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A New Cognitive Bias Modification Technique to Influence Risk Factors for Eating Disorders

Emily Matheson, BPsycHons[1]

Tracey D. Wade, PhD[1]

Jenny Yiend, PhD[2]

[1] School of Psychology, Flinders University, Adelaide, South Australia, Australia

[2] Institute of Psychiatry, King's College London

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Address correspondence to: Emily Matheson, School of Psychology, Flinders University, GPO Box 2100, Adelaide, South Australia, 5001, Australia; Phone +61-8-8201 7993; Email: emily.matheson@flinders.edu.au

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Abstract

Objective: Eating disorder psychopathology is associated with a propensity to interpret ambiguous stimuli to be negatively related to one's appearance and self-worth. The relative impact of modifying interpretation bias for these respective stimuli is unknown. Hence the main aim of the current study was to compare two cognitive bias modification protocols targeting interpretation bias (CBM-I), one focused on appearance and the other on self-worth, in terms of impacting interpretation bias, body dissatisfaction and negative affect. The appearance-based CBM-I protocol was developed for the current study. **Method**: Female university students (N=123) were randomised into one of three CBM-I conditions: appearance, self-worth or control. Immediately following a negative induction that significantly increased body dissatisfaction and negative affect, participants underwent their respective CBM-I training. **Results:** the CBM-I for appearance produced significant changes in the targeted bias, as well as significant improvements (moderate effect sizes) in appearance satisfaction, relative to the CBM-I for self-worth and control conditions. **Discussion**: The results support the usefulness of the CBM-I for appearance protocol, and suggests that this technique warrants further investigation with respect to modifying interpretation bias and risk factors associated with eating disorder psychopathology. Null effects of CBM-I for self-worth should be interpreted in light of study limitations, including the potential unsuitability of training material for young women. CBM-I for both types of interpretation bias should be evaluated in future research.

Keywords: cognitive bias modification; interpretation bias; body dissatisfaction; appearance

Cognitive theories propose that the development and maintenance of various psychopathologies can be partially attributed to the tendency to preferentially process disorder-salient stimuli above all other information types, resulting in an interpretation bias. Research consistently shows that eating disorder risk is associated with the perception of ambiguous stimuli to be negatively related to one's appearance (Brockmeyer et al., 2018; Rodgers & Dubois, 2016) and self-worth (e.g., Cooper, 2005; Cooper & Cowen, 2009; Pringle, Harmer, & Cooper 2010). For instance, a friend stating they joined a gym would be interpreted by the person at risk as evidence that they too should exercise and improve their weight and shape (interpretation bias related to appearance), or that they are lazy for not doing so (interpretation bias related to self-worth), rather than considering a more adaptive resolution (e.g., a friend's pride in their new found motivation).

The use of cognitive bias modification targeting interpretation bias (CBM-I) for therapeutic purposes aims to train individuals to adopt adaptive explanations for ambiguity. Techniques typically involve presenting individuals with a series of ambiguous scenarios that consistently yield an adaptive resolution once disambiguated. In consistently constraining individuals' interpretations to one theme, a new "production rule" is formed (Hoppitt, Mathews, Yiend &, Mackintosh, 2010; Mackintosh, Mathews, Yiend, Ridgeway, & Cook, 2006). Subsequently, CBM-I efficacy is determined by individuals' ability to apply this newly formed rule to new ambiguous information, as well as the degree to which targeted symptomatology is impacted.

Given that individuals with greater psychopathology are likely to have more difficulty in generating positive interpretations, standardized CBM-I paradigms have proven more effective relative to self-generated CBM-I (Rohrbacher, Blackwell, Holmes, & Reinecke, 2014). Four studies utilizing such standardized paradigms relevant to eating disorders exist. The first study trained a subclinical eating disorder sample to interpret emotionally

ambiguous scenarios that were consistent with either a positive/neutral, or negative self-worth (Yiend, Parnes, Shepherd, Roche, & Cooper, 2014). Both forms of CBM-I produced significant bias change congruent with the training valance. The negative CBM-I training had a significant impact on eating disorder symptomatology, with participants demonstrating a significant increase in depression and intrusive thoughts, related to weight and shape, during a mirror exposure task, as well as food restriction. Conversely, the positive/neutral form of CBM-I significantly reduced anxiety, depression and intrusive thoughts during two behavioural tasks (i.e., mirror exposure and weighing).

