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RESEARCH ARTICLE

Emotional processing in recovered anorexia nervosa patients: A 15 year longitudinal study

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Abstract

Objective: This 15 years longitudinal study aimed to examine whether difficulties in cognitive processing of emotions persisted after long-term recovery from anorexia nervosa (AN), and its link to anxiety and depression.

Method: Twenty-four females, who were tested longitudinally during their acute and recovered AN phases, and 24 healthy control (HC) women, were screened for anxiety, depression, alexithymia, emotion regulation difficulties (ER; only assessed in recovery phase), and completed an experimental task to analyse emotional experience.

Results: In spite of significant improvement in alexithymia, anxiety, and depression with AN recovery, some emotion functioning difficulties did not normalize. The occurrence of comorbid anxiety and depression explained the reduced ability to identify, understand, and accept emotions in long-term recovery (relative to controls), but not the increased global difficulty in using ER strategies, which revealed a more stable nature of deficit. With recovery, negative emotions linked to situations addressing food and body weight are felt more intensely.

Conclusions: Managing emotions, especially the negative ones, remains a challenge for individuals recovered from AN. Under this circumstance, maladaptive eating behaviour can serve as an affect regulatory function, increasing the risk of relapse. Emotional education is an important avenue in protecting long-term AN relapse.

KEYWORDS
anorexia nervosa, anxiety, depression, emotional processing, recovery

Abbreviations: ANCOVA, Analysis of covariance; AN, Anorexia nervosa; BMI, Body mass index; DERS, Difficulties in Emotion Regulation Scale; TAS-DDF, Difficulty in describing feelings to others; TAS-DIF, Difficulty in identifying feelings; ER, Emotion regulation; EEQ-AN, Emotional Evaluation Questionnaire for Anorexia Nervosa; TAS-EOT, Externally oriented thinking; HC, Healthy control; IDED-IV, Interview for the Diagnosis of Eating Disorders-IV; KS, Kolmogorov-Smirnov test; K, Kurtosis; MANCOVA, Multivariate analysis of covariance; SAS, Self-Rating Anxiety Scale; Sk, Skewness; SPSS, Statistical Package for the Social Sciences Version 25; TAS-20, Toronto Alexithymia Scale; SDS, Zung Self Rating Depression Scale.

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Highlights

- Impaired emotional functioning tends to normalize with long-term AN recovery. Nevertheless, greater difficulties in emotion regulation (ER) seem to persist
- Anxiety and depression only explained difficulties in emotional clarity and acceptance
- ER difficulties can be a risk factor for long-term AN relapse

1 | INTRODUCTION

Anorexia nervosa (AN) is an eating disorder characterized by food restriction and severe weight-loss that affects young women, mainly (American Psychiatric Association, 2013). It is considered a multifactorial disorder predisposed by biological, psychological, familiar, and sociocultural factors (e.g., Connan et al., 2003; Treasure et al., 2012; Treasure & Schmidt, 2013). Notwithstanding the influence of these factors, a significant body of research supports viewing AN as a disorder that includes core emotion dysregulation problems. Several systematic reviews found evidence of impaired recognition of, and response to, social-affective stimuli (Caglar-Nazali et al., 2014; Oldershaw et al., 2011), lower mentalization ability about oneself (Simonsen et al., 2020), emotion regulation (ER) difficulties (Aldao et al., 2010; Hatch et al., 2010; Oldershaw et al., 2015), and increased levels of alexithymia (Caglar-Nazali et al., 2014; Nowakowski et al., 2013; Oldershaw et al., 2015; Westwood et al., 2017) in individuals with AN. In fact, a multitude of methods have been used to assess disturbances along the temporal continuum of emotional processing in AN (e.g., self-report measures, cognitive tasks, event-related potentials). Overall, their findings give credit to the view that AN reflects a core disturbance in emotion at the earliest time interval of information processing with subsequent effects on the later stages of the subjective experience of emotion and self-regulation (Hatch et al., 2010). Accordingly, it has been suggested that AN patients use maladaptive eating behaviours (e.g., dietary restriction, bingeing, purging) as a way to avoid, suppress or regulate negative emotions (e.g., Brockmeyer, Bents, et al., 2012; Heatherton & Baumeister, 1991; Macht, 2008; Wildes et al., 2010).

