ORIGINAL ARTICLE

An experimental Study on the Induction of an Eating Disorder-Specific Interpretation Bias in Healthy Individuals: Testing the Interpretation Modification Paradigm for Eating Disorders (IMP-ED)

Julia Korn[1] · **Fanny Alexandra Dietel[2]** · **Andrea Sabrina Hartmann[3]**

Abstract

The aim of this experimental study was to examine whether interpretation biases are possible mechanisms of genesis of eating disorders (ED). We investigated the induction of an interpretation bias in healthy women using an Interpretation Modification Paradigm for ED (IMP-ED). We employed a modified version of the Word-Sentences Association Paradigm, with feedback reinforcing positive or negative responses to enhance either positive or negative interpretation, respectively. These two training conditions ($n = 33$ each) were compared to a no-feedback control group ($n = 31$). Effects on appearance-related self-esteem and body satisfaction as well as emotional vulnerability were measured in a subsequent Cyberball Ostracism Task (COT). Reinforcement of positive responses significantly reduced the endorsement of negative interpretations compared to the control group. Reinforcement of negative responses compared to no-feedback significantly decreased appearance-related self-esteem and reduced body image satisfaction compared to positivity training. The induction did not add to the deterioration in self-esteem, body satisfaction, and emotions experienced due to the COT. The IMP-ED successfully changed initial response tendencies by reducing a threat bias, and influenced core symptoms. Impacts of modifications of interpretation tendencies on emotional vulnerability and symptoms should be further studied in clinical samples, and could eventually inform the development of an efficient and economic online bias modification program.

Keywords Cognitive bias modification · Interpretation bias · Bias induction · Emotional vulnerability · Eating disorders

Cognitive biases, precisely negative interpretation biases, have been suggested to cause and maintain mental disorders (e.g., Beck and Clark 1997; Popescu and Băban 2014; Williams et al. 1997). An interpretation bias can be defined as a tendency to interpret ambiguous stimuli or information in consistent ways, in terms of disorders a threatening or negative way (Hirsch et al. 2016). Individuals with eating disorders (ED) show distorted information processing (Vitousek and Hollon 1990) which is congruent with existing dysfunctional schemata (Lee and Shafran 2004; Vitousek and Hollon 1990) and manifests besides attentional bias (e.g., Aspen et al. 2013; Brooks et al. 2011; Shafran et al. 2007) and memory bias (Griffith et al. 2015; Polivy and Herman 2017; Williamson et al. 2004) as an interpretation bias (Cooper 1997; Williamson et al. 2000) related to ED relevant stimuli. Previous research provides evidence of a general negative body shape-related bias in the interpretation of ambiguous sentences in subclinical samples (Jackman et al. 1995; Rosser et al. 2010). A recent study found a strong association between eating-disordered cognitions and implicit interpretation biases (Misener and Libben 2017). In a previous study, we provided further data supporting an association between interpretation bias and ED symptoms. This study revealed that despite interpretation biases regarding ambiguous content around social and general anxiety as

✉ Julia Korn
Julia.Korn@uksh.de

Fanny Alexandra Dietel
dietel@uni-muenster.de

Andrea Sabrina Hartmann
andrea.hartmann@uni-osnabrueck.de

[1] Department of Psychiatry, University of Lübeck, Ratzeburger Allee 160, 23538 Lübeck, Germany

[2] Department of Clinical Psychology and Psychotherapy, Institute of Psychology, University of Münster, Münster, Germany

[3] Department of Human Sciences, Institute of Psychology, Osnabrück University, Knollstrasse 15, 49069 Osnabrück, Germany

well as eating disorders (i.e., related to weight, shape, and eating), only the bias regarding the latter content was significantly associated with ED-psychopathology in women with pronounced ED psychopathology (Korn et al. submitted). It remains uncertain, however, whether the interpretation bias is a mechanism relevant to the genesis of ED, and whether it would be worthwhile to target it in interventions. Therefore, experimental studies which manipulate the interpretation bias and assess its impact on disorder-relevant symptoms are needed (Mathews and MacLeod 2002).

Cognitive Bias Modification for interpretation biases (CBM-I) programs with the aim of practicing more adaptive interpretation styles were originally developed as a mean to test causal associations between the biases and disorder-relevant symptoms focusing on anxiety (Grey and Mathews 2000; Mathews and Mackintosh 2000). Supporting such associations, experimentally induced biases in non-anxious participants were found to resemble those observed in anxious populations and to increase the vulnerability to anxious mood (Mathews and Mackintosh 2000; Mathews and MacLeod 2002). So far, three meta-analytic reviews have examined the efficacy of CBM-I in individuals with anxiety and depression or healthy samples (Cristea et al. 2015; Hallion and Ruscio 2011; Menne-Lothmann et al. 2014). In the majority of the reviewed studies, positive CBM-I resulted in an increase in positive interpretation bias and a decrease in negative mood. The only experimental study on the modification of an interpretation bias in women with an ED and women with body dysmorphic disorder revealed that participants were able to change their negative interpretation of body-related ambiguous situations after they were explicitly instructed to imagine themselves feeling positive in each of the situations (Williamson et al. 2000). However, this instruction may imply a mood induction rather than a change in interpretation. To sum up, while previous research, mainly on anxiety disorders but also on depression, found rather consistently that interpretation biases can be experimentally induced or modified by CBM-I methods and effect the disorder-relevant mood, studies using CBM-I on ED are lacking.

Besides core symptoms, CBM-I should also reduce emotional vulnerability, defined as mood reactivity to emotional challenges (Menne-Lothmann et al. 2014). There is evidence that those prone to negative emotional states are less likely to interpret ambiguous events in a relatively positive way than others (Eysenck et al. 1991; Lawson et al. 2002). Yet, findings of studies investigating a causal effect of experimentally induced biases on emotional vulnerability are somewhat mixed (Hallion and Ruscio 2011; Menne-Lothmann et al. 2014). Some studies revealed that healthy participants (Hirsch et al. 2007; Mackintosh et al. 2006; Wilson et al. 2006) and anxious participants (Murphy et al. 2007) trained to interpret ambiguity in a non-anxious way reported an

attenuated anxious reaction to a subsequent stressor. Other studies, in contrast, did not find a transfer of training to stress responding (e.g., for depression: (Mobius et al. 2015; Yiend et al. 2014) and for body dysmorphic disorder (Premo et al. 2016). A further study found enduring cognitive effects of training after a 24-h delay between training and test, but did not detect any beneficial effects of the training on levels of anxiety (Yiend et al. 2005). In sum, while effects of bias induction on emotional vulnerability have been inconsistent in studies on anxiety disorders (for an overview, see Hirsch et al. 2016), respective studies supporting a causal relationship between interpretation bias and emotional vulnerability in ED do not exist. Nevertheless, if the interpretation bias proves to be etiologically relevant for ED symptoms and associated emotional vulnerability, it could be targeted as a mechanism of change in interventions.

Therefore, the first research aim of the present study is to investigate the induction of an ED-specific interpretation bias in an unselected sample as a proof-of-principle study (Mathews and MacLeod 2002). Furthermore, we aimed to examine the effects of the induced bias on ED-relevant symptoms and on emotional vulnerability. The three main training methods commonly used within CBM-I are homograph paradigms, ambiguous situation paradigms, and the Word-Sentence Association Paradigm (WSAP; Beard and Amir 2008). In the WSAP, a negative or positive word is presented, followed by an ambiguous sentence. Information on the interpretation bias is provided by the endorsement rate, which indicates whether the participant believes that the word and sentence match, and by reaction time measures. In our previous study we used an adapted version of the WSAP, the Sentence-Word Association Paradigm (SWAP; presenting the sentence first) in a sample with subclinical ED, and successfully demonstrated the existence of a negative ED-related and specific interpretation bias (Korn et al. submitted). By giving feedback on the reaction choice, it is possible to train or modify interpretation tendencies. However, training with the WSAP or the modified version SWAP (Hindash and Amir 2012) has only been applied to interpretation biases specific to anxiety (Amir et al. 2010; Beard and Amir 2008), depression (Mobius et al. 2015), and body dysmorphic disorder (Summers and Cougle 2016). Interestingly, a four session training using the WSAP to modify problematic social and appearance-related threat interpretation biases in individuals with elevated body dysmorphic disorder symptoms reduced bulimia symptoms (Summers and Cougle 2018).