Two studies sought to modify interpretation bias associated with interpersonal difficulties in women with anorexia nervosa that can damage self-worth. The first study explored multiple sessions of CBM, targeting attentional (CBM-A) and interpretation bias for negative social stimuli (Cardi et al., 2015). Over a two-week period the women completed five sessions of CBM-A (direct attention toward positive social cues and away from negative cues) and CBM-I (beginning interpretation training of social-relevant scenarios). At post-intervention, the multi-session training significantly modified attentional and interpretation bias, as well as ameliorated anxiety and self-compassion. There was no impact on eating disorder symptoms. A more recent study found a single session of CBM-I to be comparably effective to a CBM-I control condition, with respects to modifying interpretation biases. Furthermore, the training had no impact on eating disorder behaviour or stress levels (Turton, Cardi, Treasurer, & Hirsch, 2018).

A final study successfully used an appearance-based CBM-I to modify social- and appearance-related interpretation bias in those with heightened body dysmorphia symptomology (Summers & Cougle, 2016). CBM-I significantly reduced self-reported bulimia symptoms in those with high pre-treatment symptomatology; however there was no impact on drive for thinness (Summers & Cougle, 2018). No study has directly investigated

the effects of an appearance-based CBM-I on eating disorder psychopathology. An important and novel contribution of the current study is the development of a new appearance-based CBM-I protocol, which is the first approach to both *assess* and *modify* appearance-related interpretations biases.

In a review of CBM procedures, MacLeod (2012) noted that the effectiveness of CBM-I procedures beyond anxiety and depression was largely uncertain. The small body of literature summarized above, emerging since this review, suggests that CBM-I shows therapeutic potential in eating disorders. Direct comparisons of CBM-I for appearance and self-worth stimuli may indicate which protocol shows most promise, or whether both are worth pursuing, thus helping to efficiently shape future evaluations in the field. Therefore, the primary objective of the current study was to examine the effects of two CBM-I protocols, one targeting bias related to appearance and the other targeting bias related to self-worth, with respect to modifying disorder-salient bias and improving two risk factors for eating disorder psychopathology, body dissatisfaction and negative affect (Jacobi & Fittig, 2011). The cognitive-behavioural model would suggest that self-worth is a central maintaining factor of appearance concern and disordered eating (Fairburn, 2007), so we hypothesised that CBM-I for self-worth would be more effective at modifying the targeted interpretation bias, as well as improving risk factors (body dissatisfaction and negative affect), than CBM-I for appearance and control.

Method

Participants

One hundred and forty-five university students were recruited from a volunteer research pool, where participation earned course credit. To have a homogenous sample and thus increase power, the inclusion criteria required participants to be female, aged between 17

and 25, and have a body mass index (BMI) between 18.5 and 29.9 (i.e., not underweight nor obese; World Health Organisation, 2017). Of the 145 participants recruited, the data of 123 participants were included in the analyses; n = 3 were excluded for falling outside the age range, and n = 19 were excluded for not meeting weight criteria (n = 10 were underweight and n = 9 were obese). Prior to commencement, ethics approval for the study was obtained from the Human Research Ethics Committee and informed consent was obtained from each participant.

Materials

Body dissatisfaction induction

To induce body dissatisfaction and negative affect participants viewed 16 sequential images of thin women from contemporary fashion advertisements. Using a modified version of the Consumer Response Questionnaire (Mills, Polivy, Herman, & Tiggemann, 2002) to enhance comparisons, participants were instructed to compare their own appearance to that of the women they viewed on the computer screen. Using a 100-pixel VAS, participants rated their agreeability (0 being '*strongly disagree'* and 100 being *'strongly agree'*) with the following statements: '*I would like my body to look like this woman's body*'; '*This woman is thinner than me*'; '*In a busy clothes shop, I would not like to try on bathing suits if this woman was also trying on bathing suits in the same change room*'. Inductions are routinely used in unselected samples to reduce variation in mood state levels (Segal & Ingram, 1994) and thus increase effect sizes for any subsequent improvements. The current induction has been shown to reliably induce body dissatisfaction and negative affect in unselected samples (Atkinson & Wade, 2012).