Despite the accumulating scientific literature in this field, much remains to be known regarding the nature of emotional difficulties in this eating disorder. For instance, it is unclear whether impaired emotional functioning is limited to the active phase of the illness, as a consequence of starvation and comorbid anxiety and depression, or it constitutes a trait that leverages the emergence of maladaptive eating behaviour as an ER strategy (Caglar-Nazali et al., 2014; Hatch et al., 2010; Nowakowski et al., 2013; Oldershaw et al., 2011, 2015; Westwood et al., 2017). The confounding influence of starvation upon emotions makes it particularly difficult to determine whether problems with emotion regulation fuel and perpetuate AN (Haynos & Fruzzetti, 2011).

To clarify this research question, studies analysing emotional functioning in recovered AN patients are of chief interest. However, the existent studies are not only scarce but show equivocal results. There is a line of research suggesting that poor emotion awareness and ER arise from the starvation phase, a conclusion based on the absence of significant differences between individuals recovered from AN and healthy control (HC) participants (Oldershaw et al., 2010, 2012; Morris et al., 2014; Merwin et al., 2013). Conversely, other studies have concluded that emotional difficulties tend to persist after recovery, in particular ER difficulties (Brockmeyer, Holforth, et al., 2012; Miller et al., 2009) and higher levels of alexithymia (Beales & Dolton, 2000; Tchanturia et al., 2012). In addition, there is a third line of findings that suggest that deficits in emotional functioning can be both state-dependent and trait vulnerable, depending on the emotional competence being analysed. Harrison et al. (2010) found that attentional bias to social stimuli and difficulties with emotion recognition tend to persist after recovery, whereas ER difficulties appear to remit after the acute phase of the illness.

The abovementioned studies used a cross-sectional design comparing recovered AN patients with acute AN and/or HC individuals. However, to establish whether emotional processing impairments are state or trait-like, additional research following the same cohort of participants is required (Brockmeyer, Holforth, et al., 2012; Harrison et al., 2010; Oldershaw et al., 2010, 2012; Merwin et al., 2013). To the best of our knowledge, there are only five studies in this field that have used longitudinal methodology, comparing AN individuals before and after weight restoration (Beadle et al., 2013; Becker-Stoll & Gerlinghoff, 2004; Ben-Porath et al., 2014; Haynos et al., 2014; Rowsell et al., 2016). Findings on alexithymia

suggest decreased symptomology from starvation to weight restoration periods, mainly due to improvements in two alexithymia dimensions: difficulty identifying feelings and externally oriented thinking. In turn, the difficulty in describing feelings tends to remain stable during treatment (Beadle et al., 2013; Becker-Stoll & Gerlinghoff, 2004). In respect of ER difficulties results are mixed. Two studies did not observe a significant improvement in participants' ability to regulate emotions with weight restoration (Beadle et al., 2013; Haynos et al., 2014), while two other studies reported directly contrasting findings (Ben-Porath et al., 2014; Rowsell et al., 2016). In sum, the available longitudinal data is conflicting and requires replication.

The study of the link between emotion-processing deficits and body mass index (BMI) is considered a complementary path to clarify the nature of emotional problems in AN. However, this relationship also presents controversial results. Some studies performed in the active phase of the illness found that BMI was positively correlated with ER difficulties (Brockmeyer, Holforth, et al., 2012), avoidance of affect, and distress intolerance (Corstorphine et al., 2007), and negatively correlated with social anhedonia (Tchanturia et al., 2012). In turn, other studies failed to find a significant association between BMI and ER difficulties (Harrison et al., 2010) and deficits on the ability to make inferences about another person's beliefs, desires, emotions or intentions (Oldershaw et al., 2010). Longitudinal studies also provide divergent results. Rowsell et al. (2016) observed an association between weight gain and improvement in ER difficulties, independent of the effects of psychological treatment, while Haynos et al. (2014) found these variables uncorrelated either in acute underweight or weight restored phases.

A further issue of note is the possible confounding effect of AN comorbid symptoms in the presence and variance of emotional difficulties (Hatch et al., 2010; Nowakowski et al., 2013; Oldershaw et al., 2011, 2015; Westwood et al., 2017). Data from systematic reviews suggests that emotional disorders such as anxiety and depression have potential to mediate or worsen emotional processing impairments in this eating disorder (Nowakowski et al., 2013; Oldershaw et al., 2011, 2015; Westwood et al., 2017). In fact, one study found evidence that differences in alexithymia observed between weight restored individuals and HCs were due to depression (Beadle et al., 2013). However, far more research is need, namely using a longitudinal design, in order to replicate this finding and extend it to other emotional competencies (Oldershaw et al., 2015; Kezelman et al., 2015; Westwood et al., 2017).