Our second research aim, i.e., to examine the training effects on emotional vulnerability, requires a stressor which provokes ambiguity and directly activates the manipulated cognitive mechanisms (Hallion and Ruscio 2011; Menne-Lothmann et al. 2014). According to the transdiagnostic model of ED, interpersonal difficulties

comprise a key maintaining factor (Fairburn et al. 2003). The interpersonal theory of ED further suggests that an individual's weight- and shape-based self-worth moderates the relationship between interpersonal rejection and ED symptoms (Rieger et al. 2010). Women with anorexia nervosa seem to have a negative interpretation bias for ambiguous social situations and a higher sensitivity to rejection (Cardi et al. 2017). The Cyberball Ostracism Task (COT) is an online ball-tossing game that is a commonly used and well-researched method of interpersonal rejection (Hartgerink et al. 2015; Williams et al. 2000). A recent study revealed that women with a greater tendency to base their self-worth on weight and shape demonstrated an attention bias regarding thin-ideal images after being exposed to interpersonal rejection in the COT (Rieger et al. 2017). This effect can potentially be strengthened by presenting only very attractive and slender co-players in COT, since social comparison to thin-ideals increases body dissatisfaction (Krones 2005). Therefore, it should be a suitable stressor allowing for conclusions regarding the effects of CBM-I on emotional reactivity.

In order to explore whether post-training changes were driven by negative changes in the negativity training (NT), positive changes in the positivity training (PT) or both, we compared two training groups (reinforcing a positive bias vs. reinforcing a negative bias) and included a control condition without any feedback in order to control for naturally occurring fluctuations. We hypothesized that participants would show response patterns in the SWAP corresponding to the reinforced training condition, i.e., a higher endorsement rate of positive interpretations and a lower endorsement rate of negative interpretations after PT, and vice versa for the NT condition. We expected that after the training participants would execute the reinforced response pattern more quickly. To explore the effectiveness of the Interpretation Modification Paradigm for Eating Disorders (IMP-ED), we additionally measured changes in mood states that are central to ED (e.g., Fox and Power 2009) and expected to find an effect of the induced interpretation bias on mood (e.g., after the PT, lower levels of the five emotions: sadness, anxiety, disgust, frustration, shame). Furthermore, we explored the effect of an interpretation bias on ED psychopathology, e.g., body image satisfaction and appearance-related self-esteem, both constructs which are predictors and maintaining factors of ED (Cooper 1997; Fairburn et al. 2003; Misener and Libben 2017; Stice 2002). We anticipated higher levels of body image satisfaction as well as appearance-related self-esteem in the PT group compared to the NT and the control group. In contrast, we expected lower levels of body image satisfaction and appearance-related self-esteem in the NT group than in the other two groups. Finally, we hypothesized attenuated levels of emotional vulnerability (five emotions, body image satisfaction, and appearance-related self-esteem)

in response to the COT in the PT group compared to the NT and the control group.

Method

Recruitment and Participants

Participants were recruited via bulletins in public places, mainly in University campus buildings or on the University's online blackboard. They received course credits or a payment of €5 for their participation, and were additionally able to enter a lottery with the chance of winning one of four €20 online shopping vouchers.

Inclusion criteria were female gender, age between 18 and 35 years, and sufficient knowledge of the German language. Exclusion criteria included substance misuse or dependency (with the exception of nicotine), lifetime or current diagnosis of a mental disorder, a Beck Depression Inventory (BDI II) sum score above 19 points (moderate depression), acute suicidality (BDI II item 9; item score ≥ 2) (BDI II; German language version: Beck et al. 1996; Hautzinger et al. 2006), an Eating Disorder Examination Questionnaire (EDE-Q; Fairburn and Beglin 1994; Hilbert and Tuschen-Caffier 2006) total score above 3.18 (indicative of presence of an ED in samples with bulimia nervosa) to rule out prior ED psychopathology, a history of or current psychological treatment or psychotropic medication, and a Body Mass Index (BMI) < 18.5 and ≥ 30 (not in the normal range according to the WHO 2000). In the case of acute suicidality, respondents would have been guided to external sources of assistance. Ethical approval for this study was granted by the University's institutional review board.

An a priori power analysis in G*Power (Faul et al. 2007) indicated that a sample size of $n = 111$ would be sufficient to detect small to medium effect sizes ($f = .17$) with an $\alpha = .05$ and $1-\beta = .95$ in an analysis of variance with three measurement points and three groups. A total of 114 women participated in the study. Sixteen participants met exclusion criteria, consequently their data was discarded from analyses. Data of another participant could not be analyzed due to a computer error. The final sample consists of 97 participants (IMP-PT group $n = 33$, IMP-NT group $n = 33$ and the control group $n = 31$).

Most participants were students (93.8%), followed by 3.1% employees, 2.1% trainees and 1% pupils. The three groups did not differ with regard to any sociodemographic or questionnaire data except for the SISE (see Table 1). Furthermore, there were no pre-training group differences for any SWAP measures (see Table 2) nor for any state measures: State-Self-Esteem Scale SSES (F [2, 94] = .44, $p = .643$, $\hat{\eta}_p^2 = .01$), Body Image State Scale BISS (F [2, 94] = .68, $p = .510$, $\hat{\eta}_p^2 = .01$), shame (Welch´s F [2, 57.93] = 1.46,

Table 1 Descriptive statistics of all three groups, means and standard deviations

Variable	PT (n=33)	NT (n=33)	Control (n=31)	Range	F (2, 94)	H (2)	χ^2	p
Age M (SD)	22.12 (3.59)	21.70 (2.95)	21.52 (2.57)	18–34		.303		.859
BMI M (SD)	21.84 (2.33)	21.50 (2.16)	21.71 (1.86)	18.51–28.63		.498		.780
Marital status n (%)							8.939	.320
Single	17 (51.52)	19 (57.58)	21 (67.74)					
In relationship/married	14 (42.42)	12 (42.42)	10 (32.26)					
Separated/divorced	2 (6.06)	0 (.00)	0 (.00)					
Questionnaires								
EDE-Q M (SD)	1.13 (.73)	1.03 (.68)	.87 (.55)	.11–2.75		1.543		.462
BDI II M (SD)	6.70 (4.51)	6.06 (5.13)	6.03 (4.29)	0–18		.718		.698
SISE M (SD)	1.64 (.60)	1.91 (.58)	2.00 (.45)	1–3	3.84			.025
PA M (SD)	2.93 (.55)	2.96 (.56)	3.04 (.48)	1.70–4.30		.880		.644
NA M (SD)	1.15 (.14)	1.16 (.20)	1.24 (.26)	1.00–2.30		3.344		.188

PT positive interpretation training, *NT* negative interpretation training, *BMI* Body Mass Index (kg/m^2), *EDE-Q* Eating Disorder Examination Questionnaire, *BDI II* Beck Depression Inventory II, *SISE* Single-Item Self-Esteem Scale (SISE), *PA and NA* Scale "Positive Affect" and "Negative Affect", respectively, of the Positive and Negative Affect Schedule

Table 2 Mean percentages of endorsement rates and reaction times (SD) before and after modification training

	PT	NT	Control	F (df)	p
Endorsement rate (%)					
Pre					
Positive	76.57 (12.37)	77.08 (9.19)	78.67 (11.47)	.30 (2, 92)	.740
Negative	32.69 (20.28)	26.45 (17.85)	26.44 (15.16)	1.25 (2, 89)	.292
Post					
Positive	85.35 (11.42)	81.35 (13.52)	83.56 (9.14)		
Negative	20.11 (19.02)	27.31 (18.20)	20.56 (16.38)		
Reaction time (ms)					
Pre					
Positive	1357.01 (324.37)	1298.86 (368.43)	1357.85 (323.05)	.31 (2, 92)	.734
Negative	1453.81 (403.93)	1493.00 (634.59)	1594.54 (963.01)	.42 (2, 89)	.659
Post					
Positive	1140.34 (308.07)	1074.76 (309.91)	1252.20 (345.25)		
Negative	1616.08 (786.77)	1442.00 (616.68)	1666.75 (1028.67)		

PT positive training group, *NT* negative training group, *Control* control group

$p = .240$), sadness (Welch´s F [2, 58.97] = 1.40, $p = .256$), frustration (F [2, 94] = .19, $p = .827$, $\hat{\eta}_p^2 = .004$), anxiety (F [2, 94] = .22, $p = .807$, $\hat{\eta}_p^2 = .01$), and disgust (F [2, 94] = .19, $p = .828$, $\hat{\eta}_p^2 = .004$).