Cognitive bias modification targeting interpretation (CBM-I) training

The CBM-I training took the previously reported (e.g. Yiend et al., 2014) form of word completion and question tasks. Word completion tasks, first described by Matthews and

Mackintosh (2000), have shown to be effective at modifying biases in subclinical levels of anxiety and depression (Bowler et al., 2012) and eating disorders (Yiend et al., 2014). The training material used in the CBM-I for self-worth and CBM-I control conditions, was sourced from Yiend and colleagues (2014). To our knowledge, there has not been a CBM-I training specifically designed to modify appearance-related interpretation bias using the word completion task.

Therefore, using the framework described in the aforementioned studies, the authors developed the training task 'CBM-I for appearance'. Training stimuli were informed by appearance-based feedback and rejection sensitivity scales (Altabe et al., 2004; Park, 2013; Park, Calogero, Young, & DiRaddo, 2010; Tantleff-Dunn, Thompson &, Dunn, 1995), as well as a pilot study conducted with 21 women aged between 21-27 years (M = 24.35, SD = 1.33). The women were asked to rate appearance-related terms (e.g., fit) on two 9-point Likert scales, which assessed relatedness to appearance (1 being '*completely unrelated'* and 9 being '*completely related'*) and affective valence (1 being *'completely unpleasant* and 9 being '*completely pleasant*). Based on these ratings, target words were chosen according to the degree to which they related to appearance and were positively endorsed.

The CBM-I training comprised 67 trials, each consisting of two consecutive components: an ambiguous scenario (including word completion) and a comprehension question. First, participants were presented with a 3-line ambiguous scenario, where the last word was purposely incomplete. Scenarios retained their emotional ambiguity until the final word was formed, which then disambiguated the meaning in a positive direction towards either one's appearance or self-worth. Lastly, to reinforce the positive meaning of the disambiguated passage, participants were presented with a comprehension question that required the completion of the words '*Yes*' or '*No*'. Control scenarios related to imperative (e.g., making a cup of tea) and declarative (e.g., facts about butterflies) knowledge and

retained neutrality when disambiguated. Training was delivered through an online survey program, and incorporated 4 initial practice trials. Both CBM-I for appearance (Matheson, Yiend, & Wade, 2018) and self-worth (Houlihan, Yiend, & Cooper, 2017) training materials are available via Open Science Framework. A sample training item from the three CBM-I conditions follow:

Appearance: "*Your friend is a very keen hiker and persuades you to join her and a group of friends on their next hike. You are apprehensive, given how far the hike was going to be. During the hike you realise that you are f-t*" (fit). The trained interpretation is reinforced by the comprehension question (with feedback given reflecting whether participants have responded 'correctly' or not) here: "*Are you surprised by your level of fitness? '*Correct' answer*: No*. There are an equal number of randomly distributed 'yes and 'no' responses required.

Self-worth: *"Your partner has been acting distant. You seek to reassure yourself that they are not annoyed with you for doing something wrong. You call them twice in quick succession. In your view you are being l-v-ng"* (loving). Comprehension question: *Are you too dependent on your partner? No*.

Control: "*You turn the kettle on and wait for the water to boil. You get a teabag out of the tin, which you put into a mug, and pour the boiling water onto the teabag. Next, you add the m- - k*" (milk). Comprehension question: *Have you made a cup of tea? Yes*.

Similarity Rating Task

The similarity ratings task (SRT) assessed modification of interpretation bias between pre- and post-training (Eysenck, Mogg, May, Richards, & Mathews, 1991; Mathews & Mackintosh, 2000). Similarly, the SRT assessing self-worth related bias was sourced from Yiend and colleagues (2014). Meanwhile, the authors developed corresponding tasks for the newly developed CBM-I for appearance condition. The SRTs comprised of two consecutive

subtasks: 1) a word completion task and 2) a recognition test. Together, the two SRTs consisted of 40 word completion scenarios (20 appearance-relevant and 20 self-worth relevant), which were separated into two parallel sets and their presentation counterbalanced between pre- and post-training.

