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Effect of modifying negative interpretation bias toward ambiguous social stimuli across eating and personality disorders

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Abstract

Objective: Heightened sensitivity toward social rejection has been implicated in eating disorders (ED) and personality disorder (PD). This study examined the effect of a cognitive bias modification training (CBM-I) targeting the interpretation of ambiguous social situations in individuals with comorbid ED and PD.

Method: A total of 128 participants [33 with ED and PD, 22 with ED-only, 22 with PD-only, and 51 healthy controls (HC)] were recruited from a hospital and university settings, and included in the final analyses. The participants were randomly assigned to a CBM-I task with benign resolutions or a control task with neutral resolutions in a counterbalanced order in two sessions using a within-subject design. Interpretation bias toward social stimuli was measured using the ambiguous sentence completion task before and after completing the assigned task.

Results: The CBM-I task increased benign and decreased negative interpretations with large effect sizes in the diagnostic groups, and with a moderate effect size in the HC group. Participants' anxiety levels were also reduced after the task. The size of the change in negative interpretation was positively associated with baseline negative affect, and negatively associated with baseline positive affect.

Discussion: The results suggest that modifying interpretation bias has the potential as a transdiagnostic target of treatment for ED and PD, and a fully powered clinical trial with consecutive sessions would be warranted.

Public Significance: Participants with eating disorders and/or personality disorder, and healthy controls completed a single session of a cognitive training intervention targeting rejection sensitivity. The training produced a large decrease in negative interpretation in the diagnostic groups, and a moderate effect in healthy controls. The findings indicate that training for positive processing of social information may be of value to augment treatment in conditions such as eating disorders and personality disorder, in which there are high levels of rejection sensitivity.

Zhen An and Kyung Hwa Kwag are joint first authors.

Janet Treasure and Youl-Ri Kim are joint last authors.

KEYWORDS
anorexia nervosa, bulimia nervosa, cognitive bias modification for interpretation (CBM-I), comorbidity, eating disorder, emotion regulation, personality disorder, rejection sensitivity, transdiagnostic approach

1 | INTRODUCTION

Eating disorders (ED) and personality disorder (PD) are highly comorbid. The prevalence of PD, including avoidant PD, obsessive-compulsive PD, and borderline PD in patients with ED has been found to be approximately 52% (Martinussen et al., 2017). Patients with ED and comorbid PD have a more complex prognosis with more severe clinical symptoms compared to patients with ED and other comorbid axis I disorders or those without comorbidities (Helverskov et al., 2010).

Difficulties in emotion regulation have been identified as a transdiagnostic construct between eating and personality psychopathology (Sloan et al., 2017). Rejection sensitivity has been proposed as a mechanism that can lead to emotion dysregulation. Patients with ED are characterized by heightened rejection sensitivity (Cardi et al., 2013; Rowlands et al., 2021). Rejection sensitivity has been reported to dysregulate eating behaviors in people with PD (Selby et al., 2010).

Negative interpretation bias toward ambiguous social stimuli may be a cognitive mechanism that underlies the heightened sensitivity to social rejection (Turton et al., 2018). A review of cognitive bias modification for interpretation (CBM-I) targeting biases related to appearance and self-worth among healthy, subclinical and clinical populations with ED showed a moderate-to-large reduction in such biases (Matheson et al., 2019). A library of CBM-I scenarios portraying the types of social rejection relevant to young people with ED was developed (Rowlands et al., 2020) and used in online multi-session CBM-I training for adolescents with anorexia nervosa (AN) and bulimia nervosa (BN). The results showed decreases in negative interpretations of ambiguous social situations and in ED psychopathology (Rowlands et al., 2022). CBM-I targeting rejection sensitivity has also been found to be effective in reducing negative interpretations and repetitive negative thinking in those with mood and anxiety disorders (e.g., Hirsch et al., 2018; Salemink et al., 2014). As far as we know, no research on the CBM-I effect in PD has been published. However, considering the elevated rejection sensitivity in PD, we hypothesized we will also find a decrease in the negative interpretations of ambiguous social situations as a result of CBM-I training in people with PD.

Precision psychiatry may involve using a transdiagnostic approach which allows treatments to be delivered through one single protocol, increasing the treatment efficiency and efficacy. This requires a deeper phenotyping in order to investigate facets of the core psychopathology, which includes social and interpersonal function, reward reinforcement, anxiety sensitivity, cognitive styles, and other biomarkers (Kan et al., 2019). However, the results from meta-analyses of treatment efficacy of transdiagnostic intervention programmes were mixed (Fusar-Poli et al., 2019; Sakiris & Berle, 2019). Among different transdiagnostic approaches, the shared mechanism approach received increased empirical support (Sakiris & Berle, 2019). In regard to the shared mechanism, a cognitive mechanism for sensitivity to social rejection is considered as a target of transdiagnostic approach for ED and PD.

This is a proof-of-concept study that aimed to broadly examine whether CBM-I training on interpretation bias toward ambiguous situations with a risk of social rejection would be effective in individuals with ED comorbid with PD. Our first hypothesis was that a CBM-I task consisting of scenarios with benign resolutions (experimental condition) would reduce negative interpretation bias toward ambiguous social situations, compared to a task consisting of scenarios with neutral resolutions (control condition). The second hypothesis was that the CBM-I task would produce a greater change in interpretation bias in people with comorbid ED and PD, ED-only, and PD-only compared to healthy controls. The third hypothesis was that the training would reduce anxiety and improve mood. We also explored baseline clinical features as possible predictors of treatment efficacy.

2 | METHODS

2.1 | Design

An AB/BA cross-over design was used, with the random allocation (1:1) of participants to a single session of the experimental and control version of CBM-I training. The training sessions were completed 1 week apart. The primary outcome measure was the negative interpretation bias assessed by the percentage of negative completions on an ambiguous sentence completion task. The secondary outcome measures included anxiety and mood ratings.