In sum, there are a great number of gaps in knowledge about the nature of emotion difficulties in AN, and the possible confounding effect of anxiety and depression. Several methodological differences and limitations of past research could account for the inconsistent results. Firstly, cross-sectional design, the most used methodology, is limited in its ability to establish the nature of emotion-processing deficits (secondary to nutritional state vs. vulnerability trait that play a role in the maintenance of AN). Prospective longitudinal research following the same cohort of patients is thus essential. Secondly, the inclusion of healthy matched comparison participants is important to determine whether improvements in emotional domains are in part or full and, with the exception of one longitudinal study (Beadle et al., 2013), no other known study used this methodological design. Third, the few existing longitudinal studies have assessed the participants in an initial stage of AN recovery (Beadle et al., 2013; Becker-Stoll & Gerlinghoff, 2004; Ben-Porath et al., 2014; Haynos et al., 2014; Rowsell et al., 2016) with no known studies investigating the long-term emotional functioning of recovered AN individuals. Long-term data is of major importance to add knowledge to the field, since short-term weight restoration can be insufficient to restore normative emotional function (Beadle et al., 2013; Becker-Stoll & Gerlinghoff, 2004; Haynos et al., 2014; Rowsell et al., 2016). Fourth, the definition of recovery varies widely among studies. In some, recovery is merely defined as achieving a normal weight (BMI >18.5 kg/m^2; e.g., Merwin et al., 2013; Miller et al., 2009) while in others the absence of eating disorder pathology (including amenorrhea) for at least the last 12 months is also required (e.g., Brockmeyer, Holforth, et al., 2012; Harrison et al., 2010; Oldershaw et al., 2010). In addition, two of five longitudinal studies (Becker-Stoll & Gerlinghoff, 2004; Ben-Porath et al., 2014) followed a pre-post treatment design, where the BMI change did not necessarily reflect an achievement of normative weight levels, leaving the possibility for further improvement. These heterogeneous criteria limit the comparison and generalization of findings. Fifth, the effect of comorbid symptoms, such as anxiety and depression, in the variance of emotion functioning difficulties is understudied (Oldershaw et al., 2010). Lastly, the spectrum of emotional competences addressed by past longitudinal research is limited, with most studies relying solely on alexithymia and ER difficulties. A closer look at the broader emotional experience should be considered when researching emotion-processing deficits (Torres, Guerra, Lencastre, Roma-Torres, et al., 2011).

In addressing these drawbacks, we conducted a 15 years longitudinal study to examine whether difficulties in cognitive processing of emotions persist after long-term AN recovery; as well as the role of anxiety and

depression in emotional functioning of recovered AN patients. We considered alexithymia and ER difficulties as components of emotional processing, but we also sought to evaluate other features of emotional experience. Therefore, we assessed the frequency of basic emotions in everyday life, as an indicator of core affect (Russell & Barrett, 1999), and the intensity of emotions felt via imagination of emotional scenes, as an indicator of physiological response to emotions (Iancu et al., 1999). Theoretically, successful emotion regulation is contingent on the ability to previously feel and recognise one's own emotions (Hatch et al., 2010).

A 15 years follow-up period was selected for increased probability of reaching recovered patients with stabilized emotional changes. As illustrated by Steinhausen's (2002), recovery in AN increased from 32.6% in studies with a follow-up of less than four years, to 73.2% in studies with a more than 10 years follow-up.

No specific predictions were made for the current study, as previous research have produced highly divergent data on this issue. Findings from this research will add knowledge to the nature and role of emotional difficulties in AN course impacting psychiatric treatment.

