Abstract: Body image disturbances are a prominent feature of eating disorders (EDs). Our aim was to validate a new computerized assessment of body image (CABI), simulating changes in one's own image, for this purpose we administered the Contour Drawing Rating Scale (CDRS), the CABI and the Eating Disorder Inventory-2-Body Dissatisfaction Scale to 22 inpatients with restricting anorexia nervosa (AN), 22 with binge/purge AN, 20 with bulimia nervosa (BN), and 41 healthy controls. All three scales differentiated patients with EDs from controls. Nonetheless, patients with AN and controls were more disturbed than those with BN on the CDRS, whereas a greater disturbance on some CABI dimensions was shown in patients with AN vs. BN. Our findings support the validity of the CABI in the comparison of body image disturbances in patients with EDs, and allow for better understanding of the differences in body image disturbances in different types of EDs.
Prof. Tom F. Cash  
Editor-in-Chief  
Body Image Journal  

May 3, 2015

Enclosed please find our article titled "Computerized Assessment of Body Image in Anorexia Nervosa and Bulimia Nervosa: Comparison with Standardized Body Image Assessment Tools ", which we submit to peer reviewing in the Body Image Journal.

Looking forward to know your evaluation of this work,

Sincerely,

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Computerized Assessment of Body Image in Anorexia Nervosa and Bulimia Nervosa: Comparison with Standardized Body Image Assessment Tools

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**Highlights**

- Applying a computerized self-image tool to assess body image disturbances in ED patients.
- Comparing it to standardized verbal-affective and perceptual tools.
- This computerized tool may be more sensitive in the assessment of body image in EDs.
- Multimodal research strategy enables better understanding of body-image disturbances.
Computerized Assessment of Body Image in Anorexia Nervosa and Bulimia Nervosa: Comparison with Standardized Body Image Assessment Tools

Dysfunctional body image represents a core feature of both anorexia nervosa (AN) and bulimia nervosa (BN) (Cash & Deagle, 1997; J. K. Thompson, 1997; Tovee, Benson, Emery, Mason, & Cohen-Tovee, 2003). Thus, prospective longitudinal studies have shown that the severity of body-image disturbance is a powerful predictor for the development of eating-related disturbances in adolescent (Leon, Fulkerson, Perry, & Early-Zald, 1995) and adult females (Striegel-Moore, Silberstein, Frensch, & Rodin, 1989), for an overall unfavorable prognosis in the course of AN (Smith, Feldman, Nasserbakht, & Steiner, 1993) and BN (Trentowska, Bender, & Tuschen-Caffier, 2013), and for the likelihood of relapse in recovered patients with AN (Keel, Dorer, Franko, Jackson, & Herzog, 2005; Skrzypek, Wehmeier, & Remschmidt, 2001) and BN (Fairburn, Peveler, Jones, Hope, & Doll, 1993).

An intricate interplay of multi-faceted factors may account for the disturbed body image seen in patients with eating disorders (EDs). It is firstly associated with a derangement in visuospatial ability, i.e., in the accuracy of estimation (Skrzypek et al., 2001; Waldman, Loomes, Mountford, & Tchanturia, 2013) likely leading to perceptual overestimation in both AN (Skrzypek et al., 2001; Waldman et al., 2013), and BN patients (Mohr et al., 2011). Still, body image includes also an attitudinal modality (Cash & Deagle, 1997) consisting of cognitive-evaluative (e.g., body dissatisfaction), cognitive-behavioral (e.g., avoiding mirror gazing or body checking), and affective (e.g., situational body image-related dysphoria) dimensions (Cash & Deagle, 1997; Probst, Vandereycken, Van Coppenolle, & Pieters, 1999).

More specifically female patients with an ED tend to overestimate particularly their own appearance (and to some extent other female figures), whereas only a minimal distortion is found for non-human figures (Benninghoven, Raykowski, Solzbacher, Kunzendorf, &
Jantschek, 2007; Cash & Deagle, 1997; Probst et al., 1999; Skrzypek et al., 2001). Moreover, body dissatisfaction has been related to a greater extent to the difference found between ideal and perceived appearance, than to the difference between ideal appearance and actual weight (Joiner, Heatherton, Rudd, & Schmidt, 1997). In the same token, subjective distress associated with body image has been tied more closely than the perceptual accuracy component of body image to the development of EDs (Cash & Deagle, 1997), although an association between the two dimensions has been shown in patients with an ED (Cash & Deagle, 1997; Striegel-Moore et al., 1989; Waldman et al., 2013).