2.2 | Participants

Korean participants aged 18–40 with ED and/or PD were recruited from an outpatient clinic in a university hospital and from two universities via advertisements in the Seoul metropolitan area of Korea. Patient diagnoses of AN and BN were made based on the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5; American Psychiatric Association, 2013). Diagnoses of PD were made after an interview with their psychiatrist according to the International Classification of Diseases 11th Revision (ICD-11; World Health Organization; WHO, 2022) criteria that provide a single dimensional diagnosis of PD. Students who suspected themselves of having ED or PD were recruited from the universities and completed the screening measures (i.e., SCOFF Questionnaire, with a cut-off point of ≥2;

Morgan et al., 1999, and Self-Reported Standardized Assessment of Personality-Abbreviated Scale; SAPAS-SR, with a cut-off point of ≥4; Germans et al., 2008). The students then underwent a diagnostic interview using the Eating Disorder Examination 17th version (EDE 17.0; Fairburn et al., 2014) and the Personality Assessment Schedule (PAS; Tyrer et al., 1979) with graduate or PhD students in clinical psychology. The interviewers were trained in the diagnostic interview methods by their supervising professors, who were board-certified clinical psychologists. Students who were diagnosed with AN or BN according to the EDE 17.0 or PD according to the PAS were recruited in the study. Healthy controls were recruited from the universities and qualified for participation if they reported no current or past history of psychiatric illnesses and scored <2 on the SCOFF Questionnaire, and <4 on the SAPAS-SR. The exclusion criteria for all participants were psychosis, bipolar disorder, scores lower than 80 on the Wechsler Adult Intelligence Scale-IV assessment tool (WAIS-IV; Wechsler, 2008), and participants who were currently in cognitive behavioral therapy.

A total of 134 participants participated in the study (Figure 1). This included 37 patients with comorbid eating disorder and personality disorder (EDPD), 22 patients with only an eating disorder (ED), 24 patients with only a personality disorder (PD), and 51 healthy controls (HCs). Six patients were excluded from the analysis, as they did not complete the sessions ($n = 2$) or were suspected to be

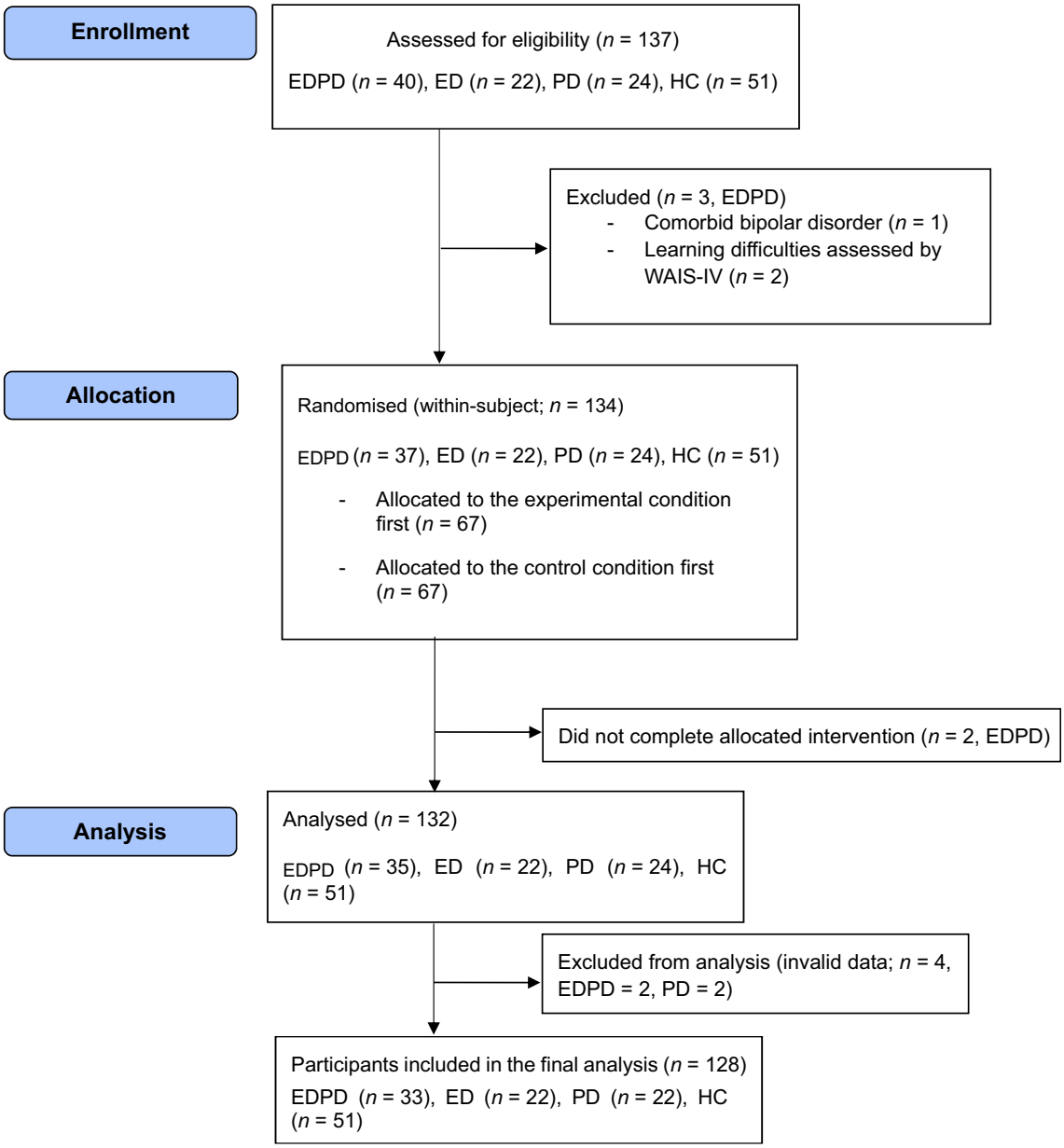

FIGURE 1 A consort diagram of the study participants. EDPD, comorbid eating disorders and personality disorder; ED, eating disorder; HC, healthy control; PD, personality disorder; WAIS-IV, Wechsler Adult Intelligence Scale-IV.

experiencing aggravation of symptoms which interfered with their ability to perform the tasks by their psychiatrist ($n = 4$). In total, 128 participants were included in the final analyses (33 with EDPD, 22 in the ED-only group, 22 in the PD-only group, and 51 HCs).

The study was approved by the Institutional Review Board of Inje University (INJE 2021-07-031-003). All participants provided written informed consent and were compensated with $70 for their participation. The study was registered with the Clinical Research Information Service (http://cris.nih.go.kr, Registration number: KCT0006628; changes made to the pre-registered information are addressed in Supplement 1).