The word completion task appeared in a similar format to that described in the CBM-I training; however the aim of the SRT was to assess, rather than to modify, biases. Thus, when the fragmented word was complete, each scenario and comprehension question retained emotional ambiguity, rather than reflecting and reinforcing positive interpretations, respectively. Further, each scenario was presented with a corresponding title, such as the "Family Christmas Card": *Every year your mother organises a family portrait to use for Christmas cards. The photographer places you front and centre. You start to think about how many people will see the c-rd. (card). Is the card for celebrating Easter?" N- (No).*

In the recognition task, test sentences appeared beneath a title that corresponded with the previously encoded assessment scenarios. Participants were instructed to rate how similar in meaning the sentence was to the original passage on a scale between 1 (*very different*) and 4 (*very similar)*. Each scenario had four corresponding test sentences; two target sentences and two foils sentences. Target items reflected either a positive or negative interpretation of the scenario. While, foil sentences were unrelated to appearance or self-worth and assessed participants' general response bias (i.e., the tendency to respond to ambiguity in a positive or negative manner). Thus, the inclusion of both target and foil items, allowed for the distinction between modifying interpretation bias and more general priming effects of training (Mathews & Mackintosh, 2000). Test sentences were programmed to appear individually and at random. A sample set of test sentences for the "*Family Christmas Card*" scenario follow:

*People will enjoy seeing your photo on the Christmas card (*positive target)

People will dislike your appearance in the photo (negative target)

The photographer was kind (positive foil)

The photographer was rude (negative foil)

Measures

Interpretation bias Similarity rating scores were used to assess the changes in interpretation and response bias, using target and foil items respectively (Yiend et al, 2014). Interpretation bias indices were calculated separately for appearance and self-worth, at pre- and post-training, by subtracting the mean negative target rating from the mean positive target rating. Meanwhile, general response bias indices (mean positive foil rating minus mean negative foil rating) captured participants' tendency to respond in a more positive or negative manner. Bias scores ranged between -4 and 4, with 0 indicating no bias, and positive and negative values indicating a positive or negative interpretation bias, respectively.

Trait measures. The 9-item Body Dissatisfaction subscale from the Eating Disorder Inventory (Garner, Olmsted, & Polivy, 1983) was used to measure body dissatisfaction. Participants were asked to indicate how often the statement was true for them on a 6-point Likert scale ranging from 1 (*never*) to 6 (*always*). Responses to item numbers 3, 5, 6, 7 and 9 were reverse-coded and the total score on the nine items were converted to a mean score, with higher values indicating a greater level of body dissatisfaction. The internal reliability of the questionnaire in this population was .85, and the range of corrected item-total correlations was .4 to .78.

Depression and anxiety were assessed using the two relevant subscales from the Depression, Anxiety and Stress Survey (Lovibond & Lovibond, 1995). Participants rated the applicability of statements as having occurred in the past week. Responses were scored on a 4-point Likert scale ranging from 0 (*did not apply to me at all*) to 3 (*applied to me very much, or most of the time*), with higher scores indicating higher levels of depression and anxiety. Total mean subscale scores were multiplied by two for comparison to normative data, where

higher scores indicate a higher psychopathology. The internal reliability for the depression and anxiety subscales was .92 and .81, respectively, with corrected item-total correlations ranging from .55 to .83 and .3 to .65, respectively.

State measures. Visual analogue scales (VAS; Heinberg & Thompson, 1995) were used to assess participants' state level of appearance and weight satisfaction, by indicating a response to the following questions: (1) "*How satisfied do you feel about your appearance right now?*" (2) "*How satisfied do you feel about your weight right now*?" Participants indicated their level of satisfaction by dragging a slider along a 100-pixel VAS, which was fixed with two extreme values (0 indicating *extreme dissatisfaction* and 100 indicating *extreme satisfaction*). Lower scores indicated a lower level of satisfaction.

Negative affect was assessed using the Negative Affect subscale from the Positive Affect and Negative Affect Schedule (Watson, Clarke, & Tellegen, 1988). The measure was comprised of ten words relating to negative feelings (e.g., *distressed* or *jittery*) and required participants to indicate the level to which they were experiencing this feeling on a 5-point Likert scale ranging from 1 (*very slightly or not at all*) to 5 (*extremely*). Internal consistency for the Negative Affect subscale for the present study was .91, and the range of corrected item-total correlations was .6 to .81.

Procedure

The procedure is depicted in **Figure 1**. Participants attended a single session with six sequential phases lasting a total of 90 minutes. After data collection, participants were formally debriefed about the study objectives and provided with referrals for any concerns regarding body dissatisfaction.

Results

Participant characteristics and baseline measures

As shown in **Table 1** the three groups did not differ on any baseline variables. Negative affect was severely positively skewed, however results remained unchanged when inverse transformations were applied; thus original scores are reported.