2 | METHOD

2.1 | Participants

Forty participants were identified as having been diagnosed with AN between 2002 and 2003 (acute AN phase) at a public psychiatric service that provides specialized treatment for eating disorders in the North of Portugal. All participants were evaluated during the acute AN phase for cognitive processing of emotions (see Torres et al., 2011 for more detail). Six participants were removed from this initial sample due to the absence of updated contacts. Twenty-nine of the 34 participants (85.3%) agreed to participate in the longitudinal assessment. After a diagnostic interview, we excluded five participants who met criteria for AN diagnosis. A total of 24 female participants were identified as being fully recovered from AN at a 15 years follow-up (recovered AN phase) and also comprised the paired sample of the study. Participants were considered fully recovered from AN, regardless of AN subtype, if they met two conditions in the 12 months preceding study follow-up: (1) BMI equal or superior to 18.5 kg/m^2 and, (2) do not meet any AN diagnostic criteria, according to the DSM-5 (APA, 2013). In the acute phase, participants (n = 24) were aged between 13 and 28 years (M = 18.46; SD = 4.3), BMI ranged from 12.8 to 17.3 kg/m^2 (M = 15.42; SD = 1.46), and 16 participants (67%) suffered from AN restrictive subtype and the remaining eight (33%) corresponded to the binge-purge subtype. At 15 years follow-up the participants (n = 24) were aged between 27 and 42 years (M = 31.17; SD = 4.53) and BMI varied from 18.5 to 24.7 kg/m^2 (M = 20.66; SD = 1.48). Participants underwent a generic, behaviourally based treatment program, based on the guidelines from the American Psychiatric Association (APA, 2006), with nutritional rehabilitation and psychiatric management valences. They did not receive a treatment directly targeting improvement of ER.

The HC sample consisted of 24 females, ranging from 26 to 44 years of age (M = 30.38; SD = 4.35), with BMI between 18.9 and 24.8 kg/m^2 (M = 21.36; SD = 1.83), recruited via advertisements through local community and personal contacts. Data collected were cross-sectional, that is obtained at a single point in time, and the participants were not followed longitudinally. The HC sample had normal weight (BMI between 18.5 and 24.9 kg/m^2) and no current or previous diagnosis of eating disorders.

2.2 | Materials

In this study, we applied the same measures used at the acute AN phase (cf. Torres et al., 2011) and added one instrument to assess ER difficulties with the aim of extending the emotional competencies analysed in case-control approach.

Interview for the Diagnosis of Eating Disorders-IV (IDED-IV). The IDED-IV (Kutlesic et al., 1998) was applied to confirm the presence of AN diagnosis at baseline and the absence of this diagnosis at 15 years follow-up. The Portuguese version of IDED-IV (Torres, Guerra, Lencastre, Williamson, et al., 2008) has yielded sufficient reliability and validity data to use for establishing a diagnosis of eating disorder, according to DSM-IV-TR (APA, 2000) criteria. However, the recent transition from DSM-IV-TR to DSM-5 (APA, 2013) has resulted in a broader definition of AN: the threshold for determining low weight was raised, fear of weight gain does not need to be verbalized if behaviours interfering with weight gain can be observed, and amenorrhea criteria was removed. Considering that the DSM-5 is less stringent for meeting AN criteria, all patients who met DSM-IV-TR criteria at baseline, retained this same diagnosis with application of the DSM-5. To adhere to the new definition of AN, we changed the coding process of the interview in the follow-up assessment in accordance with the DSM-5. Data maintained integrity throughout recoding due to the dynamic nature of the IDED-IV. The IDED-IV addresses the participant's history of eating disorder symptoms and current eating

pattern, thus allowing for exploration of the reasons for maintaining a low weight. We used this information to infer fear of weight gain without needing to be verbalized, and thus expand the Criterion B as defined in DSM-5. We adjusted the maximum BMI threshold to 18.5 kg/m^2 for determining low weight (Criterion A) and removed the DSM-IV-TR amenorrhea criteria. No changes were made to Criterion C (body image disturbance, undue influence of weight or shape on self-evaluation, or the denial of seriousness of low weight). Questions to define diagnostic subtype for AN allowed for exclusion of other eating disorder diagnoses due to overlapping symptoms (e.g., binge eating, purging, and body image disturbance). Participants were considered to meet criteria for AN diagnosis if they presented with three or more scores in all subscales of the diagnostic section. Lastly, participants were considered recovered from AN if their BMI was above 18.5 kg/m^2 with absence of eating disorder symptoms (i.e., they scored less than three in all subscales of diagnostic criteria) for the last 12 months or more.

Self-Rating Anxiety Scale (SAS). The SAS (Zung, 1971) is a self-report measure whose 20 items cover a variety of anxiety symptoms. The Portuguese version of the SAS (Ponciano et al., 1982; Serra et al., 1982) has satisfactory psychometric properties, including construct and predictive validity. Cronbach's alpha for our sample was 0.79.

Zung Self Rating Depression Scale (SDS). The SDS (Zung, 1965) is a self-report measure comprised of 20 items that assess levels of depression. The Portuguese version of this scale (Diegas & Cardoso, 1986) presented a one-factorial structure with good convergent validity. In the present study Cronbach's alpha was 0.86.