It is difficult to optimize specific tools for the assessment of body image due to its multi-faceted nature. Today, two main strategies are applied for the assessment of affective and perceptual aspects. The first, consisting of questionnaires, evaluates body-related affective aspects; the second focuses on perceptual accuracy and evaluates perceptual measures (J. K. Thompson, 1997).

Despite extensive use, both strategies may have considerable limitations. Inherently, questionnaires evaluate body image in an indirect manner, and usually conceptualize body satisfaction as a uni-dimensional rather than a multi-dimensional construct. The most significant drawback of perceptual measures is that they do not assess the participant’s own image, nor do they have the potential to measure the distortion interactively, during the assessment process.

Several new strategies for the assessment of body image disturbance have been recently implemented, in an attempt to overcome some of these limitations. One strategy is based on standardized quantitative assessment software systems, which use biometric data based on real body shapes. A few studies have previously assessed body image disturbances in patients with EDs using software measures. Most of these studies (Benninghoven et al.,
2007; Ferrer-García & Gutierrez-Maldonado, 2008; Overas, Kapstad, Brunborg, Landro, & Lask, 2014; Roy & Forest, 2007) although not all (Tovee et al., 2003), have shown greater body size overestimation in patients with AN and BN vs. non-ED controls. In addition, Ferrer-García & Gutiérrez-Maldonado (Ferrer-Garcia & Gutierrez-Maldonado, 2008) have shown that control individual considered at risk of developing an ED (i.e., showing pathological scores on the Eating Attitudes Test-26 (EAT-26) and the Eating Disorder Inventory-2 (EDI-2) reveal greater overestimation of body size in comparison to a not-at-risk group. Lastly, Roy and Meilleur (Roy, 2010) have shown a decrease in body image distortion in 70% of patients with AN following inpatient treatment.

Hence, we developed a new instrument for the assessment of body image, the Computerized Assessment of Body Image (CABI) (Harari, Furst, Kiryati, Caspi, & Davidson, 2001). Our primary aim was to assess the validity of the CABI in comparison to the existing body assessment methods in particular the widely used perceptual Contour Drawing Rating Scale (CDRS) (M. A. Thompson & Gray, 1995) and the Body Dissatisfaction scale of the EDI-2 (EDI-2-BD) (27). The comparison between the CABI, CDRS and EDI-2-BD was carried out with respect to the perceptual, affective, and ideal-related dimensions of body image. Our secondary aims were to compare body image disturbances in different ED types, and to assess the factors affecting body image. We hypothesized that the CABI will be found a valid tool for the assessment of body image in patients with an ED when compared with standardized measures. Secondly, although all patients with EDs will show a greater disturbance in all aspects of body image in comparison to non-ED controls with all tools used, malnourished AN patients will be more disturbed than normal weight BN patients, particularly in those measurements taken with the CABI.
METHODS

Participants

The study included 22 inpatients diagnosed with DSM-IV (APA, 1994): restrictive type AN (AN-R), 22 inpatients diagnosed with binge/purge type AN (AN-B/P), 20 inpatients diagnosed with BN, and 41 healthy controls. All patients were hospitalized in the adolescent and adult inpatient ED departments at the Chaim Sheba Medical Center, Tel Hashomer, Israel. Inclusion criteria comprised of female gender between the ages of 15 to 25; exclusion criteria comprised of lifetime or current schizophrenic spectrum disorder, bipolar disorder, organic-brain disorder, mental retardation, and lifetime or current medical illness that could potentially affect appetite or weight (e.g., diabetes mellitus or thyroid disorders). The patients did not receive any psychotropic medication for at least two weeks prior to their assessment.

Healthy controls included 41 female volunteers between the ages of 15-25 years. Adolescent controls were recruited from families of the staff of the hospital, and adult controls from several universities using advertisements. Healthy controls were matched with the research patients for age, years of schooling, ethnic origin, and catchment area. Healthy controls were required to have no lifetime or current psychiatric disorder, medical disorder or chronic use of medications, and no stigmata indicative of an ED. They were required to have a body mass index (BMI) between 20-25 kg/m² (Bray, 1992), and regular menses since menarche.