Instruments

Tasks

The Sentence-Word Association Paradigm (SWAP) To assess interpretation tendencies of ambiguous eating disorder-relevant sentences and changes after training, participants conducted the SWAP before and after the IMP-ED. In contrast to the original WSAP version (Beard and Amir 2009), this computer-based program presents the ambiguous sentence before a valent word. The SWAP has been successfully applied to assess interpretation bias in depressed samples (Hindash and Amir 2012; Mobius et al. 2015). All ED-relevant stimuli have been previously developed and used in other studies (Dietel et al. 2018; Korn et al., submitted). After displaying a fixation cross for 500 ms on the screen in order to attract the participants' attention, an ambiguous sentence was presented for 3000 ms (e.g., "You calculate your BMI and find out it is in the normal range."). This was followed by either a positive or neutral word (e.g., "satisfied") or a negative word (e.g., "disappointed"). Further examples were, "You see your naked body in the mirror after taking a shower", followed by "handsome"vs. "dis-

gusting", or "Somebody tells you, you are curvy", followed by "feminine"vs. "fat". The word remained on the screen until the participants either pressed "S" on the keyboard if they thought that the sentence and word were related or "L" if they thought that the sentence and word were not related. Participants were instructed to answer as quickly as possible. Before the pre-assessment, 10 non-ED-related practice trials were presented. In the pre- and post-assessment, 60 ambiguous sentences were displayed, half of them followed by a positive word and the other half by a negative word. Positive and negative words were randomly presented.

Interpretation Modification Paradigm for Eating Disorders (IMP-ED) To induce the interpretation bias we slightly modified the SWAP. Participants were randomly assigned to one of three groups (NT, PT, control group). The NT group received positive feedback ("correct") if they rated an ambiguous sentence and a negative disorder-specific word as being related and negative feedback ("false") if they believed that an ambiguous sentence and a positive or neutral word were related. This feedback was reversed for the PT group, and the control group received no feedback. Each group received 60 ambiguous sentences and 10 unambiguous filler trials. Each sentence was presented twice—once combined with a positive word and once with a negative word, resulting in 140 trials. In line with Mobius et al. (2015), filler trials were added to prevent participants from merely reacting to the valence of the word without reading the previously presented sentence.

Cyberball Ostracism Task (COT; (Williams et al. 2000; Williams and Jarvis 2006) In order to provoke stress by an ambiguous ED-relevant stressor, participants underwent a modified version of the COT. This paradigm is an online ball-tossing game ostensibly played with two co-players who are, in fact, controlled by the program. In our experiment participants were told that the other players were people from research departments at cooperating institutions. Before the task started participants had to create their own profile (name, age, profession, education, hobbies). Furthermore, they were told that their co-players would see their profile together with the full-length photo taken at the beginning of the experiment. The participants were also shown profiles and full-length photos of their virtual (fictitious) very attractive and slender female co-players, displayed for the whole duration of the task. The task lasted about 6 min, during which stress induction was generated by excluding the participant after the first five tosses. The COT has been successfully used for stress induction and symptom activation in clinical samples (Heeren et al. 2012; Rehman et al. 2009; Westermann et al. 2012). Recovery from provoked effects has been found to take from one (Williams 2009) to 45 min (Zadro et al. 2006).

Measures of Psychopathology, Demographic Data, and Manipulation Check

Participants filled out a questionnaire which included the assessment of demographic data such as age, marital status, and profession, as well as the inclusion and exclusion criteria.

Beck Depression Inventory-II (BDI-II; German language version: Beck et al. 1996; Hautzinger et al. 2006) The BDI-II consists of 21 items assessing depressive psychopathology. Items are rated on a 4-point scale, with higher scores representing higher levels of pathology. For the present study, internal consistency of the total score was $\alpha = .82$. As mentioned above, the item "suicidality" was used as an exclusion criterion.

Eating Disorder Examination Questionnaire (EDE-Q; German language version: (Fairburn and Beglin 1994; Hilbert and Tuschen-Caffier 2006) The EDE-Q is a measure of ED psychopathology. It consists of 22 items (plus six items for diagnostic purposes) which can be assigned to four subscales (Shape Concern, Weight Concern, Eating Concern and Restraint). Items are rated on a 7-point scale, with higher scores reflecting higher levels of eating psychopathology. For the present study, internal consistency of the total score was $\alpha = .81$ and of the subscales $.55 \leq$ Cronbach's $\alpha \leq .82$.

Need Threat Questionnaire (NTQ; van Beest and Williams 2006; Williams 2009) The NTQ contains five scales (belonging, self-esteem, meaningful existence, control, mood) as well as a manipulation check. We only selected the manipulation check for the present study. Two items assessed the feeling of being ignored and excluded during the COT on a 5-point Likert scale, with a higher score indicating stronger feelings. One item assessed the estimated percentage of received balls. Additionally, we inserted one item asking for possible reasons for exclusion in the game (multiple-choice format: coincidence, transcription error, other team players are friends with each other, dislike of my person, boring profile, other reasons). Four further items assessed whether the participants were aware of the SWAP and COT before the experiment and assessed participants' assumptions about the purpose of these paradigms.

Positive and Negative Affect Schedule (PANAS; German language version: Krohne et al. 1996; Watson et al. 1988) The German adaptation of the PANAS assesses emotional states. It consists of 20 adjectives, 10 of which assess positive affects and 10 negative affects. Intensity of affects at a specific point in time is rated on a 5-point Likert scale, with a higher score reflecting a higher intensity. For the present

study, internal consistency was α = .81 for Positive Affect and α = .63 for Negative Affect.

Single-Item Self-Esteem Scale (SISE; Robins et al. 2001)

To control for individual differences in self-esteem, we administered the SISE. Participants were asked to indicate on a 4-point Likert scale to what extent they agreed with the item: "I have high self-esteem". A high score reflects a high self-esteem. The SISE is a reliable measure of self-esteem (retest reliability after 5 years $RR = .75$) and is highly correlated with the Rosenberg Self-Esteem Scale (Rosenberg 1965) $r = .72$–80, Robins et al. 2001).

State Measures

Body Image States Scale (BISS; Cash et al. 2002; Vocks et al. 2007)

This six-item measure assesses different domains of body experience, e.g., dissatisfaction with physical appearance, feelings of attractiveness. Items are rated on a 9-point Likert scale. A higher score indicates a higher body image satisfaction. For the present study, internal consistency was α = .39.

Negative Emotions

Changes in the five emotions anxiety, disgust, frustration, shame, and sadness were assessed using visual analogue scales (VAS). On a scale ranging from 0 to 100, participants rated how they felt at a certain point in time. Anchors were set at 0, 50, and 100 reflecting an increase in intensity. The VAS for anxiety, frustration, and sadness are translated and adapted versions which have been used in studies on the influence of media on body image and have shown high convergent validity (e.g., Durkin and Paxton 2002; Heinberg and Thompson 1995). The VAS for disgust and shame were developed for the present study and previous studies in samples with body dysmorphic disorder, respectively, as both emotions are central to these disorders (Fox and Power 2009; Kollei and Martin 2014).