2.3 | Measures

2.3.1 | Demographic and clinical characteristics questionnaires and diagnostic interviews

At baseline, the participants completed demographic and clinical questionnaires assessing age, gender, body mass index (BMI), ED and PD psychopathology, emotion regulation, and negative affect. Among the students, those who scored ≥2 on the SCOFF Questionnaire or ≥4 on the SAPAS-SR were interviewed using the EDE 17.0 and PAS, respectively.

Eating disorder examination 17th version (EDE 17.0; Fairburn et al., 2014)

The EDE 17.0 is a semi-structured interview that measures the range and severity of ED features in the DSM-5 on four subscales (restraint, eating concern, shape concern, and weight concern). The Korean version of the EDE (Fairburn et al., 1993) is reliable (Cronbach's $\alpha = .72–.89$; Heo et al., 2004).

Personality assessment schedule (PAS; Tyrer et al., 1979)

The PAS is a semi-structured interview that assesses the presence of 24 personality traits in the ICD-11 trait model. The reliability of the Korean version is good (Cronbach's $\alpha = .91$; Choi et al., 2015).

Eating disorder examination-questionnaire (EDE-Q; Fairburn et al., 2008)

The EDE-Q is a 36-item self-reported measure that assesses eating-related psychopathology over a 28-day period on four subscales (restraint, eating concern, shape concern, and weight concern). The reliability of the Korean version of the EDE-Q is good (Cronbach's $\alpha = .92$; Bang et al., 2020).

Personality inventory for DSM-5 Short Form (PID-5-SF; Maples et al., 2015)

The PID-5-SF is a 100-item self-reported measure that assesses 25 pathological personality trait facets and five higher-order domains in the DSM-5. The reliability of the Korean version is adequate (Cronbach's $\alpha = .77$; Hong et al., 2018).

Personality assessment questionnaire for ICD-11 personality trait domains (PAQ-11; Kim et al., 2021)

The PAQ-11 is a 17-item self-reported measure that evaluates the severity and five domains of ICD-11 PD (i.e., negative affectivity, anankastia, detachment, dissociality, and disinhibition). The internal consistency of the five domains is acceptable (Cronbach's $\alpha = .7$; Kim et al., 2021).

Neuroticism extraversion openness five-factor inventory (NEO-FFI; Costa Jr & McCrae, 1992)

The NEO-FFI is a 60-item self-reported questionnaire that evaluates five personality domains (12 items per domain) of a five-factor model: N = neuroticism, E = extraversion. O = openness, A = agreeableness, and C = conscientiousness. The internal consistency of the Korean version is satisfactory (Cronbach's $\alpha = .68–.86$; Ahn & Chae, 1997).

Depression, anxiety, stress scale-21 (DASS-21; Lovibond & Lovibond, 1995)

The DASS-21 is a 21-item self-reported questionnaire that evaluates participants' depression, anxiety, and stress on three subscales. The reliability of the Korean version is satisfactory (Cronbach's $\alpha = .87$, .83, and .83 for the Depression, Anxiety, and Stress subscales, respectively; Jun et al., 2018).

Difficulties in emotion regulation scale (DERS; Gratz & Roemer, 2004)

The DERS is a 36-item self-reported instrument that evaluates emotion dysregulation on six subscales: awareness, clarity, goals, impulse, non-acceptance, and strategies. The reliability of the Korean version of the DERS is good (Cronbach's $\alpha = .92$; Cho, 2007).

Positive affect and negative affect schedule (PANAS; Watson et al., 1988)

The PANAS is a 20-item self-reported measure that consists of 10-item scales for positive and negative affect. The reliability of the Korean version of the PANAS is satisfactory (Cronbach's $\alpha = .81$; Park & Lee, 2016).

2.3.2 | Sentence completion task (SCT)

This task was designed by Cardi et al. (2015) to measure the valence of interpretations of ambiguous social scenarios pre- and post-CBM-I training. The sentences were modified to fit Korean culture when needed. In each trial, the participants read 10 stem sentences that depicted socially ambiguous situations on the computer screen while simultaneously listening to them over headphones, and completed the sentences by writing down as many responses as possible in 90 s. Following that, they marked an asterisk next to the response that they thought to be the best completion to the situation (hereafter called "endorsed" responses). The percentage of total negative and benign responses and the number of endorsed negative and benign responses were used to analyze the participants' interpretations of

ambiguous situations. We used different sets of sentences in the experimental and control conditions to prevent learning effects. Five researchers rated the completions as benign or negative. The inter-rater reliability for the ratings was high (Fleiss' $k = .79$). Disagreements in the ratings were resolved in a weekly meeting among the raters. A sample SCT sentence is provided in Supplement 2.

2.3.3 | Cognitive bias modification for interpretation (CBM-I) training task

An adapted version of Rowlands et al.'s (2020) cognitive bias modification for interpretation training task for people with EDs was used. The themes of the scenarios used for the training were virtual rejection/exclusion, rejection associated with the aspects of EDs, rejection triggered by ambiguous/benign comments or behaviors of others, and rejection perceived when confiding in others. Three hundred scenarios were translated into Korean and modified to fit Korean culture when needed.

Additional scenarios with salient themes for PD were generated, targeting rejection sensitivity and emotion regulation that people with PD struggle with in social situations. Thirty scenarios were included in the study after consensus meetings on their intensity and applicability, including 17 rejection triggered by ambiguous/benign comments or behaviors of others, and 13 rejection perceived when confiding in others. The scenarios covered a wide range of everyday social situations relevant to family, friendships, romantic relationships, education, work, leisure activities, and social media use.

In the experimental condition, the participants were instructed to listen to the socially ambiguous scenarios over headphones which were resolved with benign resolutions after a 1000 ms pause. Then, they answered a comprehension question that reinforced the benign interpretation with either a "yes" or "no" response (i.e., by pressing "N" for yes or "B" for no on the keyboard). It was followed by a feedback message of "correct" or "incorrect" on the screen, and a sound effect was given over the headphones. Participants were given 120 scenarios with benign endings and 10 randomly distributed scenarios with retained ambiguity and without feedback (i.e., catch trials) to ensure that they were attending carefully to the scenarios and to facilitate intermittent reinforcement as a more accurate reflection of real life. The 120 scenarios consisted of rejection-related themes relevant to EDs and PD, including 20 virtual rejection/exclusion, 36 rejection associated with the aspects of EDs, 29 rejection triggered by ambiguous/benign comments or behaviors of others, and 35 rejection perceived when confiding in others. The session took 70 min with three blocks and two breaks between the blocks.