Toronto Alexithymia Scale (TAS-20). The TAS-20 (Bagby et al., 1994) is a self-report questionnaire measuring alexithymia. It consists of 20 items loading onto three subscales: (1) Difficulty in identifying feelings (TAS-DIF); (2) Difficulty in describing feelings to others (TAS-DDF); and (3) Externally oriented thinking (TAS-EOT). The Portuguese version (Prazeres et al., 2000) replicated the same factor structure of the original version and showed high internal consistency ($\alpha = 0.79$), 3-week temporal stability ($r = 0.90$; $p < 0.001$), and construct and predictive validity. Here, Cronbach's alpha was 0.81.

Difficulties in Emotion Regulation Scale (DERS). The DERS (Gratz & Roemer, 2004) is a 36-item self-report scale used to assess facets of emotion dysregulation, including the following subscales: (1) Strategies (limited access to ER strategies); (2) Non-acceptance (non-acceptance of emotional responses); (3) Awareness (tendency to attend to and acknowledge emotions); (4) Impulse (impulse control difficulties), (5) Goals (difficulties engaging in goal directed behaviour in the presence of negative emotions); and (6) Clarity (lack of emotional clarity). The Portuguese version DERS (Coutinho et al., 2010) demonstrated high internal consistency ($\alpha = 0.93$), four-week temporal stability ($r = 0.82$; $p < 0.000$), and construct and predictive validity. In this study, Cronbach's alpha coefficient for the DERS was 0.951.

Emotional Evaluation Questionnaire for Anorexia Nervosa (EEQ-AN). The EEQ-AN was developed by Torres and Guerra (2003) with the aim of evaluating the emotional experience of individuals with AN and their meta-emotional abilities. The EEQ-AN consists of two parts. Part I focuses on the assessment of core affect and analyses the frequency of basic emotion in everyday life (positive emotions: joy, interest and surprise; internally based negative emotions: guilt, sadness, shame and fear; externally based negative emotions: disgust, contempt and anger). The frequency of each emotion was rated on a 5-point Likert-type scale, ranging from 1 (*never*) to 5 (*nearly always*). Part II is focused on the assessment of 28 prototypical emotional episodes and consists of an experimental approach through which participants are asked to imagine the main basic emotions, and its intensity, that they may feel in the presence of different situations that are briefly described in writing. Intensity was rated on a 6-point Likert-type scale (0 = *I do not feel anything,* 5 = *I feel very much*). Prototypical emotional episodes were composed of 10 stimuli describing situations directly associated with AN, that is, addressing food, body weight, and appearance (AN stimuli; e.g., "When I think that I have eaten too much"), 10 stimuli concerning general daily situations (general stimuli; e.g., "When someone treats me unfairly"), and eight stimuli to mislead participants about the aim of the questionnaire. A full description of the prototypical emotional episodes included in the EEQ-AN is available in Torres, Guerra, Lencastre, Roma-Torres, et al. (2011).

2.3 | Procedure

This study received approval from the Ethical Committee of the Faculty of Psychology and Education Sciences, University of Porto (Reference 2-11/2015) and from Centro Hospitalar São João, Porto (Reference CE-92-2014). Informed written consent was provided by all participants. In the AN sample, participants completed the informed consent process at both time assessments: AN acute phase and follow-up. The diagnostic interview and questionnaires were administered by a trained clinician.

2.4 | Data analysis

No missing-values were found. The normal distribution of data was met for all variables based on the Kolmogorov-Smirnov test (KS; with Lilliefors Significance Correction) and the following criteria: absolute skewness (Sk) and kurtosis (K) values lower than 3.0 and 8.0, respectively (Kline, 2005). *T*-tests were conducted to compare demographic characteristics of AN recovered and HC samples. Pearson correlation coefficient (*r*) was calculated to explore the relationship of BMI with the SAS, SDS, and TAS-20 in the AN sample (both phases). The association between these variables was also examined using change scores (i.e., difference between recovered and acute AN phases). Paired sample *t*-test (for the measure's total scores) and one-way repeated measures multivariate analysis of variance (repeated MANOVA; for measure's subscales/factors) were applied to identify changes that may have occurred from the acute to the recovered AN phase in anxiety, depression, alexithymia, frequency of basic emotions in daily life (EEQ-AN, part I), and intensity of emotions felt via the imagination of emotional scenes (EEQ-AN, part II). To analyse emotional intensity, we grouped the 20 prototypical emotional episodes in four groups: (1) AN stimuli inducing positive emotions ($n = 3$); (2) General stimuli inducing positive emotions ($n = 3$); (3) AN stimuli inducing negative emotions ($n = 7$); and (4) General stimuli inducing negative emotions ($n = 7$). For each of these groups, the sum score of the stimulus intensity was calculated. In this experimental task, changes in the emotions conveyed in these hypothetical situations were not analysed due to the assumption violation of the McNemar's test (i.e., lack of the minimum expected of cell frequency).