State Self-Esteem Scale (SSES; German language version: Heatherton and Polivy 1991; Rudolph et al. 2015)

The SSES assesses three factors of self-esteem at a given point in time: performance self-esteem, social self-esteem, and appearance self-esteem. For the present study, we only used the scale "Appearance", which contains five items rated on a 5-point Likert scale. Higher scores indicate higher self-esteem. For this study, internal consistency was α = .31.

Procedure

After the participants had provided informed consent, three photos (full-length portraits) were taken of each participant in front of a white wall in a standardized room. Participants selected one of these three photos, which was ostensibly to

be used for a computer program for mood induction later on, but remained on the digital camera. Then, participants were individually taken to the laboratory and seated in front of the computer screen. All data were assessed using the computer program Inquisit 4 Web player 4.9.0. (Millisecond, Seattle).

In an online screening participants answered questions regarding sociodemographic characteristics, inclusion and exclusion criteria as well as symptoms of mental disorders. Subsequently, mood (VAS scales), body image satisfaction (BISS), and appearance-related self-esteem (scale "Appearance" of the SSES) were assessed as a first state measure (pre-assessment). After the pre-assessment of the interpretation bias using the SWAP without feedback, participants were randomly assigned by random number service to one of the three groups: While responding to the SWAP, participants either received feedback for the induction of a positive bias, feedback for the induction of a negative bias, or no feedback. Subsequently, a second state measure (post assessment) and a post-assessment of the interpretation bias using the SWAP without feedback were conducted. Afterwards participants completed the modified COT. Finally a last state measure (referred as post-COT assessment) and a manipulation check for the tasks were conducted. After the post-COT assessment, a debriefing took place. To adjust for a potential negative impact, participants in the NT group were offered the chance to perform the SWAP in the positive induction condition.

Statistical Analyses

Data analysis was conducted using SPSS Statistics Version 22. To evaluate demographic and psychosocial differences between groups, univariate analyses of variance (ANOVAs) or Kruskal–Wallis-H test or χ^2 tests were used. For the manipulation check of the COT, group differences using χ^2 and Fisher's exact tests were calculated. For each participant at both assessment points pre- and post-induction, the percentages of endorsement (endorsement rate) of positive and negative interpretations were calculated. Group differences at baseline were checked using univariate ANOVAs. To analyze effects on reaction times, we eliminated outliers defined as trials within the first and last percentile of all trials (Mobius et al. 2015). Then, for each participant, the mean reaction time for endorsing and rejecting positive and negative interpretations of each assessment point were calculated. We calculated three 3 (between-subject factor group: PT, NT, control) × 2 (within-subject factor time: pre-assessment, post-assessment) mixed repeated measures ANOVAs: first on the percentage of endorsements to investigate effects of the induction, second on reaction times for endorsement and rejection of positive and negative interpretations, and third to analyze training effects on body image satisfaction, appearance-related self-esteem, and negative

emotional states (anxiety, disgust, frustration, shame, and sadness). Finally, to analyze training effects on body image satisfaction and appearance-related self-esteem, and negative emotional states (anxiety, disgust, frustration, shame and sadness) after exposure to the COT, a 3 (between-subject factor group: PT, NT, control) × 3 (time: pre-assessment, post-assessment, post-COT-assessment) mixed repeated measures ANOVA was used. We did not insert SISE as a covariate because the SSES, which is more relevant for this study, did not differ between the groups at pre-assessment. As a measure of effect size, partial eta-squared is reported (small = .01; medium = .06; large = .14; Cohen 1992). For t-tests for dependent samples, Cohen's d_z is reported (small = .20, medium = .50, large = .80; Lakens 2013).

Results

Impact of Bias Induction on Endorsement Rates and Reaction Times

The repeated measures ANOVA on the endorsement rate of negative interpretations revealed a significant interaction effect between time and training group, $F(2, 89) = 9.28$, $p < .001, \hat{\eta}_p^2 = .17$. Three separate 2 × 2 repeated measures ANOVAs revealed a significant interaction effect between time and group comparing NT versus PT: $F(1, 60) = 15.25$, $p < .001, \hat{\eta}_p^2 = .20$, PT versus control group: $F(1, 59) = 4.15$, $p = .046$, $\hat{\eta}_p^2 = .07$, and NT versus control group: $F(1, 59) = 6.67$, $p = .012$, $\hat{\eta}_p^2 = .10$ (see Fig. 1).

The repeated measures ANOVAs on the endorsement rate of positive interpretations revealed no significant interaction effects, $F(2, 92) = 1.48$, $p = .238$, $\hat{\eta}_p^2 = .03$. Mean percentages of endorsement rates are presented in Table 2.

There were no significant interaction effects between time and group on reaction time for endorsement of positive interpretations ($F[2, 92] = 1.73$, $p = .183$, $\hat{\eta}_p^2 = .04$), for

endorsement of negative interpretations ($F[2, 87] = 1.21$, $p = .302$, $\hat{\eta}_p^2 = .03$), for rejection of negative interpretations ($F[2, 92] = 1.64$, $p = .200$, $\hat{\eta}_p^2 = .03$), or for rejection of positive interpretations ($F[2, 86] = .35$, $p = .709$, $\hat{\eta}_p^2 = .01$).

Impact of Bias Induction on State Body Satisfaction, Self-Esteem, and Negative Emotions

A repeated measures ANOVA on *appearance-related self-esteem* revealed a significant interaction effect between time and training group, $F[2, 94] = 3.60$, $p = .031$, $\hat{\eta}_p^2 = .07$. Three separate 2 × 2 repeated measures ANOVAs showed a significant interaction effect between time and group for PT versus NT ($F[1, 64] = 5.60$, $p = .021$, $\hat{\eta}_p^2 = .08$, and for NT versus control group ($F[1, 62] = 4.11$, $p = .047$, $\hat{\eta}_p^2 = .06$), but not for PT versus control group ($F[1, 62] = .05$, $p = .831$, $\hat{\eta}_p^2 < .00$). Figure 2 displays a decrease in appearance-related self-esteem in the NT group compared to the PT and control group, both of which minimally increase from pre- to post-assessment.

A repeated measures ANOVA on *body image satisfaction* revealed a significant interaction effect between time and training group, $F(2, 94) = 3.37$, $p = .039$, $\hat{\eta}_p^2 = .07$ (see Fig. 3). Only one of the three separate 2 × 2 repeated measures ANOVAs revealed a significant interaction effect between time and group (NT vs. PT: $F[1, 64] = 6.45$, $p = .014$, $\hat{\eta}_p^2 = .09$; NT versus control: $F[1, 62] = 3.09$, $p = .084$, $\hat{\eta}_p^2 = .05$; PT versus control: $F[1, 62] = .29$, $p = .592$, $\hat{\eta}_p^2 = .01$).

Separate 3 (group: PT, NT, control) × 2 (time: pre-assessment, post-assessment) repeated measures ANOVAs on the five *negative emotions* revealed no significant interaction effect between time and training group: shame ($F[2, 94] = 2.03$, $p = .137$, $\hat{\eta}_p^2 = .04$), sadness ($F[2, 94] = .73$, $p = .485$, $\hat{\eta}_p^2 = .02$), frustration ($F[2, 94] = .83$, $p = .440$, $\hat{\eta}_p^2 = .02$), anxiety ($F[2, 94] = .49$, $p = .613$, $\hat{\eta}_p^2 = .01$), and disgust ($F[2, 94] = .11$, $p = .897$, $\hat{\eta}_p^2 = .002$). However, there was a main effect of time for shame ($F[1, 94] = 4.61$,
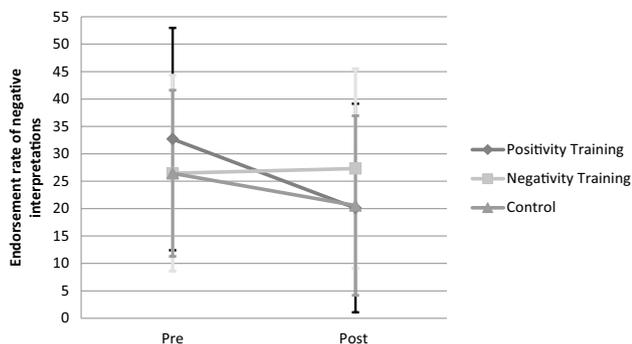