Body Dissatisfaction Induction

A manipulation check was conducted using 3 (Training Group) x 2 (Time) mixed analysis of variance (ANOVA) to assess the changes in the three state variables between pre and post-induction. Across all three groups, the induction significantly exacerbated body dissatisfaction and negative affect as indicated by a main effect of Time (appearance satisfaction, $F[1, 120] = 29.16$, $p < .001$; weight satisfaction, $F[1, 120] = 19.61$, $p < .001$; negative affect $F[1, 120] = 21.66$, $p < .001$). There were no significant main effects of Training Group for any of the three dependent variables; nor significant interactions between Training Group and Time. After the induction, there was no difference between the three groups on any of the three variables (appearance satisfaction $F[2] = .94$, $p = .39$; weight satisfaction $F[2] = .76$, $p = 47$; negative affect $F[2] = .64$, $p = .53$). Hence all groups experienced commensurate changes on the outcome variables.

The impact of CBM-I on state variables

Changes in body dissatisfaction and negative affect between pre-training (i.e. post-induction) and post-training, across the three groups were assessed using 3 (Training Group) × 2 (Time) repeated measures ANOVA.

As shown in **Table 3**, appearance satisfaction was associated with a main effect of Time, with no main effect of Training Group and a significant interaction between Time and Training Group. A significant main effect of Time was observed for weight satisfaction and negative affect, no main effect of Training Group, nor was an interaction between Time and Training Group associated with either variable.

Post hoc analyses were conducted on the significant interaction between Time and Training Group for appearance satisfaction using Cohen's *d* within-group effect sizes and their 95% confidence intervals. Analyses revealed that CBM-I for appearance was associated with a significant medium sized improvement in appearance satisfaction, *d* = .61 [.18:1.04]; these effects were not mirrored in the CBM-I for self-worth (*d* = .31 [-.15:.77]) or CBM-I control (*d* = .21 [-.22:.64]) conditions.

Impact of CBM-I on modifying bias

Interpretation and response bias indices (calculated by collapsing the different directions of interpretation, see methods) were considered together in a three-way mixed ANOVA, to compare the specific interpretative consequences of CBM-I (indicated by responses to target items) to wider priming effects of training (indicated by responses to foil items), respectively. (Yiend et al., 2005; Yiend et al, 2014; Lee et al., 2016; Savulich et al., 2017). A mixed model ANOVA was conducted, with Training Group (CBM-I for appearance vs. CBM-I for self-worth vs. CBM-I control) as a between-subjects factor and Bias Type (target vs. foil) and Time (pre- vs. post-training) as within-subject factors.

As shown in **Table 3**, for self-worth bias indices, no main effects or three-way interaction were observed. Meanwhile, for appearance bias indices (see **Table 3**), significant main effects of Time, Bias Type and Training Group were observed. Accompanying the effects was a significant interaction between Training Group and Time. Post hoc analyses of the interaction were conducted using Cohen's *d* within-group effect sizes and their 95% confidence intervals. Analyses revealed a significant medium sized increase in positive bias in the CBM-I for appearance condition (*d* =.72 [.29:1.15]); however the CBM-I for self-worth (*d* =.02 [-.47:.44]) and CBM-I control (*d* =.10 [-.32:.54]) conditions were not associated with such effects. No significant three-way interaction between Time, Training

Group and Bias Type was observed, indicating no significant difference in the trajectory of interpretation vs. response bias between the three training groups over time.

Directions of change associated with CBM-I bias

Using pre- and post-training interpretation bias indices for appearance and self-worth, we examined the direction of change and whether this was congruent with the training that participants received. Of the 44 participants in the CBM-I for appearance condition, 29 (66%) showed a change in the predicted direction (i.e., increased positive interpretations towards appearance), 12 (27%) showed a change in the adverse direction (i.e., reduced positive interpretations), and 3 (7%) showed no change in bias. After removing the data of unresponsive participants (i.e. those who showed no change in bias), the difference in proportions of congruent and incongruent bias change was significant, $\chi^2(1, N = 41) = 7.05$, $p < .01$. For the 37 participants in the CBM-I for self-worth condition, 15 (40.5%) demonstrated a bias change congruent with training (i.e., increased positive interpretations towards self-worth), while the scores of 21 (56.8%) participants were incongruent (i.e., reduced positive interpretations) and 1 (2.7%) showed no change. The difference in proportions of congruent and incongruent bias change was not significant, $\chi^2(1, N = 36) = 1$, $p < .32$.