In the control condition, a similar procedure was used with the only difference being that the scenarios ended with neutral resolutions with unresolved ambiguity, followed by comprehension questions without feedback. The task had 100 scenarios which were divided into two blocks with a break, and took 50 min to complete. It was different from the control task in a previous study (Turton et al., 2018) which included 50% benign and 50% negative scenarios. We assumed that replacing benign and negative scenarios with neutral scenarios would better serve as a control condition as suggested by the authors (Turton et al., 2018). Sample CBM-I experimental and control task scenarios are provided in Supplement 2.

2.3.4 | Visual analogue scale (VAS)

In the VAS measuring anxiety ("Are you anxious?"), the participants rated their anxiety level on a scale from 0 to 10 (0 was not at all anxious, and 10 was very anxious). In the VAS measuring mood ("How are you feeling?"), they rated their mood on the same scale (0 was very bad, and 10 was very good).

2.4 | Procedure

The study took place at the outpatient site or the universities from September 2021 to March 2022. Participants were told about the study and interviewed using the WAIS-IV. They completed a set of baseline questionnaires within a week before the first session. In the first session, the participants completed the SCT and VAS ratings, and either the experimental or control version of the CBM-I task, depending on the condition to which they were randomly allocated. After the task, they completed the SCT and VAS ratings again. In the second session held 1 week later, the participants followed the same procedure as in the first session with a different version of the CBM-I task, depending on what they did in the first session. Then, they completed the PANAS, and provided written feedback on the task upon departure.

2.5 | Data analyses

One-way analysis of variance (ANOVA) was conducted to compare the demographic and clinical characteristics, and the baseline SCT responses of the participants. A $4 \times 2 \times 2$ mixed-effects linear model was used to examine interactions among the groups (EDPD, PD, ED, and HC), time (pre- and post-task) and tasks (experimental and control) regarding the negative and benign responses in the SCTs, and the VAS ratings. Paired *t*-tests were conducted to compare the difference between pre- and post-task within each group. For subsidiary analyses, one-way ANOVA was performed to compare the size of the decrease in the negative interpretations among the groups. When multiple testing was used with *n* sets of comparisons for the post-hoc or subsidiary analyses, Bonferroni correction was applied.

For exploratory analyses, independent *t*-tests were conducted to compare the effect of CBM-I between (1) students and patients in the diagnostic groups, and between (2) participants with AN and BN in the ED groups. Pearson's correlation was conducted to examine the association between the size of the decrease in the negative interpretation and the clinical variables.

3 | RESULTS

3.1 | Baseline analyses

3.1.1 | Participant characteristics

The demographic and clinical characteristics of the participants who completed the baseline measures are presented in Table 1. There was no difference in age, gender, or BMI among the groups. There were more patients than students in the EDPD group. The EDPD and ED groups had higher levels of ED psychopathology, and the EDPD and PD groups had higher levels of personality pathology. The EDPD and PD groups had higher levels of negative emotional symptoms than the ED or HC groups.

In all participants with ED, there was no significant difference in the clinical measures at baseline between those with AN and BN, other than BMI.

TABLE 1 Demographic and clinical characteristics at baseline in adults with eating disorders and/or personality disorder and healthy controls.

					ANOVA			
	EDPD[a] ($n = 37$)	ED[b] ($n = 22$)	PD[c] ($n = 24$)	HC[d] ($n = 51$)	F or χ^2	df	p	Post hoc Tukey
Age (years), mean (*SD*)	25.27 (5.04)	25.18 (3.57)	25.00 (4.47)	23.43 (2.18)	2.02	3, 130	.089	N/A
Gender (female), *n* (%)	33 (89.2)	20 (90.9)	19 (79.2)	47 (92.2)	$\chi^2 = 2.92$	3, 130	.404	N/A
Group (patients), *n* (%)	28 (75.7)	10 (45.5)	10 (41.7)	N/A	$\chi^2 = 8.79$	3, 130	.012	N/A
AN, *n* (%)	15 (40.5)	5 (22.7)	N/A	N/A	$\chi^2 = 1.95$	1, 59	.162	N/A
BN, *n* (%)	22 (59.5)	17 (77.3)	N/A	N/A				N/A
BMI, kg/m^2	21.87 (5.57)	21.90 (5.10)	22.37 (5.69)	22.45 (4.86)	.12	3, 120	.950	N/A
EDE-Q, Total	3.62 (1.42)	2.69 (1.37)	2.01 (1.49)	1.35 (1.07)	22.53	3, 120	<.001	a > b, c**, d**; b > d**
Restraint	3.17 (1.71)	2.43 (1.79)	1.41 (2.03)	1.11 (1.31)	12.50	3, 120	<.001	a > c*,d**; b > d*
Eating concern	3.03 (1.72)	2.03 (1.24)	1.13 (1.52)	.55 (.82)	27.19	3, 120	<.001	a > b,c**, d**; b > d**
Shape concern	4.14 (1.70)	3.01 (1.63)	2.70 (1.66)	1.79 (.16)	16.70	3, 120	<.001	a > b, c, d**; b > d
Weight concern	3.69 (1.95)	2.94 (1.60)	2.08 (1.35)	1.50 (1.20)	15.17	3, 120	<.001	a > c*,d**; b > d*
PID-5-SF, Total	132.65 (35.73)	84.35 (34.39)	121.65 (36.15)	73.08 (31.14)	25.71	3, 121	<.001	a > b**,d**; c > b*,d**
Negative affectivity	41.06 (13.68)	24.41 (13.46)	37.09 (13.72)	19.47 (10.02)	25.28	3, 121	<.001	a > b**,d**; c > b*,d**
Detachment	28.82 (11.42)	16.00 (10.05)	25.35 (11.10)	15.86 (9.08)	13.55	3, 121	<.001	a > b**,d**; c > b,d**
Psychoticism	17.59 (10.31)	10.35 (6.72)	16.78 (8.03)	7.94 (6.55)	12.63	3, 121	<.001	a > b,d**; c > d**
Antagonism	19.68 (11.06)	17.65 (7.78)	19.00 (8.36)	15.90 (8.70)	1.31	3, 121	.273	N/A
Disinhibition	25.50 (8.54)	15.94 (5.97)	23.43 (8.71)	13.90 (7.61)	18.03	3, 121	<.001	a > b**,d**; c > b,d**
PAQ-11	41.63 (9.51)	31.82 (10.22)	38.83 (9.36)	26.31 (7.60)	24.12	3, 123	<.001	a > b*, d**; c > d**
NEO-FFI								
Neuroticism	44.06 (7.42)	33.29 (12.25)	42.30 (9.83)	29.67 (8.31)	21.72	3, 121	<.001	a > b*, d**; c > b,d**
Extraversion	31.74 (11.10)	41.59 (10.70)	33.35 (10.55)	42.88 (9.02)	10.61	3, 121	<.001	a < b*,d**; c < d*
Openness	41.12 (7.11)	41.41 (7.71)	41.09 (8.51)	41.16 (6.50)	.01	3, 121	.999	N/A
Agreeableness	42.65 (5.72)	42.65 (8.57)	42.30 (5.61)	45.39 (5.13)	2.34	3, 121	.077	N/A
Conscientiousness	38.47 (10.51)	40.00 (9.03)	38.57 (8.82)	44.53 (7.74)	4.18	3, 121	.007	d > a, c
DASS-21, Total	28.05 (16.30)	11.30 (10.95)	28.33 (15.70)	7.58 (6.37)	27.88	3, 130	<.001	a > b**, d**; c > b**, d**
Depression	8.95 (6.74)	3.05 (4.17)	9.38 (6.15)	2.63 (2.67)	18.13	3, 130	<.001	a > b**, d**; c > b**, d**
Anxiety	7.14 (6.41)	2.78 (3.22)	7.04 (5.90)	.96 (1.39)	18.19	3, 130	<.001	a > b*, d**; c > b*, d**
Stress	11.97 (5.17)	5.45 (4.76)	11.92 (6.09)	4.00 (3.63)	28.04	3, 130	<.001	a > b**, d**; c > b**, d**
DERS	111.16 (24.09)	79.59 (23.14)	103.17 (28.63)	71.80 (17.18)	26.35	3, 130	<.001	a > b**, d**; c > b*,d**
PANAS								
Positive	22.05 (9.40)	29.68 (7.79)	23.54 (8.38)	29.18 (7.06)	7.71	3, 130	<.001	a < b*,d**; c < d
Negative	27.22 (8.71)	20.73 (9.26)	28.00 (8.81)	18.41 (7.53)	11.82	3, 130	<.001	a > b,d**; c > b,d**