Differences between recovered AN and HC groups in all analytic variables were examined by means of analysis of covariance (ANCOVA; for measures total scores) and multivariate analysis of covariance (MANCOVA; for measures subscales/factors). Given the difference between these groups in education (years of schooling) we controlled for the effect of this variable. MANCOVA was also applied to explore whether group differences found in emotion-processing variables (TAS-20, DERS, and EQQ-AN) remained, after controlling for the potential confounding effect of education and comorbid emotional disorder (SAS and SDS). Multicollinearity between dependent variables, and between dependent variables and covariates, was tested through Pearson correlation coefficients (*r*). No multicollinearity was found (all *r* values bellow .80; Field, 2005).

Eta squared and partial eta squared were used as an estimation of effect sizes for paired *t*-test and ANCOVA, respectively. Eta squared and partial eta squared values were defined as small (η^2 and $\eta^2_p < 0.01$), medium (η^2 and $\eta^2_p < 0.06$) or large (η^2 and $\eta^2_p < 0.14$; Field, 2005). Data were analysed using the Statistical Package for the Social Sciences Version 25 (SPSS).

3 | RESULTS

3.1 | Demographic characteristics

Comparisons between recovered AN and HC groups revealed no mean differences in age, $t\ (46) = 0.62$, $p = 0.54$, $d = 0.17$ and BMI, $t\ (46) = -1.47$, $p = 0.149$, $d = -0.42$. However, HC participants had more years of schooling ($M = 16.58$, $SD = 1.95$) in comparison with the recovered AN group ($M = 14.67$, $SD = 3.42$), $t\ (37) = -2.38$, $p = 0.021$, $d = -0.69$.

3.2 | BMI and its association with emotion-related variables

Correlational analysis between emotion-related variables (SAS, SDS, and TAS) and BMI was carried out separately for acute AN and recovered AN data, and no significant correlations were found (r between -0.09 and 0.16; $p > 0.05$; for detail see Table S1). Similarly, no significant associations between these variables were observed using the change scores (r between -0.13 and 0.17; $p > 0.05$). The association between BMI and DERS (total and subscales scores) was tested in the recovered AN phase and no significant correlations were found (r between -0.16 and -0.07; $p > 0.05$).

3.3 | Anxiety, depression, alexithymia, and emotion regulation difficulties: longitudinal analysis and group comparison

There was a significant decrease in anxiety, depression, and alexithymia from the acute to the recovered AN stage (see Table 1), with large effect sizes (η^2 between 0.34 and 0.64). Repeated-measures MANOVA analysis confirmed that there was also a significant multivariate effect of time on the combined alexithymia factors: $F\ (3, 21) = 8.00$, $p = 0.001$, Wilks' $\Lambda = 0.47$, $\eta^2_p = 0.53$ (Table 2). The alexithymia prevalence rate (established cutoff for alexithymic cases: TAS-20 $\geq$ 61, Taylor et al., 1997) in acute AN participants was 58%, and in recovered AN participants was 17%.

Regarding the differences between recovered AN group and HC group, after controlling for education,

TABLE 1 Longitudinal and group comparisons in anxiety, depression, alexithymia, and difficulties in emotion regulation (total scores)

Measure	AN ($n = 24$) M (SD)	Recovered AN ($n = 24$) M (SD)	HC ($n = 24$) M (SD)	AN versus Recovered AN		Recovered AN versus HC[a]	
				paired t-test	η^2	F	η^2_p
SAS	47.08 (11.65)	37.38 (6.75)	31.25 (4.80)	3.47**	0.34	9.36***	0.17
SDS	52.88 (11.80)	36.46 (9.37)	31.08 (6.99)	6.42***	0.64	3.69	0.08
TAS-20	62.33 (15.13)	46.88 (11.52)	38.83 (10.01)	4.94***	0.51	3.13	0.07
DERS	–	81.79 (24.63)	59.96 (15.66)	–	–	11.86***	0.21

Abbreviations: AN, anorexia nervosa; DERS, Difficulties in Emotion Regulation Scale; HC, healthy control group; SAS, Self Anxiety Scale; SDS, Zung Self Rating Depression Scale; TAS-20, Toronto Alexithymia Scale.