Fig. 1 Change of endorsement rate of negative interpretations from pre- to post- assessment time in the positive and negative interpretation bias training groups, and the control group
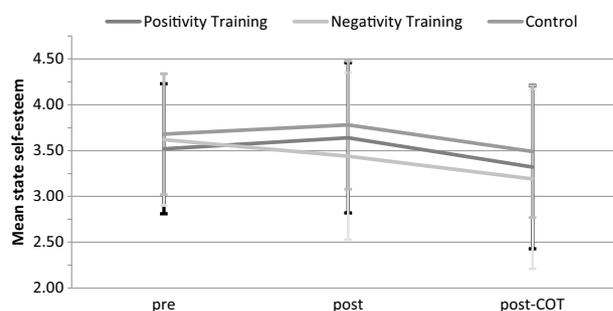

Fig. 2 Change of state self-esteem from pre- to post- and post-COT assessment time in the positive and negative interpretation bias training groups, and the control group. Error bars represent standard deviations
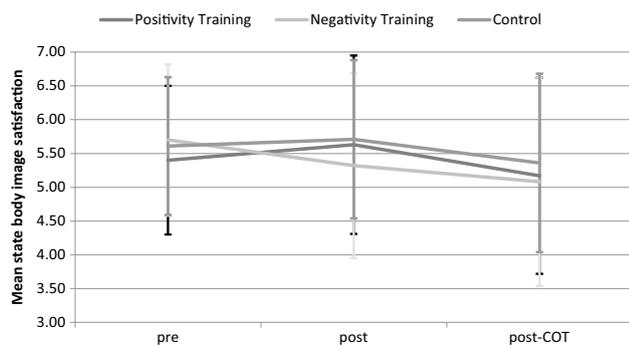
Fig. 3 Change of state body image satisfaction from pre- to post- and post-COT assessment time in the positive and negative interpretation bias training groups, and the control group. Error bars represent standard deviations

Table 3 Means and standard deviations of mood states at pre-, post- and post-COT assessment time

	PT Mean (SD)	NT Mean (SD)	Control Mean (SD)
Mood			
Shame			
Pre	14.33 (22.55)	7.39 (12.03)	11.65 (18.19)
Post	7.33 (17.14)	7.61 (16.14)	8.87 (19.25)
Post-COT	13.15 (22.27)	15.21 (23.85)	12.87 (22.70)
Sadness			
Pre	9.33 (14.95)	6.73 (12.96)	14.71 (23.64)
Post	8.18 (16.89)	9.76 (18.0)	15.16 (27.23)
Post-COT	12.82 (20.62)	15.39 (26.17)	17.94 (28.53)
Frustration			
Pre	19.58 (20.70)	16.06 (24.39)	17.29 (25.27)
Post	13.61 (22.40)	15.79 (24.41)	16.55 (28.08)
Post-COT	18.91 (25.92)	26.45 (33.48)	24.48 (29.57)

PT positive training group, *NT* negative training group, *Control* control group

$p = .034$, $\hat{\eta}_p^2 = .05$), revealing a decrease in shame in all groups (see Table 3 for means and SDs).

Impact of Bias Induction on Emotional Vulnerability

Manipulation check

The item "being ignored" reached a mean of 3.87 ($SD = 1.07$) and "being excluded" a mean of 3.93 ($SD = 1.05$). ANOVAs revealed no significant effect of group for either of these items ($ps > .10$). The estimated amount of received balls ranged from 3 to 100%, with a mean of 13.03% ($SD = 10.68$). A total of 15 participants (15.5%) stated that they detected the manipulation of the COT. As they were

equally distributed across the three groups (χ^2 [2] = .48, $p = .787$, V = .1) and their data did not present as outliers, they were not excluded from analysis. Three other participants reported that they had heard about the paradigm before (3.1%; $p = .535$). Reasons stated for being excluded in the game were (multiple reasons could be chosen): coincidence (50.5%), other players being friends (44.3%), dislike of participant (28.9%), boring profile of participant (18.6%), bad internet connection (18.6%), lack of attractiveness of participant (14.4%), and other reasons (23.7%). All Chi squared tests on these reasons revealed no significant group differences ($ps > .10$). The manipulation check of the SWAP revealed that 10 participants (10.3%) had heard about the task before. They remained in the dataset because they were equally distributed across the groups (χ^2 [2] = .98, $p = .610$, V = .1) and their data also did not present as outliers.

A repeated measures ANOVA on *appearance-related self-esteem* revealed no significant interaction effect between time and training group, F (4, 188) = 1.96, $p = .102$, $\hat{\eta}_p^2 = .04$. We found a main effect of time (F [2, 93] = 14.99, $p < .001$, $\hat{\eta}_p^2 = .24$), indicating an overall reduction in appearance-related self-esteem from post- to post-COT assessment (see Fig. 2).

A repeated measures ANOVA on *body image satisfaction* revealed no significant interaction effect between time and training group, F (4, 188) = 1.68, $p = .156$, $\hat{\eta}_p^2 = .04$. The main effect of time reached significance (F [2, 93] = 6.85, $p = .002$, $\hat{\eta}_p^2 = .13$), revealing a general decline in body image satisfaction in all participants from post- to post-COT assessment (see Fig. 3).

Separate repeated measures ANOVAs *on the five negative emotions* revealed no significant time x training group interactions (all $ps > .05$). The ANOVAs with Greenhouse–Geisser corrections revealed significant main effects of time for shame (F [1.8, 188] = 5.44, $p = .007$, $\hat{\eta}_p^2 = .06$), sadness (F [1.6, 188] = 3.82, $p = .032$, $\hat{\eta}_p^2 = .04$), and frustration (F [1.7, 188] = 5.08, $p = .010$, $\hat{\eta}_p^2 = .05$), indicating a drop in mood in all groups from post- to post-COT assessment (see Table 3).

Discussion

The aim of the present study was to investigate the relevance of an ED-related interpretation bias to the genesis of ED. Thus, we examined whether such a bias can be experimentally induced and has an impact on disorder-specific symptoms and emotional vulnerability.

First, regarding the modification of interpretation tendencies, the results showed that the IMP-ED enhances an adaptive bias by significantly reducing the acceptance of negative interpretations after the PT. Interestingly, the results of a meta-analysis (Menne-Lothmann et al. 2014) showed that on average 67% of participants increased their

endorsement of positive interpretations after PT, but that this effect was not significant for mentally healthy samples and was increased in samples with mood symptoms. In our findings, IMP-ED resulted in a reduction of the threat bias rather than an induced positive bias. Contrary to our expectations but in line with a study in depressed participants, we did not find training effects in the NT on any outcome measures of the WSAP (Joormann et al. 2015). In view of the fact that our sample consisted only of healthy participants, mainly students who had no lifetime mental disorders, this finding might be explained by reactance effects in the NT group (Mobius et al. 2015), if participants became aware of the training contingencies (Beard and Amir 2008). The negative feedback was rather explicit and, therefore, was probably in conflict with their natural reaction tendency. As a solution to decrease participants' negative reactions to negative feedback and thus enhance the effects of the IMP, it might be worthwhile to reinforce interpretation patterns more implicitly (Mobius et al. 2015). Additionally, induction of negative biases might only be successful in at-risk samples assuming to find there less reactance, as the negative feedback might be more in line with their natural reaction patterns. Yet, this has not been tested, and might be ethically doubtful.