Discussion

The current research sought to comparatively examine two CBM-I approaches and their influence on modifying interpretation bias and two risk factors for eating disorder psychopathology. In contrast to the original hypothesis, results supported the newly developed CBM-I for appearance protocol, with the approach proving to be more effective at modifying the targeted bias and improving symptomatology than CBM-I for self-worth. Specifically, CBM-I increased positive-appearance related interpretations of ambiguity and produced significant medium sized improvements in appearance satisfaction. No significant

changes to bias or symptomatology were observed in those who completed CBM-I for self-worth.

Our results are inconsistent with those of Yiend and colleagues (2014) who found CBM-I for self-worth to be an effective approach for retraining disorder-salient bias, and reducing anxiety, depression and intrusive thoughts related to appearance. The inconsistencies may relate to differences in sample demographics, namely age and clinical severity. Specifically, the current study used an unselected sample with varying levels of psychopathology and a mean age of 19 years, relative to a subclinical sample with a mean age of 29 years. Subsequently, age and clinical severity may determine the suitability of training material and the degree of pre-existing bias, respectively. First, the content of the self-worth training material may have been somewhat unsuitable for the younger sample. Self-worth in younger female populations is likely to hinge on appearance, studies and dating, as opposed to marriage, children and a full time career, which were reoccurring themes in the existing self-worth training scenarios. Exposure to scenarios that one has yet to experience or achieve may foster negative self-worth bias and subsequently feelings of failure or discontent. In future studies of similar aged females to the present sample, researchers should review the CBM-I for self-worth material and modify training scenarios to be more reflective of younger female life domains. More generally, researchers using CBM should place close attention to the suitability of the training content and seek to match or adapt items to be as relevant as possible to the concerns of the sample. In the wider interpretation bias literature the importance of the content match with the concerns of the sample has been termed ‘content specificity’ and has been the subject of specific investigation in some vulnerable populations (e.g. Savulich, Freeman, Shergill & Yiend, 2015). Second, prior to the intervention, the current sample reported high levels of general response bias and positive self-worth bias, indicating a propensity to respond to ambiguity in an optimistic manner, both

generally and regarding self-worth. Therefore, modifying bias in a direction that is already congruent with participants' cognitions is likely to reduce the potency of the intervention.

An important contribution of the current research was the development of a CBM-I for appearance protocol. Although there was a specific effect of CBM-I on interpretation bias (target items), a similar pattern of results also emerged for general response bias (foil items). Matthews and Mackintosh (2000) propose that the current assessment of bias may be sensitive to experimental noise, resulting in target and foil items being equally encoded and considered similar in meaning to the original message. Specifically, the text method assesses bias on the assumption that the individual will consistently respond to ambiguity with one form of interpretation (e.g., positive target), therefore rejecting the three alternative interpretations (e.g., positive foil, negative target and negative foil). For example, an interpretation such as, "*People will enjoy seeing your photo on the Christmas card*" (positive target) leads to the correct rejection of the positive foil "*the photographer was kind*". However, when encoding the original passage, these specific interpretations are not visible to the individual. As such, more generic interpretations may have been generated and encoded into memory, such as "*the photographer found me appealing*", "*I felt accepted*" or "*the experience was enjoyable*". In this case, both the positive target and foil item would be considered as accurate representations of the outcome, thus leading the individual to rate both items as similar in meaning. We can conclude that we induced an interpretation bias as well as a more general positive bias and our ability to distinguish between these two effects represents a limitation of the current CBM-I protocol which may require further modification.