All participants and their parents or other legal guardians, in the case of minors under the age of 18, agreed to participate in the study by signing a written informed consent. The study was approved by the local IRB committee. Participation was voluntary and anonymous, and each participant was given coded numbers known only to the principal investigators (D.S., A.C.). Data was analyzed for the whole sample and not for individual participants.
Instruments

Diagnosis of an ED, according to the DSM-IV (Association, 1994) has been established using the Eating Disorders Family History Interview (EDFHI) (Strober, 1987). This is a semi-structured clinical interview designed to gather detailed information on weight and eating history, previously used in studies of ED patients (Kaye et al., 1998) including in Israeli samples (Yackobovitch-Gavan et al., 2009). Other lifetime DSM-IV Axis I psychiatric morbidity was assessed using the Structured Clinical Interview for DSM-IV Axis I Disorders-Patient Edition (SCID-I/P Version 2.0) (First et al., 1993).

Assessment of body-image

Three tools were used for the assessment of body-image: the Contour Drawing Rating Scale (CDRS; 20) consists of 9 female contour images sorted from extreme underweight to extreme overweight. The CDRS has been found to show good validity and test-retest reliability (r=.78; (M. A. Thompson & Gray, 1995), and is accepted as a standardized tool for the assessment of body image disturbances in clinical and community populations (Lombardo, Russo, Lucidi, Iani, & Violani, 2004; M. A. Thompson & Gray, 1995). In the present study, participants have been asked to choose the image that best fits the way they think (perceptual), feel (an affective component), and wish they looked like (ideal body image). Two additional dimensions, assessing the extent of the participants' satisfaction with their perceived images have been constructed by subtracting the ideal body image from these perceptual and affective components of body image.

The Computerized Assessment of Body Image (CABI; 19) displays a realistic pictorial simulation of weight changes, applied to a real source image. The process is based on a method developed for the representation of biological shape modifications (Harari et al., 2001). Still pictures of frontal body images are captured using a digital camera in an adjusted
room sufficiently illuminated for photography purposes. Body parts are identified and marked and then the digital picture is processed by the software. Each body part is separately and independently processed according to its shape-change potential (e.g., arm –cylinder, or abdomen –sphere); facial simulation was not assessed because of technical limitations.

Following this step, the altered body parts are automatically merged back into a whole body with an adjustment of joint areas. As a result, the processed images represent lifelike body shape changes. A single photograph for each individual is taken in uniform conditions related to clothing (full body leotards), background, lighting and position. Twenty-four simulated images were processed and introduced to the participants the day after the photograph has been taken.

The Body-Dissatisfaction Scale of the Eating Disorder Inventory-2 (EDI-2-BD; Garner, 1991), assessing the extent of dissatisfaction with different parts of the body. This scale was used in the present study as an affective body image assessment tool. The EDI-2 has been previously validated in Israeli samples (Yackobovitch-Gavan et al., 2009).

The final results of the image processing steps are a photo series of continuous body shape change simulation scale (i.e., continuous scale). The series contains a random uniform sequence displaying original and transformed images. Four of the images are original (non-simulated, 100% of original weight) whereas the remainder 20 are images with different levels of simulated weight changes (lowest weight 86% of original weight and highest – 116%, see Figure 1; this range is based on that used in previous studies (Stein et al., 2002). In the continuous scale, a graphical slider allows the participant to adjust her body shape until it fits her perceived appearance, while the change in percentage is hidden from her.

A specific non-ordinal pattern of the images has also been applied. Accordingly, participants are asked to estimate whether each self-image presented is an underweight,
overweight or unchanged simulation of her. An Identification Index (CABI-ii) is then constructed, including all identification errors made by the participant, taking into consideration the magnitude of the distortion. Each picture is scored (0) for correct estimation, (1) for a minor error (e.g., an overweight estimation when weight is unchanged), and (2) for a major error (e.g., an overweight estimation when weight is reduced). The CABI-ii also indicates the error's direction, namely whether the participant perceives herself as overweight (-ii), or underweight (+ii) versus her actual weight. The CABI-ii scores range from -48 to +48, when scores closer to zero represent lower body distortion. Following this non-ordinal presentation, the picture series is presented to the participants once more, this time as a continuous scale (ordered from 86-116% of original weight). The participants are asked to choose the picture that best fits their perceptual, affective and ideal body image. This procedure has been similarly applied when using the CDRS.