Our second aim was to examine the efficacy of the IMP-ED in terms of affecting ED symptoms and reducing emotional vulnerability. As expected, reinforcing negative interpretations led to a short-term decrease in appearance-related self-esteem. NT also led to a significant reduction in body image satisfaction, however, only compared to the PT. Against our hypothesis, PT did not significantly increase body satisfaction or appearance-related self-esteem but corresponds to the pattern of the control group, which might represent a ceiling effect in this mentally healthy control group. In line with Mobius et al. (2015) but in contrast to results of the meta-analysis by (Menne-Lothmann et al. 2014), the IMP-ED did not differentially affect negative emotions. Only descriptively but not significantly data revealed reductions in negative affect in the PT condition, e.g., a decrease in shame and frustration. Nevertheless, overall these short-term effects on ED-relevant symptoms provide first evidence for the effectiveness of the IMP-ED. Future studies might want to assess the impact of bias induction on even more ED-specific symptoms, e.g., drive for thinness or eating-specific beliefs.

As an efficient CBM technique, beneficial effects of a single interpretive training session should also become apparent in attenuated levels of emotional vulnerability in response to a stressor. Contrary to our expectations, we did not find beneficial effects on stress reactivity, measured as alterations in negative emotions, appearance-related self-esteem, and body image satisfaction from pre- to post-COT. This is in line with Yiend et al. (2014), who were able to effectively change the interpretation bias in depressed adults within a single session, without finding a reduction in self-reported stress responding. In contrast several studies have shown that emotional vulnerability changed in the absence of mood changes during CBM (Amir et al. 2008; Hirsch et al. 2007; MacLeod et al. 2002; Wilson et al. 2006). It should be considered that CBM-I effects may not immediately become apparent after a single session (Hallion and Ruscio 2011; Menne-Lothmann et al. 2014). Therefore, studies investigating the effects of multi-session CBM-I on emotional vulnerability are needed. Moreover, in our sample reactance effects might have led to similar healthy emotional response patterns in the NT to those in the PT group (see Mobius et al. 2015). As the effects of modification programs on disorder-relevant symptoms seem to be moderated by the extent of a successful induction (e.g., Beard and Amir 2008; Cowden Hindash and Rottenberg 2017; Hallion and Ruscio 2011), the lack of induction of a negative bias may be responsible for the absence of group differences in emotional vulnerability after the stress test.

The results of the manipulation check and the significant main effects of time indicate rather a general effect of the COT paradigm. In our study, all participants reported a decrease in appearance-related self-esteem, lower body image satisfaction, and higher levels of shame, sadness and frustration after the ostracism task. As social rejection seems to be highly relevant for samples with ED (Rieger et al. 2017, 2010) and should therefore function as an adequate stressor, further studies in clinical samples with ED or at-risk groups using the COT paradigm might yield larger effects on emotional vulnerability and a higher impact of the bias induction on reactivity to COT.

Some limitations of the study need to be mentioned. IMP-ED did not succeed in revealing the interpretation bias on reaction time measures. This is in line with a previous study testing the IMP for depression, which compared two extreme training conditions to a control group (Mobius et al. 2015). Previous research using the WSAP yielded mixed results regarding changes in reaction time (Amir et al. 1998, 2012; Hindash and Amir 2012), which might at least partially be explained by the interdependency of reaction time measures and response choices. A higher number of trials could minimize this effect (Mobius et al. 2015; Ogniewicz et al. 2014). Future studies may also include a multi-method approach for the examination of stress, rather than the exclusive reliance on self-report measures (Joormann et al. 2015). As we did not include an independent measure of interpretation bias, we cannot rule out that participants simply learned a rule about how to respond (Salemink et al. 2007). It is of note that most of our participants were psychology students and 10 women had heard about the SWAP before. However, as they were equally distributed across all the three groups and did not qualify as outliers, they were not removed from the dataset. Another limitation is the high number of ANOVAs

without corrections for multiple testing. We decided not to use correction for multiple testing, as we did not want to miss potential small training effects in this first proof-of-concept study (O'Keefe 2003). Finally, also due to our proof-of-principle design, we are unable to draw conclusions on the effectiveness of the IMP-ED in clinical or at-risk samples.

This is the first study to indicate that initial interpretation tendencies in response to ambiguous eating disorder-relevant situations can be partially changed by IMP-ED in a healthy sample. Our findings, therefore, provide a basis and underline the need for further research on interpretation modification effects on psychopathology. Although we did not find differential training effects on emotional vulnerability in our sample, the results suggest that the IMP-ED may have clinical utility.

Compliance with Ethical Standards

References

Amir, N., Foa, E. B., & Coles, M. E. (1998). Negative interpretation bias in social phobia. *Behaviour Research and Therapy, 36*(10), 945–957.

Amir, N., Weber, G., Beard, C., Bomyea, J., & Taylor, C. T. (2008). The effect of a single-session attention modification program on response to a public-speaking challenge in socially anxious individuals. *Journal of Abnormal Psychology, 117*(4), 860–868. https://doi.org/10.1037/a0013445.

Amir, N., Bomyea, J., & Beard, C. (2010). The effect of single-session interpretation modification on attention bias in socially anxious individuals. *Journal of Anxiety Disorders, 24*(2), 178–182. https://doi.org/10.1016/j.janxdis.2009.10.005.

Amir, N., Prouvost, C., & Kuckertz, J. M. (2012). Lack of a benign interpretation bias in social anxiety disorder. *Cognitive Behaviour Therapy, 41*(2), 119–129. https://doi.org/10.1080/16506073.2012.662655.

Aspen, V., Darcy, A. M., & Lock, J. (2013). A review of attention biases in women with eating disorders. *Cognition and Emotion, 27*(5), 820–838. https://doi.org/10.1080/02699931.2012.749777.

Beard, C., & Amir, N. (2008). A multi-session interpretation modification program: Changes in interpretation and social anxiety symptoms. *Behaviour Research and Therapy, 46*(10), 1135–1141. https://doi.org/10.1016/j.brat.2008.05.012.

Beard, C., & Amir, N. (2009). Interpretation in social anxiety: When meaning precedes ambiguity. *Cognitive Therapy and Research, 33*(4), 406–415. https://doi.org/10.1007/s10608-009-9235-0.

Beck, A. T., & Clark, D. A. (1997). An information processing model of anxiety: Automatic and strategic processes. *Behaviour Research and Therapy, 35*(1), 49–58.

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Manual for the Beck Depression Inventory-II*. San Antonio, TX: Psychological Corporation.

Brooks, S., Prince, A., Stahl, D., Campbell, I. C., & Treasure, J. (2011). A systematic review and meta-analysis of cognitive bias to food stimuli in people with disordered eating behaviour. *Clinical Psychology Review, 31*(1), 37–51. https://doi.org/10.1016/j.cpr.2010.09.006.

Cardi, V., Turton, R., Schifano, S., Leppanen, J., Hirsch, C. R., & Treasure, J. (2017). Biased Interpretation of Ambiguous Social Scenarios in Anorexia Nervosa. *European Eating Disorders Review, 25*(1), 60–64. https://doi.org/10.1002/erv.2493.

Cash, T. F., Fleming, E. C., Alindogan, J., Steadman, L., & Whitehead, A. (2002). Beyond body image as a trait: The development and validation of the Body Image States Scale. *Eating Disorders, 10*(2), 103–113. https://doi.org/10.1080/10640260290081678.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155–159. https://doi.org/10.1037/0033-2909.112.1.155.

Cooper, M. (1997). Bias in interpretation of ambiguous scenarios in eating disorders. *Behaviour Research and Therapy, 35*(7), 619–626.

Cowden Hindash, A. H., & Rottenberg, J. A. (2017). Moving towards the benign: Automatic interpretation bias modification in dysphoria. *Behaviour Research and Therapy, 99,* 98–107. https://doi.org/10.1016/j.brat.2017.09.005.

Cristea, I. A., Kok, R. N., & Cuijpers, P. (2015). Efficacy of cognitive bias modification interventions in anxiety and depression: Meta-analysis. *British Journal of Psychiatry, 206*(1), 7–16. https://doi.org/10.1192/bjp.bp.114.146761.

Dietel, F. A., Möbius, M., Steinbach, L., Dusend, C., Wilhelm, S., & Buhlmann, U. (2018). Effects of induced appearance-related interpretation bias: A test of the cognitive-behavioral model of body dysmorphic disorder. *Journal of Behavior Therapy and Experimental Psychiatry, 61,* 180–187. https://doi.org/10.1016/j.jbtep.2018.07.003.