[a]ANCOVA; covariate: education.

**$p < 0.01$, ***$p < 0.001$.

TABLE 2 Longitudinal and group comparisons in alexithymia and difficulties in emotion regulation (subscales)

Measure	AN ($n = 24$) M (SD)	Recovered AN ($n = 24$) M (SD)	HC ($n = 24$) M (SD)	AN versus Recovered AN[a]		Recovered AN versus HC[b]	
				F	η^2_p	F	η^2_p
TAS-20							
TAS-DIF	23.21 (7.85)	16.08 (6.79)	11.13 (4.87)	19.24***	0.46	4.75*	0.10
TAS-DDF	17.17 (5.45)	12.17 (4.17)	9.71 (3.62)	13.37***	0.37	3.70	0.08
TAS-EOT	21.96 (4.49)	18.63 (4.39)	18.00 (4.20)	12.83**	0.35	0.22	0.01
DERS							
DERS-strategies	–	17.75 (7.16)	11.83 (3.28)	–	–	13.66***	0.23
DERS-non-acceptance	–	15.50 (6.09)	11.13 (5.59)	–	–	5.90**	0.12
DERS-awareness	–	13.63 (4.86)	12.67 (3.93)	–	–	0.40	0.01
DERS-impulse	–	12.79 (4.89)	8.29 (2.46)	–	–	13.25***	0.23
DERS-goals	–	13.08 (4.49)	9.38 (3.79)	–	–	9.59***	0.18
DERS-clarity	–	9.04 (4.01)	6.67 (1.95)	–	–	4.66*	0.09

Abbreviations: AN, anorexia nervosa; DERS, Difficulties in Emotion Regulation Scale; HC, healthy control group; TAS-20, Toronto Alexithymia Scale Total Score; TAS-DDF, Difficulty in Describing Feelings to Others; TAS-DIF, Difficulty in Identifying Feelings; TAS-EOT, Externally Oriented Thinking.

[a]One-way repeated measures MANOVA; TAS-20 Model: F (3, 21) = 8.00, $p = 0.001$, Wilks' $\Lambda = 0.47$, $\eta^2_p = 0.53$.

[b]MANCOVA (covariate: education); TAS-20 Model: F (3, 43) = 2.33, $p = 0.088$, Wilks' $\Lambda = 0.86$, $\eta^2_p = 0.14$; DERS Model: F (6, 40) = 2.43, $p = 0.043$, Wilks' $\Lambda = 0.73$, $\eta^2_p = 0.27$.

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

there was a significant difference between groups on SAS, with the recovered AN group presenting higher levels of anxiety, but not on SDS and TAS-20 total (Table 1). In alexithymia factors, there was no significant difference between groups on TAS-DDF and TAS-EOT ($p > 0.05$; Table 2). Conversely, greater TAS-DIF scores were reported by participants who recovered from AN relative to HC group. The recovered AN group also presented higher mean scores in DERS total and in all DERS subscales ($p < 0.05$), with exception of Awareness subscale (Table 2).

3.4 | The role of anxiety and depression in emotion-processing difficulties during the an recovered phase

For variables that differed significantly between recovered AN versus HC groups, main effect of group was examined, after controlling for the influence of education and emotional disturbance. In alexithymia, group differences were no longer significant in the TAS-DIF, F (1, 43) = 0.27, $p = 0.605$, $\eta^2_p = 0.01$. In contrast, with DERS, findings revealed group differences for the total score, F

(1, 43) = 6.03, $p = 0.020$, $\eta^2_p = 0.12$. Of the DERS subscales, Strategies, F (1, 43) = 7.02, $p = 0.011$, $\eta^2_p = 0.14$, Impulse, F (1, 43) = 5.37, $p = 0.025$, $\eta^2_p = 0.11$, and Goals, F (1, 43) = 4.92, $p = 0.032$, $\eta^2_p = 0.10$ remained statistically significantly different for recovered AN and HC participants, after controlling for covariates. Conversely, group differences were no longer significant for the Non-Acceptance, F (1, 43) = 1.55, $p = 0.220$, $\eta^2_p = 0.04$, and Clarity subscales, F (1, 43) = 0.77, $p = 0.386$, $\eta^2_p = 0.02$.