**Assessment of depression and anxiety**

Depression and anxiety have been assessed because of their known influence on body image in patients with EDs (McCabe, Ricciardelli, Sitaram, & Mikhail, 2006; Overas et al., 2014). Depression has been evaluated using the self-rating Beck Depression Inventory (BDI) (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961), and anxiety with the trait scale, i.e. the general tendency to display anxiety scale) of the State Trait Anxiety Inventory (STAI-Trait) (Spielberger, Gorsuch, & Lushene, 1970). Both scales have been extensively used in patients with EDs (Pollice, Kaye, Greeno, & Weltzin, 1997), including in Israeli samples (Yackobovitch-Gavan et al., 2009).

**Procedure**

Patients were interviewed on admission with the EDFHI and the SCID-I/P version 2.0 by experienced psychiatrists and child and adolescent psychiatrists. Diagnoses were
confirmed in clinical meetings of the teams of the two departments. Healthy controls were similarly interviewed with the EDFHI and the SCID-I/P by a Master's degree psychologist trained in psychiatric interviewing by one of the study's principal investigators (D.S.). The EDI-2-BD, BDI, STAI-Trait, CDRS, and CABI were distributed to the patients in random order by Master's level clinical psychology students within two weeks of admission, upon the stabilization of their medical condition. These tools were similarly administered to the control participants. Evaluations took place in a specific research room in the Sheba Medical Center, which was well illuminated and were carried out individually. All evaluations were performed in the morning hours, at least one hour after the previous meal, to minimize the variability related to feeding conditions. Patients’ weight and height are routinely taken in these departments in the morning hours, using standardized procedures. The weight and height of the control participants were similarly assessed and were taken last to reduce their influence on the other findings.

**Statistical Analysis**

Correlations among the different tools assessing body image disturbance, i.e., the CABI, CDRS, and EDI-2-BD, as well as the correlations between these parameters and the demographic, clinical and psychometric measures introduced, were analyzed using Pearson correlation coefficients for interval parameters and Spearman Rho’s for ordinal parameters.

Due to the large number of measures included in the study, the groups were first compared with multivariate analysis of variance (MANOVA) and then with univariate analysis of variance (ANOVA) for each measure. Post hoc Tukey’s pairwise comparisons were used to determine the specific differences among the four groups. Analysis of covariance (ANCOVA) was used to control for the effect of the between-group differences in age, education, BMI, depression and anxiety on the CDRS, CABI and EDI-2-BD dimensions.
RESULTS

Significant between-group differences were found for age, education level and BMI (see Table 1). Patients with AN-R were significantly younger than both AN-B/P and BN groups, likely resulting in significantly less years of schooling. Healthy controls were not different from any other group in age and education level. Both groups with AN had a significantly lower BMI in comparison to patients with BN and healthy controls. No between-group differences were found for ethnic origin (data not shown).

Using MANOVA we found a significant overall between-group difference for the CDRS and CABI perceptual/affective dimensions and for EDI-2-BD [F(21,265)=4.25, p<.0001]. Table 2 summarizes the specific between-group comparisons for all dimensions. Patients with AN-R, AN-B/P, and BN scored significantly higher on the CABI perceptual and affective body image dimensions compared with the healthy controls. Whereas no between-group differences were found for CABI ideal body image, the difference between the CABI affective and ideal body image dimensions was significantly higher for all ED groups in comparison to the healthy controls. With regard to the difference between the CABI ideal and perceptual body image, only the BN group scored higher than the healthy controls.

The assessment of the CABI-ii revealed that patients with AN-R and AN-B/P scored significantly higher on the perceptual distortion (scores more distant from zero) dimension compared to the controls. Moreover, the CABI-ii score of the two groups with AN was negative, namely they perceived themselves as more overweight than they actually were, compared with the positive score of the controls, who perceived themselves as more underweight than they really were (see Table 2).