Note: Data are shown as mean (standard deviation), or frequency (%). Analysis by one-way analysis of variance (ANOVA). *p*-values <.05 was defined as significant. *p-values <.01, **p-values <.001

Abbreviations: AN, anorexia nervosa; BMI, body mass index; BN, bulimia nervosa; DASS-21, depression anxiety stress scale-21; DERS, difficulties in emotion regulation scale; ED, eating disorder; EDE-Q, eating disorder examination questionnaire; EDPD, comorbid eating disorder and personality disorder; HC, healthy control; N/A, not applicable; NEO-FFI, neuroticism extraversion openness five-factor inventory; PANAS, positive affect and negative affect schedule; PAQ- 11, personality assessment questionnaire for ICD- 11; PD, personality disorder; *SD*, standard deviation.

3.1.2 | Interpretation of ambiguous social situations at baseline

The EDPD group produced more total negative and fewer total benign responses on the baseline SCT than other groups. Among the participants with ED, there was no significant difference in the SCT responses at baseline between those with AN and BN (t[53] = .102, p = .919; see Supplement 3 for the participants' baseline interpretation of ambiguous social situations).

The negative interpretation bias toward ambiguous social stimuli at baseline was positively correlated with PAQ-11, PID-5-SF, EDE-Q, DASS-21, DERS, and PANAS negative scores, and neuroticism (r = .47, .49, .40, .55, .54, .41, and .51, respectively), and negatively with extraversion and PANAS positive scores (r = −.51 and −.46, respectively).

3.2 | Effects of the CBM-I training

3.2.1 | CBM-I training task data

The mean accuracy of the comprehension questions in the CBM-I task was 96.09% (SD = 5.42). The EDPD group performed less accurately than other groups (M = 91.59, SD = 7.35, F = 13.70, p < .001). In the catch trials, the mean percentage of negative interpretations was 7.24% (SD = 11.32). The EDPD group made more negative interpretations than other groups (M = 14.69, SD = 16.85, F = 7.07, p < .001).

3.2.2 | Sentence completion task: Percentage of total negative and benign responses

As shown in Table 2, the mixed effects linear model showed the main effects for time, task, and group for the percentage of total negative and benign SCT responses [(Time, F(3, 124) = 22.34, p < .001, η_p^2 = .15; Task, F(3, 124) = 17.69, p < .001, η_p^2 = .13; Group, F(3, 124) = 7.29, p < .001, η_p^2 = .15 for negative responses; Time, F(3, 124) = 21.87, p < .001, η_p^2 = .15; Task, F(3, 124) = 16.91, p < .001, η_p^2 = .12; Group, F(3, 124) = 7.25, p < .001, η_p^2 = .15 for benign responses)]. There was an interaction between time and task for the percentage of negative and benign responses on the SCTs [(F(3, 124) = 83.05, p < .001, η_p^2 = .40 for negative responses; F(3, 124) = 83.49, p < .001, η_p^2 = .40 for benign responses)]. An interaction was also found among time, task, and group for the percentage of negative and benign responses [(F(3, 124) = 4.67, p = .004, η_p^2 = .10 for negative responses; F(3, 124) = 4.92, p = .003, η_p^2 = .11 for benign responses)]. Figure 2 presents the main and interaction effects among groups.

Subsequent pairwise comparisons showed that in the experimental condition, in all four groups, the percentage of benign responses increased, and negative responses decreased from pre- to post-CBM-I with medium (HC: p < .001, d = .66) to large effect sizes (EDPD: p < .001, d = 1.02; ED: p = .002, d = .75; PD: p < .001, d = 1.19). In the control condition, there was no difference between pre- and post-CBM-I. The results of endorsed negative and benign responses are presented in Supplement 4.

TABLE 2 Frequency of negative and benign interpretations pre- and post- CBM-I and control tasks in adults with eating disorders and/or personality disorder and healthy controls.