Current findings should be interpreted in the context of limitations additional to those already mentioned. Firstly, the design did not include qualitative assessments at debriefing, thus participants' awareness of the study's intentions is unknown. The impact of participants' awareness of intervention intentions on CBM-I efficacy remains unclear, with some evidence

suggesting this knowledge enhances bias modification and symptom change (Mobini et al., 2014), while others found it to hinder treatment effects (Orchard, Apetroaia, Clarke, & Creswell, 2017). Future efforts should look to include quantitative and/or qualitative awareness checks to determine the relationship between awareness and CBM-I efficacy. Second, despite null effects of CBM-I for self-worth on bias and symptomatology (i.e., weight satisfaction and negative affect), the approach should not be considered ineffective. Current findings are likely to be indicative of ceiling effects. The current unselected sample were positively biased at baseline, both generally and towards self-worth, and as such participants bias is likely to be less amenable to positive manipulation. These findings are consistent with previous studies, which found an adaptive interpretation bias in healthy populations prior to completing CBM-I training (e.g. Yiend, Savulich, Coughtrey, & Shafran, 2011; Hirsch & Mathews, 2000). Applying CBM-I for self-worth to a subclinical or clinical sample, with maladaptive biases and higher levels of trait body dissatisfaction and negative affect, may elicit changes in a positive direction (Yiend et al., 2014). Therefore, future efforts should seek to compare the two CBM-I approaches in a subclinical or clinical sample to determine whether the current findings were due to varying degrees of psychopathology.

Overall, development of a CBM-I approach that assesses and modifies appearance-related interpretation bias is an important contribution to the currently limited understanding of the role of CBM-I in eating disorders. Given that state variables of an unselected sample were impacted after a single session of CBM-I for appearance, long term effects of the approach in a subclinical population should be explored. Specifically, it would be of value to investigate whether multi-session training generates a more pronounced improvement in bias and symptomatology, and whether these changes persist over time.

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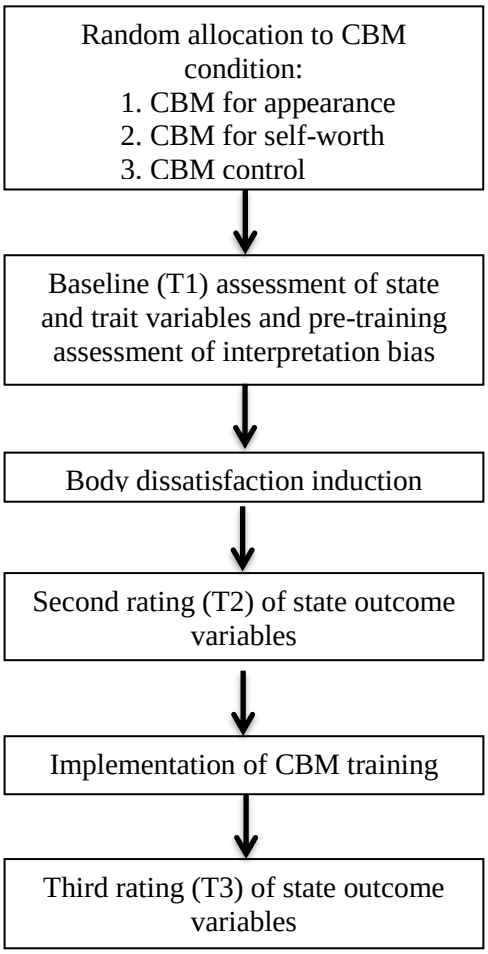

Figure 1. Study Design

567 Table 1

568 *Baseline demographics and dependent variables*

Variable	CBM-I Appearance (*n* = 44)		CBM-I Self-Worth (*n* = 37)		CBM-I Control (*n* = 42)		*Main effect of Group*	
	M	*SD*	*M*	*SD*	*M*	*SD*	*F(2, 122)*	*p*
Age	19.55	1.61	19.49	1.33	19.21	1.41	.62	.54
Body mass index	22.70	2.82	23.08	2.98	22.47	2.67	.46	.63
Body dissatisfaction	3.63	1.00	3.67	.92	3.52	.88	.26	.77
Anxiety	1.35	1.11	1.43	1.16	1.61	1.21	.57	.57
Depression	1.25	1.21	1.44	1.34	1.72	1.40	1.41	.25
Appearance satisfaction	49.41	23.95	45.43	25.14	52.88	26.17	.87	.42
Weight satisfaction	46.11	31.35	44.91	26.40	53.31	27.25	1.03	.36
Negative affect	1.33	.45	1.48	.53	1.49	.72	1.06	.35
Appearance interpretation bias	.15	.79	-.07	.69	-.12	.72	1.77	.17
Response bias (appearance-related foils)	.55	.43	.40	.42	.43	.52	1.20	.30
Self-worth interpretation bias	.48	.58	.43	.62	.25	.49	1.99	.14
Response bias (self-worth related foils)	.45	.58	.42	.47	.35	.48	.39	.68

