD} \pm 0.76$, $p<0.001$) showed improvements. However, the Δ analysis showed a significant difference between these two groups ($Z=-5.45$, $p<.001$). Data show better values for the TAU+BPT group than TAU. Thus, at the end of the treatment, the patients of TAU+BPT were healthier than the controls and showed better SCL-90 scores. We consider these results important but expected, in line with previous research underlining the relationship between positive body image and psychological well-being, widely described in the literature [25, 26, 36, 97]. In this case, it is not surprising that TAU+BPT, which had improvements in BUT, had more significant improvements at the SCL-90. We expected an improvement in body uneasiness to be related to an improvement in the general psychopathological state. The connection between body image and psychological well-being is strong [124, 125]. Furthermore, negative or altered body image was found not only in eating disorders but also in other psychiatric conditions like depression [126], anxiety disorders [127], and PTSD [128], suggesting a still unclear interaction between body image and other common mental diseases. Therefore, we can argue that the BPT intervention, centered on body awareness and multi-perceptive bodily perception, promotes the recovery of the general psychopathological state and the improvement of body uneasiness.

Continuing with data analysis, we measured improvements in psychological traits related to eating disorders and measured with EDI-3. The General Psychological Maladjustment (GPM) we used consists of the summed T-score of the nine psychological scales of EDI-3 (low self-esteem, personal alienation, interpersonal insecurity, interpersonal alienation, interoceptive deficits, emotional dysregulation, perfectionism, asceticism, maturity fears). As previously seen, both groups showed significant improvements in EDI-3. Therefore, we looked for an additional effect of BPT comparing the ΔMean of the two groups (Table 3). Data show a more significant enhancement in the TAU+BPT group ($\Delta=-38.18$ $\text{SD}=\pm 42.58$ $p<0.001$) than TAU ($\Delta=-10.25$ $\text{SD}=\pm 23.55$, $p=0.001$). In addition, the difference in the deltas was statistically significant ($Z=-4.50$, $p<.001$), thus showing a further additional effect of the BPT on TAU. To the authors' knowledge, there is no research about body image disturbance treatments and their possible additional therapeutic effects on psychological traits in eating disorders.

For this reason, this data was unexpected and suggestive. One possible explanation for these results could involve interoceptive awareness and its connection with emotional regulation [129]. More specifically, evidence suggests this connection [129], emphasizing the central role of interoception awareness in the emotional experience and its regulation [130], high cognitive functions, and correlate relationships and behaviors [129, 131, 132, 133]. According to these studies, BPT through interoceptive awareness exercises and, more broadly, favoring a greater awareness of the different body perceptions could gradually improve the emotional dysregulation and then promote significant improvements in the psychological traits measured with the EDI-3's GPM score. Thus, the interoceptive part of the BPT could be the cause of the unexpected improvements observed [89].

What is already known on this subject?

Body image disturbance involves cognitive, affective, and perceptive components, but most treatments (e.g., CBT-E, Body Project, Body Wise) [39, 40, 41] do not focus on the perceptual one. Some treatments, such as mirror exposure (M.E.) [101], have attempted to bridge the gap, showing a medium-low efficacy in BID treatment. Following a cognitive neuroscience approach, body image results from integration processes of different sensory modalities (visual, proprioceptive, interoceptive, tactile) [34]. BID treatments should therefore integrate different sensory modalities

[54]. In our study, we verified the effectiveness of a treatment for body image disturbance (BPT) focused on different sensory modalities (interoceptive, proprioceptive, and tactile) and applied in addition to an E.D. protocol for in-patients.

What does this study add?

Our data show an additional effect of the BPT protocol on the entire treatment and seem to confirm what has recently emerged in the literature: on the one hand, the importance of treatments for BIDs that focus on the perceptive component of the disturbance [38]; on the other hand, the importance of integrating different multisensory perception in the treatment of BID [34]. Moreover, the interoceptive exercises [89] of the BPT could be causing the unexpected improvement observed in the **General Psychological Maladjustment** of the EDI-3, opening up to possible developments. The data confirm the effectiveness of the treatment for the body image disturbance and suggest more detailed studies.