	EDPD(n = 33)					ED(n = 22)					PD(n = 22)					HC(n = 51)				
	Pre	Post	t (df = 32)	p	d	Pre	Post	t (df = 21)	p	d	Pre	Post	t (df = 21)	p	d	Pre	Post	t (df = 50)	p	d
SCT_E_N	34.18 (19.14)	17.64 (14.96)	5.87	<.001	1.02	21.23 (17.68)	11.00 (10.03)	3.50	.002	.75	27.36 (11.49)	15.27 (9.69)	5.56	<.001	1.19	18.27 (10.65)	12.08 (7.85)	4.69	<.001	.66
SCT_C_N	19.70 (14.70)	23.33 (16.19)	−1.29	.202	−.23	11.95 (11.25)	13.55 (13.43)	−1.03	.314	−.22	14.77 (10.23)	20.95 (20.73)	−1.60	.124	−.34	11.53 (8.32)	12.67 (9.91)	−1.06	.310	−.14
SCT_E_B	65.82 (19.14)	82.36 (14.96)	−5.87	<.001	−1.02	78.77 (17.68)	89.00 (10.03)	−3.50	.002	−.75	72.64 (11.49)	84.73 (9.69)	−5.56	<.001	−1.19	81.73 (10.65)	87.92 (7.86)	−4.69	<.001	−.66
SCT_C_B	80.30 (14.70)	76.64 (16.18)	1.30	.202	.23	88.05 (11.25)	86.45 (13.43)	1.03	.314	.22	85.23 (10.23)	78.59 (20.70)	1.70	.104	.36	88.27 (9.57)	87.33 (9.91)	.86	.397	.12

Note: Interaction and main effects are as follows; for SCT_N, the effects were, Time [F(3, 124) = 22.34, p < .001, η_p^2 = .15], Task [F(3, 124) = 17.69, p < .001, η_p^2 = .13], Group [F(3, 124) = 7.29, p < .001, η_p^2 = .15], Time × Group [F(3, 124) = 1.33, p = .269, η_p^2 = .03], Task × Group [F(3, 124) = .15, p = .932, η_p^2 = .004], Time × Task [F(3, 124) = 83.05, p < .001, η_p^2 = .40], and Time × Group × Task [F(3, 124) = 4.67, p = .004, η_p^2 = .10]. For SCT_B, the effects were, Time [F(3, 124) = 21.87, p < .001, η_p^2 = .15], Task [F(3, 124) = 16.91, p < .001, η_p^2 = .12], Group [F(3, 124) = 7.25, p < .001, η_p^2 = .15], Time × Group [F(3, 124) = 1.30, p = .277, η_p^2 = .03], Task × Group [F(3, 124) = .17, p = .918, η_p^2 = .004 Time × Task [F(3, 124) = 83.49, p < .001, η_p^2 = .40], Time × Group × Task [F(3, 124) = 4.92, p = .003, η_p^2 = .11]. Data are shown as mean (standard deviation). Analysis by paired samples t-test. Effect sizes are calculated as Cohen's d. p-values <.05 was defined as significant.

Abbreviations: ED, eating disorder; EDPD, comorbid eating disorder and personality disorder; HC, healthy control; PD, personality disorder; SCT_C_B, SCT control condition total benign responses; SCT_C_N, SCT control condition total negative responses; SCT_E_B, SCT experimental condition total benign responses; SCT_E_N, sentence completion task experimental condition total negative responses.

3.2.3 | Comparison of the size of the decrease in negative interpretations among the groups

One-way ANOVA revealed a difference in the size of the decrease in negative interpretations among the groups in the experimental condition ($p = .003$; Figure 3). A post hoc test showed a difference between the EDPD and HC groups, with the EDPD group demonstrating greater decreases in post-CBM-I SCT negative responses than the HC group, with a large effect size ($p = .002$, $\eta^2 = .104$) after correction for multiple testing. In the control condition, the size of the decrease did not differ among the groups. There was no difference in the size of decrease between students and patients in the diagnostic groups (data available if requested).

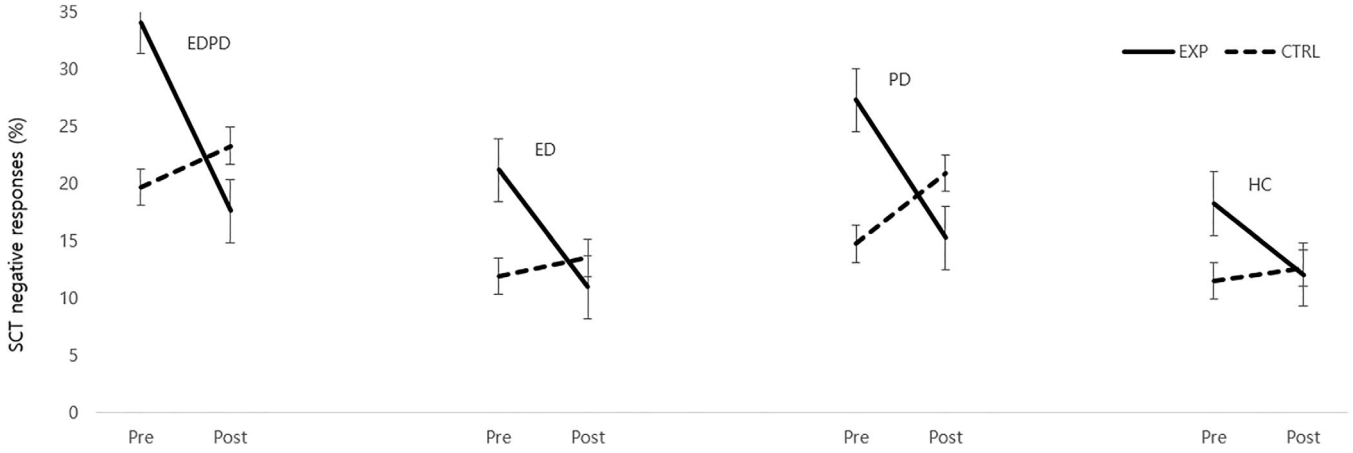

FIGURE 2 Negative interpretation of ambiguous social stimuli pre- and post-CBM-I experimental and control tasks among adults with eating disorder and/or personality disorder and healthy controls. There were main effects of time, task, and group for the percentage of negative SCT responses. Time [$F(3, 124) = 22.34$, $p < .001$, $\eta_p^2 = .15$], Task [$F(3, 124) = 17.69$, $p < .001$, $\eta_p^2 = .13$], Group [$F(3, 124) = 7.29$, $p < .001$, $\eta_p^2 = .15$]. Interactions between time and task, and among time, task, and group were found. Time × Task [$F(3, 124) = 83.05$, $p < .001$, $\eta_p^2 = .40$], Time × Group × Task [$F(3, 124) = 4.67$, $p = .004$, $\eta_p^2 = .10$]. CTRL, control condition; ED, eating disorder; EDPD, comorbid eating disorder and personality disorder; EXP, experimental condition; HC, healthy control; PD, personality disorder; SCT, sentence completion task.