Table 2 also summarizes the between-group differences for the CDRS and the EDI-2-BD. Patients with BN showed more pathological scores than the two groups with AN, and the
controls on the CDRS perceptual and affective dimensions. Patients with AN were not
different from control participants in these dimensions. Both groups with AN showed higher
scores on CDRS ideal body image in comparison to controls. On the other hand, patients with
BN scored significantly higher on the difference between the CDRS ideal and perceptual
body image in comparison to patients with AN-R and controls. Lastly, patients with AN-B/P
and BN showed significantly more body dissatisfaction than controls on the EDI-2 (EDI-2-
BD; see Table 2).

The overall between-group difference for depression (BDI) and anxiety (STAI-Trait)
[F(6,162)=8.28, p<.0001] according to the MANOVA was significant. Table 1 summarizes
the specific between group differences for these dimensions. All three groups with an ED
scored significantly higher than the healthy controls on the BDI. While, only patients with AN
showed significantly higher scores on the STAI-Trait in comparison to the healthy controls.

Finally, a considerable portion of the patients had comorbid disorders. The numbers and
percentages for depressive disorders for patients with AN-R, AN-B/P, and BN were 9 (41%),
16 (73%), and 8 (40%), respectively. The respective distribution for anxiety disorders was 2
(9%), 0, and 0, , for obsessive compulsive disorder 3 (14%), 2 (9%), and 3 (15%), and for no
comorbidity 8 (36%), 4 (18%), and 9 (45%). No between-group differences were found for
comorbidity except for depressive disorders (results not shown).

All significant between-group differences for the CDRS were maintained when
controlling for age, years of education, BDI, STAI-Trait, and BMI and for the CABI when
controlling for age, education, and BMI (data not shown). Controlling for BDI and STAI-
Trait maintained the significant between-group differences for the CABI perceptual, affective
and ideal-body image dimensions, but not for the differences between the CABI ideal and
perceptual/affective dimensions (data not shown). Lastly, in the case of the EDI-2-BD, all

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significant between group differences were maintained when controlling for age, education level and BMI, but not when controlling for BDI and STAI-Trait (data not shown).

**DISCUSSION**

The aims of this study were threefold. Firstly to establish whether a computerized assessment of one’s own body image (the CABI) is a valid tool for the assessment of body image disturbances in patients with EDs by comparing its ability to differentiate between these patients and non-ED controls to that of accepted standardized verbal (EDI-2-BD) and perceptual (CDRS) tools. Secondly, including three distinct ED types across several dimensions of body image enabled us to compare the body-image disturbances of patients with restricting vs. B/P behaviors, and of normal weight vs. low-weight patients. Lastly, we aimed to assess whether different factors would be associated with different dimensions of body image.

**Similarities and differences between the CABI, CDRS and EDI-2-BD**

The dimensions of body image assessed using the CABI were in line with the corresponding dimensions of the well-established CDRS and EDI-2-BD methods. Across the three groups with EDs, most body-image dimensions were different in comparison to healthy controls. This relates in particular to the greater overestimation of body size in patients with EDs with respect to the perceptual and affective dimensions of both the CABI and the CDRS. These findings, shown also in other studies using different software techniques (Benninghoven et al., 2007; Ferrer-Garcia & Gutierrez-Maldonado, 2008; Overas et al., 2014; Roy & Forest, 2007), likely support the validity of the CABI in the assessment of the perceptual and affective dimensions of body image disturbances in patients with EDs.

Nonetheless, noteworthy differences emerged between the CABI and the CDRS. Thus, whereas the CABI’s perceptual and affective dimensions differentiated between all
there groups with ED and controls, in the case of the CDRS, these dimensions distinguished BN patients from both groups with AN and controls. The greater sensitivity of self-images to distinguish between patients with EDs and controls in comparison to a neutral female figure was noted also in other computerized studies (Benninghoven et al., 2007) On the other hand, in contrast to our findings, other studies using the CDRS demonstrated its ability in differentiating all ED types from healthy controls (M. A. Thompson & Gray, 1995). To conclude, we suggest that despite these inconsistencies, our findings add to other computerized studies in showing superiority in distinguishing patients with EDs from healthy controls when assessing perceptual overestimation of one’s own body in comparison to neutral female figures (Overas et al., 2014).