Highlights

Our study has a significantly larger sample (N=182) than most studies on BID treatments [30, 39, 41, 42]. Moreover, we observed a clear and statistically significant additional effect of BPT on the treatment as usual. We consider these data relevant in the body image disturbance and eating disorders fields of research. However, data relating to the effects of specific treatments for BID on E.D. protocol are not clear yet, as pointed out by Ziser et al. [44]. Moreover, the improvement observed in the **General Psychological Maladjustment** of the EDI-3 was unexpected and suggestive and deserved more profound studies.

Conclusion

This study aims at verifying additional effects of Body Perception Treatment on a standard treatment for eating disorder in-patients. BPT is a novel treatment for BID focused on the perceptive component of the disturbance and is characterized by integrating different body perceptions (tactile, proprioceptive, and interoceptive self-perception). The outcomes of this study are encouraging. We observed higher and statistically significant improvements in the BPT group compared to the control group for all the psychometric variables considered (BUT, SCL-90 and EDI-3). These data show that BPT effectively reduces body uneasiness, improves the general psychopathological state, and, unexpectedly, favors the enhancement of personality traits strongly correlated to eating disorders. The improvements observed are in line with the current research regarding the importance of focusing on BID's perceptive component [38] and integrating different sensory stimulations in BID treatments [34, 82]. In particular, the possible explanation for the efficacy of the BPT seems to be in line with what the Allocentric Lock Hypothesis theorized [74, 76]. Thus, repeated experiences of egocentric body perception could, in fact, gradually unlock the allocentric body representations allowing a reduction of bodily misperception. To verify this, new and more in-depth studies must be scheduled. Furthermore, the repeated experiences of interoceptive perception of the BPT could explain the improvements observed in EDI-3. In particular, these data seem to align with the emerging pathway of interoceptive awareness [129, 131, 132, 133] and its role in emotional regulation.

However, the body image disturbance in eating disorders is still not fully understood, and the available treatments need improvements [43, 44]. In particular, it is necessary to develop and improve specific therapies for the perceptive component of the BID [38]. So, we believe that it is possible to enhance the effects observed with the BPT through the integration of other therapeutic techniques focused on the perceptive component of the BID: VR-body swapping [102], Mirror

Exposure [101], or the novelty Hoop Training [119] for example. This integration could help develop increasingly effective treatments, thus deepening our knowledge of BID and improving the prognosis of patients with eating disorders.

Concluding, further studies in different directions are needed. First of all, this study did not analyze the data using the E.D. diagnoses as independent variables. Therefore, it is unclear how BPT leads to observed improvements, mainly how it acts on the body's misperception and is related to the enhancement observed in EDI-3. Moreover, further studies are needed to understand how BPT influences relapse rates, unfortunately still very high in eating disorders, and its effects in the medium and long term. Finally, other studies will be needed to verify the efficacy of BPT for outpatients.

COMPLIANCE WITH ETHICAL STANDARDS:

Conflict of Interest: The authors declare that they have no conflict of interest

Ethical approval: This study adhered to the tenets of the Declaration of Helsinki and was approved by the internal "Comitato Etico Ospedale Maria Luigia" ethics committee.

Informed Consent: participants in the TAU+BPT group provided written Informed Consent before their participation. Information about the comparison group (TAU) was collected retrospectively from medical records.

Level of Evidence:

Level II: controlled trial without randomization

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[3] The reader interested could deepen this hypothesis reading Riva G. *Allocentric lock in anorexia nervosa: New evidence from neuroimaging studies*, *Medical Hypotheses*, Volume 79, Issue 1, 2012, Pages 113-117, ISSN 0306-9877, <https://doi.org/10.1016/j.mehy.2012.03.036>.