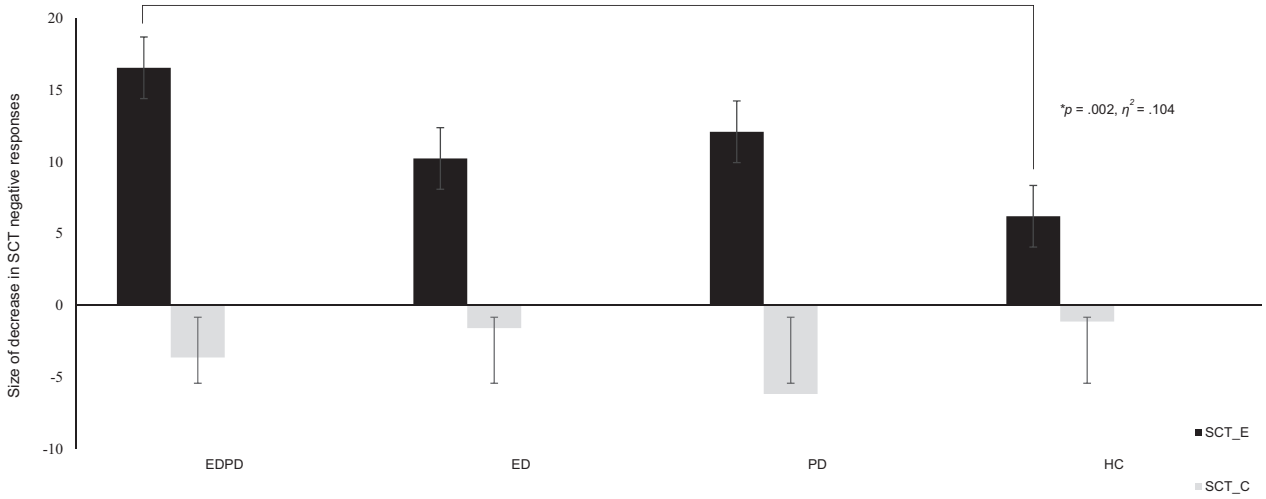

FIGURE 3 Comparisons of the size of the decrease in negative interpretation among adults with eating disorder and/or personality disorder and healthy controls. Data are shown as mean and standard error. Analysis by one-way analysis of variance (ANOVA). Effect sizes are calculated as eta-squared (η^2). *p*-values <.008 was defined as significant after Bonferroni correction. The size of the decrease is defined as the difference between the percentage of negative responses in pre-CBM-I SCT and the percentage of negative responses in post-CBM-I SCT. A higher score indicates a greater size of decrease. EDPD group had a greater degree of decrease in the percentage of negative responses in post-CBM-I SCT than HC group ($p = .002$, $\eta^2 = .104$). ED, eating disorder; EDPD, comorbid eating disorder and personality disorder; HC, healthy control; PD, personality disorder; SCT, sentence completion task; SCT_C, SCT control condition; SCT_E, SCT experimental condition. $^*p = .002$, $\eta^2 = .104$.

TABLE 3 Anxiety and mood scores pre- and post-CBM-I and control tasks in adults with eating and/or personality disorders and healthy controls.

	EDPD($n = 33$)					ED($n = 22$)					PD($n = 22$)					HC($n = 51$)				
	Pre	Post	t ($df = 32$)	p	d	Pre	Post	t ($df = 21$)	p	d	Pre	Post	t ($df = 21$)	p	d	Pre	Post	t ($df = 50$)	p	d
Anxiety_E	5.06 (2.63)	4.18 (2.57)	3.13	.004	.34	2.27 (2.37)	1.73 (2.05)	2.16	.042	.46	5.05 (2.42)	4.05 (2.63)	3.92	.001	.84	2.55 (2.01)	2.08 (1.80)	3.34	.002	.47
Anxiety_C	4.55 (2.20)	4.30 (2.07)	1.25	.222	.22	2.23 (2.27)	2.05 (2.13)	.78	.446	.17	4.43 (2.98)	3.67 (3.01)	2.77	.012	.60	2.51 (2.27)	2.04 (2.07)	3.64	.001	.51
Mood_E	4.78 (2.15)	5.06 (1.79)	−1.14	.263	−.20	6.23 (1.97)	6.50 (1.54)	.21	.367	−.20	5.73 (1.96)	5.32 (1.96)	1.57	.131	.34	6.71 (1.60)	6.71 (1.70)	.00	1.000	.00
Mood_C	4.94 (1.66)	7.19 (13.38)	−1.00	.327	−.17	6.68 (1.49)	6.23 (1.72)	.21	.096	.37	5.43 (1.99)	5.38 (1.94)	.21	.833	.05	6.47 (2.01)	6.31 (1.98)	1.27	.209	.18

Note: Interaction and main effects are as follows; for Anxiety, the effects were, Time [$F(3, 124) = 50.53$, $p < .001$, $\eta_p^2 = .29$], Task [$F(3, 124) = 1.31$, $p = .255$, $\eta_p^2 = .10$], Group [$F(3, 124) = 12.59$, $p < .001$, $\eta_p^2 = .23$], Time × Group [$F(3, 124) = 1.76$, $p = .159$, $\eta_p^2 = .04$], Task × Group [$F(3, 124) = .87$, $p = .459$, $\eta_p^2 = .02$], Time × Task [$F(3, 124) = 5.65$, $p = 019$, $\eta_p^2 = .04$], Time × Group × Task [$F(3, 124) = 1.21$, $p = .309$, $\eta_p^2 = .28$]. For Mood, the effects were, SCT_B: Time [$F(3, 124) = .47$, $p = .495$, $\eta_p^2 = .004$], Task [$F(3, 124) = .31$, $p = .578$, $\eta_p^2 = .003$], Group [$F(3, 124) = 1.97$, $p = .112$, $\eta_p^2 = .05$], Time × Group [$F(3, 124) = 1.35$, $p = .263$, $\eta_p^2 = .03$], Task × Group [$F(3, 124) = 1.31$, $p = .275$, $\eta_p^2 = .03$], Time × Task [$F(3, 124) = .24$, $p = .622$, $\eta_p^2 = .002$], Time × Group × Task [$F(3, 124) = .89$, $p = .449$, $\eta_p^2 = .02$]. Data are shown as mean (standard deviation). Analysis by paired samples t-test. Effect sizes are calculated as Cohen's d. p-values <.05 was defined as significant.