A somewhat puzzling difference between the two tools is the finding of a significant difference in the ideal body image between both groups with AN and controls when using the CDRS but not in the CABI. If perceiving one’s own body is considered more sensitive to perceptual and affective distortion than a neutral figure, this should have been the case also for one’s desired image. Still, the ideal figures for all groups with the CABI were around the non-simulated image (i.e., around 100%), suggesting no distortion for self-ideal body image (see Table 2). By contrast, the ideal figure for all groups with the CDRS was well below the mean of around 4-5 out of 9 female contour drawings, with the low-weight AN patients and even normal controls preferring an even skinnier image than the two normal weight groups (see Table 2). In the same token, discrepancies between patients with EDs and controls in the differences between the perceptual/affective and ideal body image were greater with the CDRS than the CABI (see Table 2). Perhaps, there is a greater influence of the societal thin-body ideal when relating to a general female figure, a procedure putatively allowing for some distancing from painful contents related to one’s own image (Overas et al., 2014).
Differences in body-image disturbances among the different types of ED

Several differences in the various dimensions of body image have been found among the three groups with ED. Accordingly, patients with AN and healthy controls are more disturbed than those with BN on the CDRS perceptual, and affective dimensions. Moreover, in keeping with other studies (Tovee et al., 2003), patients with AN but not BN, have differed from controls in preferring skinnier ideal body image according to the CDRS, and in having a greater distortion on the CABI-ii (see Table 2). The greater perceptual overestimation of patients with AN versus BN, shown also in other studies using software techniques (Benninghoven et al., 2007), is likely associated with their lower BMI and greater malnutrition (Bamford, Attoe, Mountford, Morgan, & Sly, 2014). By contrast, despite the greater body-image overestimation of patients with AN and their preference of thinner ideal body image, patients with BN do reveal greater discrepancy between the perceptual/affective and ideal body image dimensions of the CDRS than patients with AN (see Table 2). This may reflect greater distress in the comparison of ideal and perceived weight in patients with an ED in the case of normal weight vs. low weight conditions, although it is of note that no differences have been found between patients with AN and BN in EDI-2-BD. Despite these inconsistencies, our findings may support the importance of affective dimensions in the development and maintenance of body image disturbance in patients with an ED above and beyond the influence of perceptual distortions (Skrzypek et al., 2001; J. K. Thompson, 1997).

Factors influencing body image

The use of MANCOVA has shown that the between group differences in body image as assessed with all three tools (CDRS, CABI and EDI-2-BD) maintained their significance when controlling for age, years of schooling, and BMI. In keeping with the findings of Øverås et al. (Overas et al., 2014), the lack of influence of BMI on the perceptual and affective
dimensions of body image across all methods, suggests that they represent an inherent trait in
the development and maintenance of an ED further to the influence of reduction of weight.
These findings are also in accordance with studies showing that disturbances in body image in
young females of normal weight may represent a risk factor for the development of later EDs
(Leon et al., 1995; Striegel-Moore et al., 1989). In this respect, our findings are consistent
also with studies showing that women recovered from AN (Bachner-Melman, Zohar, &
Ebstein, 2006) and BN (Stein et al., 2003), show more perceptual and affective body image
disturbances in comparison to non-ED controls.

Controlling for depression and anxiety revealed that between-group differences were
still maintained for all CDRS dimensions, most CABI dimensions (except for the differences
between the perceptual/affective and ideal body image dimensions), but not for the EDI-2-BD
scale. These findings suggest that the perceptual design of the CDRS and CABI, potentially
requiring greater precision and attention, may be less subject to the influence of negative
emotions than the verbal EDI-2-BD, which is basically an affective body image tool (Garner,
1991). It is of note that Øverås et al. (Overas et al., 2014) have shown that the differences in
personal images between AN and control participants do persist when controlling for
depression but not for anxiety, suggesting that the overestimation of one’s own figure may be
the result of increased anxiety. In this respect, the association of the difference between the
perceptual/affective and ideal components of one's own image with both depression and
anxiety (Gardner & Bokenkamp, 1996) suggests this discrepancy to be particularly
distressing and anxiety-inducing (Cash & Deagle, 1997; Overas et al., 2014).