569 *Note*. CBM-I = Cognitive bias modification targeting interpretation bias

570 Table 2
571
572 *Mean (standard deviation) state variables and raw target and foil scores across condition pre- and post CBM-I training*

	CBM-I Appearance		CBM-I Self-Worth		CBM-I Control	
	Pre-Training M (SD)	*Post-Training M(SD)*	*Pre-Training M(SD)*	*Post-Training M(SD)*	*Pre-Training M(SD)*	*Post-Training M(SD)*
Appearance satisfaction	39.84 (27.18)	55.75 (29.21)	37.05 (25.26)	45.14 (24.76)	44.95 (25.74)	50.36 (25.25)
Weight satisfaction	38.31 (30.90)	51.62 (32.59)	40.16 (26.19)	46.27 (24.66)	45.57 (27.00)	52.02 (25.04)
Negative affect	1.55(.12)	1.22 (.09)	1.74 (.13)	1.49 (.10)	1.61 (.12)	1.36 (.09)
Appearance Bias						
Positive target	2.58 (.45)	2.87 (.39)	2.47 (.38)	2.51 (.30)	2.46 (.35)	2.48 (.33)
Negative target	2.42 (.49)	2.17 (.51)	2.54 (.47)	2.53 (.50)	2.58 (.47)	2.36 (.56)
Positive foil	2.54 (.43)	2.64 (.39)	2.45 (.31)	2.45(.31)	2.38 (.38)	2.50 (.35)
Negative foil	1.99 (.32)	1.89 (.34)	2.05 (.36)	2.08 (.42)	1.95 (.45)	1.95 (.44)
Self-worth Bias						
Positive target	2.96 (.36)	3.0 (.35)	2.94 (.30)	2.86 (.41)	2.81 (.39)	2.85 (.34)
Negative target	2.49 (.38)	2.45 (.38)	2.51 (.50)	2.51 (.42)	2.56 (.48)	2.45 (.40)
Positive foil	2.52 (.41)	2.49 (.43)	2.47 (.28)	2.52 (.31)	2.38 (.38)	2.41 (.36)
Negative foil	2.07 (.35)	2.07 (.32)	2.06 (.40)	2.16 (.32)	2.02 (.36)	2.04 (.48)

573 *Note*. CBM-I = Cognitive bias modification targeting interpretation bias; Pre-training = post-induction assessment of outcome variables.

Table 3

Two-way and Three-way ANOVA: Impact of CBM-I on State Variables and Bias between Pre- and Post-Training

		df	*F*	*p*
State variables				
Appearance satisfaction				
	Time	1, 120	45.42	<.001
	CBM-I Training Group	2, 120	.90	.41
	Time × CBM-I Training Group	2, 120	4.95	.01
Weight satisfaction				
	Time	1, 120	35.10	<.001
	CBM-I Training Group	2, 120	.45	.64
	Time × CBM-I Training Group	2, 120	2.68	< .07
Negative affect				
	Time	1, 120	37.35	<.001
	CBM-I Training Group	2, 120	1.34	.27
	Time × CBM-I Training Group	2, 120	.42	.66
Bias Change Variables				
Change in Bias for Appearance				
	Time	1, 120	17.75	<.001
	Bias Type	1, 120	56.69	<.001
	CBM-I Training Group	2, 120	7.32	.001
	Time × Bias Type	1, 120	8.03	.01
	Time × CBM-I Training Group	2, 120	5.55	.01
	Bias Type × CBM-I Training Group	2, 120	2.69	.07
	Time × Bias Type × CBM-I Training Group	2, 120	1.79	.17
Change in Bias for Self-Worth				
	Time	1, 120	.05	.83
	Bias Type	1, 120	.18	.68
	CBM-I Training Group	2, 120	1.42	.25
	Time × Bias Type	1, 120	1.85	.18
	Time × CBM-I Training Group	2, 120	.75	.48
	Bias Type × CBM-I Training Group	2, 120	.75	.47
	Time × Bias Type × CBM-I Training Group	2, 120	.71	.50

Note. CBM-I = Cognitive bias modification targeting interpretation bias; Pre-training = post-induction assessment of outcome variables. Time = Pre- and Post-training; Bias Type = Target and Foils; CBM-I Training Group = CBM-I for appearance, CBM-I for self-worth, CBM-I control