Durkin, S. J., & Paxton, S. J. (2002). Predictors of vulnerability to reduced body image satisfaction and psychological wellbeing in response to exposure to idealized female media images in adolescent girls. *Journal of Psychosomatic Research, 53*(5), 995–1005.

Eysenck, M. W., Mogg, K., May, J., Richards, A., & Mathews, A. (1991). Bias in interpretation of ambiguous sentences related to threat in anxiety. *Journal of Abnormal Psychology, 100*(2), 144–150.

Fairburn, C. G., & Beglin, S. J. (1994). Assessment of eating disorders: Interview or self-report questionnaire? *International Journal of Eating Disorders, 16*(4), 363–370.

Fairburn, C. G., Cooper, Z., & Shafran, R. (2003). Cognitive behaviour therapy for eating disorders: A "transdiagnostic" theory and treatment. *Behaviour Research and Therapy, 41*(5), 509–528.

Fox, J. R., & Power, M. J. (2009). Eating disorders and multi-level models of emotion: An integrated model. *Clinical Psychology & Psychotherapy, 16*(4), 240–267. https://doi.org/10.1002/cpp.626.

Grey, S., & Mathews, A. (2000). Effects of training on interpretation of emotional ambiguity. *Quarterly Journal of Experimental Psychology. A, Human Experimental Psychology, 53*(4), 1143–1162. https://doi.org/10.1080/713755937.

Griffith, E., Kuyken, W., Watkins, E., & Jones, A. (2015). Do Females with Bulimia Nervosa and Eating Disorder Not Otherwise Specified Have Selective Memory Biases? *Behav Cogn Psychother, 43*(5), 602–613. https://doi.org/10.1017/s1352465814000058.

Hallion, L. S., & Ruscio, A. M. (2011). A meta-analysis of the effect of cognitive bias modification on anxiety and depression. *Psychological Bulletin, 137*(6), 940–958. https://doi.org/10.1037/a0024355.

Hartgerink, C. H., van Beest, I., Wicherts, J. M., & Williams, K. D. (2015). The ordinal effects of ostracism: A meta-analysis of 120 Cyberball studies. *PLoS ONE, 10*(5), e0127002. https://doi.org/10.1371/journal.pone.0127002.

Hautzinger, M., Keller, F., & Kühner, C. (2006). *Das Beck Depressionsinventar II. Deutsche Bearbeitung und Handbuch zum BDI II*. Frankfurt a.M.: Harcourt Test Services.

Heatherton, T. F., & Polivy, J. (1991). Development and validation of a scale for measuring state self-esteem. *Journal of Personality and Social Psychology, 60*(6), 895–910.

Heeren, A., Peschard, V., & Philippot, P. (2012). The casual role of attention bias for threat cues in social anxiety: A test on a cyber-ostracism task. *Cognitive Therapy and Research, 36*(5), 512–521. https://doi.org/10.1007/s10608-011-9394-7.

Heinberg, L. J., & Thompson, J. K. (1995). Body image and televised images of thinness and attractiveness: A controlled laboratory investigation. *Journal of Social and Clinical Psychology, 14*(4), 325–338.

Hilbert, A., & Tuschen-Caffier, B. (2006). *Eating Disorder Examination-Questionnaire: Deutschsprachige Übersetzung*. Münster: Verlag für Psychotherapie.

Hindash, A. H. C., & Amir, N. (2012). Negative interpretation bias in individuals with depressive symptoms. *Cognitive Therapy and Research, 36*(5), 502–511. https://doi.org/10.1007/s10608-011-9397-4.

Hirsch, C. R., Mathews, A., & Clark, D. M. (2007). Inducing an interpretation bias changes self-imagery: A preliminary investigation. *Behaviour Research and Therapy, 45*(9), 2173–2181. https://doi.org/10.1016/j.brat.2006.11.001.

Hirsch, C. R., Meeten, F., Krahe, C., & Reeder, C. (2016). Resolving ambiguity in emotional disorders: The nature and role of interpretation biases. *Annual Review of Clinical Psychology, 12,* 281–305. https://doi.org/10.1146/annurev-clinpsy-021815-093436.

Jackman, L. P., Williamson, D. A., Netemeyer, R. G., & Anderson, D. A. (1995). Do weight-preoccupied women misinterpret ambiguous stimuli related to body size? *Cognitive Therapy and Research, 19*(3), 341–355. https://doi.org/10.1007/BF02230404.

Joormann, J., Waugh, C. E., & Gotlib, I. H. (2015). Cognitive bias modification for interpretation in major depression: Effects on memory and stress reactivity. *Clinical Psychological Science, 3*(1), 126–139. https://doi.org/10.1177/2167702614560748.

Kollei, I., & Martin, A. (2014). Body-related cognitions, affect and post-event processing in body dysmorphic disorder. *Journal of Behavior Therapy and Experimental Psychiatry, 45*(1), 144–151. https://doi.org/10.1016/j.jbtep.2013.09.005.

Korn, J., Dietel, F.A., Hartmann, A.S. (2019). *Is it only about being fat? The specificity of interpretation biases in women with eating disorder symptoms: An online experimental assessment*. Manuscript submitted for publication.

Krohne, H. W., Egloff, B., Kohlmann, C.-W., & Tausch, A. (1996). Untersuchung mit einer deutschen Form der Positive and Negative Affect Schedule (PANAS). *Diagnostica, 42*(2), 139–156.

Krones, P. G., Stice, E., Batres, C., & Orjada, K. (2005). In vivo social comparison to a thin-ideal peer promotes body dissatisfaction: A randomized experiment. *International Journal of Eating Disorders, 38*(2), 134–142. https://doi.org/10.1002/eat.20171.

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for t-tests and ANOVAs. *Frontiers in Psychology*. https://doi.org/10.3389/fpsyg.2013.00863.

Lawson, C., MacLeod, C., & Hammond, G. (2002). Interpretation revealed in the blink of an eye: Depressive bias in the resolution of ambiguity. *Journal of Abnormal Psychology, 111*(2), 321–328.

Lee, M., & Shafran, R. (2004). Information processing biases in eating disorders. *Clinical Psychology Review, 24*(2), 215–238. https://doi.org/10.1016/j.cpr.2003.10.004.

Mackintosh, B., Mathews, A., Yiend, J., Ridgeway, V., & Cook, E. (2006). Induced biases in emotional interpretation influence stress vulnerability and endure despite changes in context. *Behavior Therapy, 37*(3), 209–222. https://doi.org/10.1016/j.beth.2006.03.001.

MacLeod, C., Rutherford, E., Campbell, L., Ebsworthy, G., & Holker, L. (2002). Selective attention and emotional vulnerability: Assessing the causal basis of their association through the experimental manipulation of attentional bias. *Journal of Abnormal Psychology, 111*(1), 107–123.

Mathews, A., & Mackintosh, B. (2000). Induced emotional interpretation bias and anxiety. *Journal of Abnormal Psychology, 109*(4), 602–615.

Mathews, A., & MacLeod, C. (2002). Induced processing biases have causal effects on anxiety. *Cognition and Emotion, 16,* 331–354.

Menne-Lothmann, C., Viechtbauer, W., Hohn, P., Kasanova, Z., Haller, S. P., Drukker, M., et al. (2014). How to boost positive interpretations? A meta-analysis of the effectiveness of cognitive bias modification for interpretation. *PLoS ONE, 9*(6), e100925. https://doi.org/10.1371/journal.pone.0100925.

Misener, K., & Libben, M. (2017). Risk for eating disorders modulates interpretation bias in a semantic priming task. *Body Image, 21,* 103–106. https://doi.org/10.1016/j.bodyim.2017.03.004.

Mobius, M., Tendolkar, I., Lohner, V., Baltussen, M., & Becker, E. S. (2015). Refilling the half-empty glass—Investigating the potential role of the Interpretation Modification Paradigm for Depression (IMP-D). *Journal of Behavior Therapy and Experimental Psychiatry, 49*(Pt A), 37–43. https://doi.org/10.1016/j.jbtep.2015.03.002.