Our findings should be interpreted considering the limitations of the study. Firstly, the
number of patients in each of the groups with an ED is relatively small. In addition, as our
sample includes only inpatients, the findings cannot be generalized to patients with less severe
EDs. Furthermore, although using the definitions of the perceptual (what do you think you look like) and affective (how do you feel you look like) body image dimensions that are recommended by Thompson and Gray (M. A. Thompson & Gray, 1995) in the use of the CDRS, these definitions might be ambiguous to patients with an ED who are likely obsessed with the way they think and feel they look like. Moreover, although all computerized studies refer to the participants’ own image, they use different assessment techniques, e.g., presumed BMI (Tovee et al., 2003), percentage of presumed body fat (Benninghoven et al., 2007), or a full body picture projected onto a wall and a mirror (Overas et al., 2014), or displayed in the computer (our study). This use of different techniques may limit the likelihood of valid comparisons among the findings of different computerized studies in the assessment of body image disturbances.

Our study has, nevertheless, some important advantages. It relates to both the perceptual and affective aspects of body image, using a computerized-quantified method versus well-accepted standardized verbal and perceptual measures. Moreover, the CABI provides 24 pictures in contrast to the standard 9 figures of the CDRS; these are presented in a random order, increasing the likelihood of a less-biased body-image evaluation. This is because the presentation of figures in either an upward or downward sequential order, as is usually the case, may increase the risk of influencing the participant's perception (Gardner, Jones, & Bokenkamp, 1995). Thirdly, the CABI also enables greater sensitivity in the assessment of body image, using two different types of measurements: the CABI-ii indicates error magnitude and directionality, whereas the continuous body shape change simulation scale reflects the individual's perceived appearance.

Conclusions and future directions
The primary aim of the study was to assess the validity and utility of a computerized evaluation of body image disturbances in patients with an ED, the Computerized Assessment of Body Image (CABI), against well-accepted standardized verbal-affective (EDI-2-Body Dissatisfaction) and perceptual (perceptual Contour Drawing Rating Scale; CDRS) tools. The findings of the present study provide, to our understanding, validation to the use of the self-image assessment method of the CABI as an additional, and perhaps more sensitive tool in addressing the role of perceptual and affective/attitudinal dimensions and their interactions in body image disturbances in patients with different types of EDs. Secondly, the use of a multidimensional assessment strategy enabled a better understanding of the differences in the various dimensions of body image in patients with AN vs. BN. Future studies implementing the CABI in larger samples, both in naturalistic follow-up studies and following treatment, may improve the choice of the treatment strategies best tailored for reducing body image disturbance, and the understanding of the role of these disturbances in the outcome of an ED.
References


Figure Captions

Figure 1. Four simulated figures using the Computerized Assessment of Body Image (CABI) software

An example of the discriminating potential of the CABI software: a figure of original body weight (100%), non-simulated (a); figures simulating 104% (b), 110% (c) and 114% (d) of body weight.
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Disclosure of conflict: No conflict of interest in this work.
Table 1: Between-group differences in demographic and psychometric variables

<table>
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<tr>
<th></th>
<th>AN-R (n=22)</th>
<th>AN-B/P (n=22)</th>
<th>BN (n=20)</th>
<th>Controls (n=41)</th>
<th>F (3,102)</th>
<th>p-value</th>
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<td>Age (years)</td>
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<td>22.02±5.0b</td>
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<td>12.70±1.9b</td>
<td>12.02±3.0ab</td>
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<tr>
<td>BMI (kg/m²)</td>
<td>16.01±1.8a</td>
<td>17.16±2.1a</td>
<td>20.96±1.9b</td>
<td>21.17±2.5b</td>
<td>35.365</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>BDI</td>
<td>21.44±13.7a</td>
<td>21.72±12.4a</td>
<td>18.40±6.7a</td>
<td>5.64±7.8b</td>
<td>16.540</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>STAI-Trait</td>
<td>53.20±12.8a</td>
<td>50.33±13.8a</td>
<td>45.67±11.8ab</td>
<td>37.46±8.5b</td>
<td>10.062</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Legend: AN-R: anorexia nervosa, restricting type; AN-B/P: anorexia nervosa, binge purge type; BN: bulimia nervosa; BMI: body mass index; BDI: Beck Depression Inventory, STAI-Trait: State Trait Anxiety Inventory-Trait.