Abbreviations: Anxiety_C, anxiety rating in control condition; Anxiety_E, anxiety rating in experimental condition; ED, eating disorder; EDPD, comorbid eating disorder and personality disorder; HC, healthy control; Mood_C, mood rating in control condition; Mood_E, mood rating in experimental condition; PD, personality disorder.

3.2.4 | Anxiety and mood outcomes

As shown in Table 3, there was a significant main effect of time and group (all ps <.001), and an interaction effect between time and task for the VAS anxiety ratings in the mixed effects linear model (group × time × task). Specifically, in the experimental condition, in all four groups, there was a greater reduction in the level of anxiety after the CBM-I task (all ps <.05). In the control condition, there were reductions in anxiety in the PD ($p = .012$) and HC groups ($p < .001$).

For mood outcomes, there was neither an effect of nor interaction among group, time, and task in VAS scores.

3.3 | Exploratory analyses

3.3.1 | Comparison of changes in negative interpretation, anxiety, and mood between participants with anorexia nervosa and bulimia nervosa in the ED groups

There was no difference in the size of the decrease in SCT negative responses, and VAS anxiety and mood scores between participants with AN and BN within the ED groups in either the experimental or control conditions (see Supplement 5 for the comparisons of the primary and secondary outcome measures between the participants with AN and BN in all participants with EDs).

3.3.2 | Correlation of clinical variables associated with the size of the decrease in negative responses after the CBM-I task

The CBM-I task induced reductions in negative cognitive bias were correlated with the baseline clinical variables. The associations between the size of the decrease in the percentage of total negative responses in the SCTs and baseline clinical variables were examined. In the experimental condition, the size of the decrease was positively correlated with PAQ-11, DASS-21, DERS, and PANAS negative scores, and neuroticism, and negatively correlated with extraversion and PANAS positive scores in the diagnostic groups, while no association was found in the HC group. In the control condition, the size of the decrease was not associated with any of the baseline clinical variables in any group.

4 | DISCUSSION

In this study, we investigated the effect of an adapted version of ambiguous scenarios training task (Rowlands et al., 2020) to train benign interpretations of ambiguous social stimuli in people with comorbid ED and PD. The study relied on a within-subject single-session laboratory-based training. The hypotheses were supported by the results. CBM-I training task produced a greater change in

participants' interpretation bias toward ambiguous social stimuli that depicted risks of rejection compared to a control task across the groups. Participants made fewer negative and more benign interpretations after the experimental condition, in which the effect size for the reduction in negative interpretation bias was large in the EDPD, ED, and PD groups, and medium in the HC groups. The CBM-I task decreased anxiety in all groups. The findings of this study suggest that CBM-I has the potential to reduce expectations of social rejection and anxiety in people comorbid for an ED and PD. Heightened rejection sensitivity can be considered as a transdiagnostic construct across ED and PD.

The EDPD group had the greatest decrease in negative interpretation bias among the groups. This could be due to the severity of their emotional symptoms. Previous work suggested that CBM-I training could be of particular benefit to more emotionally vulnerable individuals (Menne-Lothmann et al., 2014).

The reduction in negative interpretation bias in the diagnostic groups was positively related to negative mood, neuroticism, symptoms of anxiety and depression, and emotion dysregulation, and negatively associated with positive mood and extraversion. No association was found between the size of the decrease and the clinical variables in the HC group, suggesting that the effect was specific to the diagnostic groups. The exploratory analysis indicated that a greater reduction in negative interpretation bias was positively associated with symptoms of negative affect in individuals with ED and PD.

Our results from the participants with ED replicated the findings of previous studies that also demonstrated the efficacy of CBM-I in modifying negative interpretation biases toward social stimuli in adults with AN (Cardi et al., 2015; Turton et al., 2018). However, the CBM-I training task was effective in decreasing anxiety in all groups here, an outcome not found in previous studies (Rowlands et al., 2022; Turton et al., 2018). Also, unexpectedly, there was a decrease in anxiety following the control task in the PD and HC groups. These findings could be attributed to our assisted sessions, which might have reduced anxiety via interactions with a researcher compared to online sessions (Rowlands et al., 2022).

There are several limitations of this study. First, the ratio of student to patient participants differed between the diagnostic groups. However, we do not think this biased the results as there was no difference in the CBM-I effect between students and patients. Second, we did not use formal DSM-based interviews to confirm the diagnoses of PD. Yet, an intense face-to-face interview was conducted to ensure that they met the ICD-11-based PD criteria. Third, we did not include a self-reported measure on sensitivity to rejection. Fourth, the SCT stimuli depicted socially ambiguous situations, but not disorder-specific scenarios, which made it unable to determine whether a single group had responded strongly to the respective subset of items in the CBM-I. Lastly, we could not assess if the CBM-I effects persisted after the post-training assessment due to the lack of follow-up assessments.

In conclusion, the current study investigated the effect of modifying cognitive bias in interpretations of socially ambiguous situations in people with comorbid ED and PD. After the experimental CBM-I task, the participants produced fewer negative and more benign interpretations with large effect sizes in the diagnostic groups and a medium effect size in the HCs, with a marked effect in people with comorbid ED and PD. The researcher-assisted CBM-I task was effective in reducing anxiety. Individuals with higher levels of negative emotion experienced greater decreases in negative interpretations following the CBM-I task. In future studies, consecutive CBM-I sessions with follow-up assessments might be of interest to examine the clinical feasibility of such approach.

AUTHOR CONTRIBUTIONS

Zhen An: Formal analysis; investigation; methodology; writing – original draft; writing – review and editing. **Kyung Hwa Kwag:** Investigation; methodology; project administration; writing – original draft; writing – review and editing. **Mirihae Kim:** Investigation; writing – review and editing. **Jae-Won Yang:** Investigation; writing – review and editing. **Hui-Ji Shin:** Investigation. **Janet Treasure:** Conceptualization; methodology; supervision; writing – review and editing. **Youl-Ri Kim:** Conceptualization; formal analysis; funding acquisition; investigation; methodology; supervision; writing – original draft; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Data will be available upon request to the corresponding author.

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