Murphy, R., Hirsch, C. R., Mathews, A., Smith, K., & Clark, D. M. (2007). Facilitating a benign interpretation bias in a high socially anxious population. *Behaviour Research and Therapy, 45*(7), 1517–1529. https://doi.org/10.1016/j.brat.2007.01.007.

Ogniewicz, A. S., Dugas, M. J., Langlois, F., Gosselin, P., & Koerner, N. (2014). An adapted word-sentence association paradigm for generalized anxiety and worry: Assessing interpretation bias. *Journal of Experimental Psychopathology, 5*(4), 457–476. https://doi.org/10.5127/jep.00.

O'Keefe, D. J. (2003). Colloquy: Should familywise alpha be adjusted? *Human Communication Research, 29*(3), 431–447.

Polivy, J., & Herman, C. P. (2017). Restrained eating and food cues: Recent findings and conclusions. *Current Obesity Reports, 6*(1), 79–85. https://doi.org/10.1007/s13679-017-0243-1.

Popescu, A. M., & Băban, A. (2014). Cognitive biases as vulnerability factors to emotional disorders: A developmental perspective. *Cognition, Brain, Behavior: An Interdisciplinary Journal*, *18*(3), 229–242.

Premo, J. E., Sarfan, L. D., & Clerkin, E. M. (2016). Training interpretation biases among individuals with body dysmorphic disorder symptoms. *Body Image, 16,* 54–62. https://doi.org/10.1016/j.bodyim.2015.11.004.

Rehman, U. S., Ebel-Lam, A., Mortimer, A., & Mark, K. (2009). Self-confirmation striving in depression: An extension to the affective domain using an experimental design. *European Journal of Social Psychology, 39,* 900–908. https://doi.org/10.1002/ejsp.583.

Rieger, E., Van Buren, D. J., Bishop, M., Tanofsky-Kraff, M., Welch, R., & Wilfley, D. E. (2010). An eating disorder-specific model of interpersonal psychotherapy (IPT-ED): Causal pathways and

treatment implications. *Clinical Psychology Review, 30*(4), 400–410. https://doi.org/10.1016/j.cpr.2010.02.001.

Rieger, E., Dolan, A., Thomas, B., & Bell, J. (2017). The effect of interpersonal rejection on attentional biases regarding thin-ideal and non-thin images: The moderating role of body weight- and shape-based self-worth. *Body Image, 22,* 78–86. https://doi.org/10.1016/j.bodyim.2017.06.002.

Robins, R. W., Hendin, H. M., & Tresniewski, K. H. (2001). Measuring global self-esteem: Construct validation of a single item measure and the Rosenberg Self-Esteem Scale. *Personality and Social Psychology Bulletin, 27*(2), 151–161. https://doi.org/10.1177/0146167201272002.

Rosenberg, M. (1965). *Society and the adolescent self-image.* Princeton, NJ: Princeton University.

Rosser, B. A., Moss, T., & Rumsey, N. (2010). Attentional and interpretative biases in appearance concern: An investigation of biases in appearance-related information processing. *Body Image, 7*(3), 251–254. https://doi.org/10.1016/j.bodyim.2010.02.007.

Rudolph, A., Schröder-Abé, M., & Schütz, A. (2015). Development and validation of a German-language version of the State-Self-Esteem Scale. Poster presented at the XXIX International Congress of Psychology 2008 in Berlin. In Chemnitz: Universität, Institut für Psychologie.

Salemink, E., van den Hout, M., & Kindt, M. (2007). Trained interpretive bias and anxiety. *Behaviour Research and Therapy, 45*(2), 329–340. https://doi.org/10.1016/j.brat.2006.03.011.

Shafran, R., Lee, M., Cooper, Z., Palmer, R. L., & Fairburn, C. G. (2007). Attentional bias in eating disorders. *International Journal of Eating Disorders, 40*(4), 369–380. https://doi.org/10.1002/eat.20375.

Stice, E. (2002). Risk and maintenance factors for eating pathology: A meta-analytic review. *Psychological Bulletin, 128*(5), 825–848.

Summers, B. J., & Cougle, J. R. (2016). Modifying interpretation biases in body dysmorphic disorder: Evaluation of a brief computerized treatment. *Behaviour Research and Therapy, 87,* 117–127. https://doi.org/10.1016/j.brat.2016.09.005.

Summers, B. J., & Cougle, J. R. (2018). Effects of an appearance-focused interpretation training intervention on eating disorder symptoms. *Behavioural and Cognitive Psychotherapy, 46*(6), 676–689.

van Beest, I., & Williams, K. D. (2006). When inclusion costs and ostracism pays, ostracism still hurts. *Journal of Personality and Social Psychology, 91*(5), 918–928. https://doi.org/10.1037/0022-3514.91.5.918.

Vitousek, K. B., & Hollon, S. D. (1990). The investigation of schematic content and processing in eating disorders. *Cognitive Therapy and Research, 14*(2), 191–214. https://doi.org/10.1007/BF01176209.

Vocks, S., Legenbauer, T., & Heil, A. (2007). Food intake affects state body image: Impact of restrained eating patterns and concerns about eating, weight and shape. *Appetite, 49*(2), 467–475. https://doi.org/10.1016/j.appet.2007.03.006.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*(6), 1063–1070. https://doi.org/10.1037/0022-3514.54.6.1063.

Westermann, S., Kesting, M. L., & Lincoln, T. M. (2012). Being deluded after being excluded? How emotion regulation deficits in paranoia-prone individuals affect state paranoia during experimentally induced social stress. *Behavior Therapy, 43*(2), 329–340. https://doi.org/10.1016/j.beth.2011.07.005.

Williams, K. D. (2009). Ostracism: A temporal need-threat model. *Advances in Experimental Social Psychology, 41,* 275–314. https://doi.org/10.1016/S0065-2601(08)00406-1.

Williams, K. D., & Jarvis, B. (2006). Cyberball: A program for use in research on interpersonal ostracism and acceptance. *Behavior Research Methods, 38*(1), 174–180.

Williams, K. D., Cheung, C. K., & Choi, W. (2000). Cyberostracism: Effects of being ignored over the Internet. *Journal of Personality and Social Psychology, 79*(5), 748–762.

Williams, J. M. G., Watts, F. N., MacLeod, C., & Mathews, A. (1997). *Cognitive psychology and the emotional disorders* (2nd ed.). New York: John Wiley & Sons.

Williamson, D. A., Perrin, L., Blouin, D. C., & Barbin, J. M. (2000). Cognitive bias in eating disorders: Interpretation of ambiguous body-related information. *Eat Weight Disord, 5*(3), 143–151.

Williamson, D. A., White, M. A., York-Crowe, E., & Stewart, T. M. (2004). Cognitive-behavioral theories of eating disorders. *Behavior Modification, 28*(6), 711–738. https://doi.org/10.1177/0145445503259853.

Wilson, E. J., MacLeod, C., Mathews, A., & Rutherford, E. M. (2006). The causal role of interpretive bias in anxiety reactivity. *Journal of Abnormal Psychology, 115*(1), 103–111. https://doi.org/10.1037/0021-843x.115.1.103.

Yiend, J., Mackintosh, B., & Mathews, A. (2005). Enduring consequences of experimentally induced biases in interpretation. *Behaviour Research and Therapy, 43*(6), 779–797. https://doi.org/10.1016/j.brat.2004.06.007.

Yiend, J., Lee, J. S., Tekes, S., Atkins, L., Mathews, M., Vrinten, M., et al. (2014). Modifying interpretation in a clinically depressed sample using 'cognitive modification errors': A double blind randomised controlled trial. *Cognitive Therapy and Research, 38*(2), 146–159. https://doi.org/10.1007/s10608-013-9571-y.

Zadro, L., Boland, C., & Richardson, R. (2006). How long does it last? The persistence of the effects of ostracism in the socially anxious. *Journal of Experimental Social Psychology, 42,* 692–697. https://doi.org/10.1016/j.jesp.2005.10.007.