Scores with superscripts indicate the findings according to Tukey. Scores with different superscripts differ significantly from each other in the respective row at p≤.05. Scores with the same superscript do not differ significantly from each other in the respective row.
Table 2. Between-group differences in the CDRS, CABI and EDI-2-BD body image tools

<table>
<thead>
<tr>
<th></th>
<th>AN-R (n=22)</th>
<th>AN-B/P (n=22)</th>
<th>BN (n=20)</th>
<th>Controls (n=41)</th>
<th>F (3,102)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDRS Perceptual</td>
<td>3.91±1.9a</td>
<td>4.05±2.0a</td>
<td>6.15±1.6b</td>
<td>4.88±1.3a</td>
<td>7.949</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>CDRS Affective</td>
<td>4.67±2.3a</td>
<td>5.10±2.3a</td>
<td>7.15±1.6b</td>
<td>4.98±1.2a</td>
<td>8.653</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>CDRS Ideal</td>
<td>2.67±1.2a</td>
<td>2.50±1.1a</td>
<td>3.25±1.0ab</td>
<td>3.93±1.1b</td>
<td>10.634</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>CDRS Perceptual – Ideal</td>
<td>1.24±2.4a</td>
<td>1.55±2.4ab</td>
<td>2.90±1.8b</td>
<td>.95±1.3a</td>
<td>4.971</td>
<td>.003</td>
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<tr>
<td>CDRS Affective – Ideal</td>
<td>2.00±2.7abc</td>
<td>2.60±2.8ab</td>
<td>3.90±1.9b</td>
<td>1.05±1.3c</td>
<td>8.832</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>CABI Perceptual</td>
<td>105.36±4.9a</td>
<td>105.34±6.0a</td>
<td>105.40±3.7a</td>
<td>101.64±2.6b</td>
<td>6.509</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>CABI Affective</td>
<td>107.83±6.4a</td>
<td>108.86±7.0a</td>
<td>109.68±4.3a</td>
<td>102.73±3.3b</td>
<td>11.925</td>
<td>&lt;.001</td>
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<tr>
<td>CABI Ideal</td>
<td>98.01±6.7a</td>
<td>98.18±7.5a</td>
<td>96.28±5.6a</td>
<td>98.67±5.2a</td>
<td>0.697</td>
<td>.56</td>
</tr>
<tr>
<td>CABI Perceptual – Ideal</td>
<td>7.42±8.5ab</td>
<td>7.16±11.6ab</td>
<td>9.13±6.8a</td>
<td>2.97±4.6b</td>
<td>3.567</td>
<td>.02</td>
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<tr>
<td>CABI Affective – Ideal</td>
<td>10.00±9.9abc</td>
<td>10.68±12.1a</td>
<td>13.4±7.0a</td>
<td>4.06±4.6b</td>
<td>7.049</td>
<td>&lt;.001</td>
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<tr>
<td>CABI-ii</td>
<td>-3.95±7.4a</td>
<td>-3.82±7.4a</td>
<td>-1.80±5.6ab</td>
<td>2.46±5.1b</td>
<td>7.416</td>
<td>&lt;.001</td>
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<tr>
<td>EDI-2-BD</td>
<td>10.89±7.5ab</td>
<td>14.11±9.2a</td>
<td>17.31±7.9a</td>
<td>7.61±6.2b</td>
<td>7.832</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Legend: AN-R: anorexia nervosa, restricting type; AN-B/P: anorexia nervosa, bingeing purging type; BN: bulimia nervosa; CDRS: Contour Drawing Rating Scale; CABI: Computerized Assessment of Body Image; CABI-ii: CABI identification index; EDI-2-BD – Eating Disorder Inventory-2- Body Dissatisfaction Scale.

Scores with superscripts indicate the findings according to Tukey. Scores with different superscripts differ significantly from each other in the respective row at p≤.05. Scores with the same superscript do not differ significantly from each other in the respective row.
Figure 1.
Four example figures of the discriminating potential of the Computerized Assessment of Body Image (CABI) software

Original (100%)  (104%)

(110%)  (114%)