3.5 | Experimental task (EEQ-AN)

EEQ-AN (part I). Longitudinal analysis and group comparison regarding the frequency of experience of the basic emotions are described in Table 3. There was a significant increase from the acute to the recovered AN phase in the experience of positive emotions and a decrease in the experience of negative emotions (both internally and externally based), all with large effect sizes (η^2 between 0.17 and 0.46).

When comparing recovered AN and HC groups, while controlling for education (see Table 3), joy was the only positive emotion that contributed statistical significance toward distinguishing both groups; no group differences were found in interest and surprise ($p > 0.05$). In respect to negative emotions, all were experienced more often by the participants who recovered from AN, with exception of anger ($p > 0.05$). Effect size of group differences were larger for internally negative emotions (η^2_p between 0.07 and 0.09) than with externally negative emotions (η^2_p between 0.12 and 0.19).

We also examined whether the experience of joy and negative emotions (with exception of anger) still differed between participants recovered from AN and HC group, after the influence of emotional disorders (i.e., anxiety and depression) and education have been removed. Results indicated that, after controlling for covariates, there was no main effect of group on the combined externally negative emotions, F (2, 42) = 0.58, $p = 0.564$, Wilks' $\Lambda = 0.97$, $\eta^2_p = 0.03$. With respect to internally negative emotions, group differences were no longer observed on sadness, F (1, 43) = 2.60, $p = 0.114$, $\eta^2_p = 0.06$, shame, F (1, 43) = 1.35, $p = 0.252$, $\eta^2_p = 0.03$, and fear, F (1, 43) = 3.65, $p = 0.063$, $\eta^2_p = 0.08$. On the contrary, group differences in the experience of guilt remained significant, F (1, 43) = 6.71, $p = 0.013$, $\eta^2_p = .014$. Also, higher joy scores were still noted in HC group than recovered AN, after controlling for covariates, F (1, 43) = 4.42, $p = 0.040$, $\eta^2_p = 0.09$.

EEQ-AN (part II). Table 4 presents the results of longitudinal analysis and group comparison relative to the intensity of emotions felt via the imagination of emotional scenes. From the acute to the recovered AN phase, emotional intensity increased significantly in AN stimuli-inducing negative emotions, and decreased in General stimuli-inducing positive emotions ($p < 0.001$; $\eta^2 = 0.69$ and 0.71, respectively). Emotional intensity felt via the imagination of the other two groups of prototypical emotional episodes (AN stimuli inducing positive emotions and General stimuli inducing negative emotions) did not change significantly ($p > 0.05$).

Emotional intensity did not differ between recovered AN group and HC group, controlling for the effect of education, between any of the four groups of prototypical episodes ($p > 0.05$).

4 | DISCUSSION

This 15 years longitudinal study aimed to examine whether difficulties in cognitive processing of emotions persisted after long-term recovery from AN. In addition, it sought to explore the confounding effect of anxiety and depression on emotional functioning in the AN recovered phase. This is the first long-term follow-up study that we are aware of to explore these questions, representing progress for the field and providing perspective on emotional functioning in this eating disorder after treatment effects are stabilized.

Globally, we found a significant decrease in emotional dysfunction with long-term AN recovery. However, using the healthy participants as reference, we conclude that, notwithstanding this significant progress, several emotional competences did not attain normative function in the recovered AN phase. At face value, one important issue to take into consideration is the role of nutritional state in the course of emotional changes. In this regard, our findings suggest that the increase in BMI that occurred throughout the AN recovery did not have a linear effect in the reduction of alexithymia, anxiety, or depression. This finding converges with the faction of studies which documented a non-significant association between BMI and impaired emotional functioning, both in acute and recovered AN phases (Haynos et al., 2014; Harrison et al., 2010; Oldershaw et al., 2010). In practice, it suggests that emotional dysfunction does not result from malnutrition or, if so, food restriction profoundly alters ER abilities making them independent of weight variation (Haynos et al., 2014).

The decrease in alexithymia (total and factors) observed from the acute to the recovered AN phase is consistent with data from other longitudinal research, with the exception of the DDF factor, in which no significant improvement was found in the previous studies (Beadle et al., 2013; Becker-Stoll & Gerlinghoff, 2004).

TABLE 3 Comparison of frequency of experience of basic emotions felt between anorexia nervosa, recovered anorexia nervosa and healthy control groups

Measure	AN ($n = 24$) M (SD)	Recovered AN ($n = 24$) M (SD)	HC ($n = 24$) M (SD)	AN versus Recovered AN[a]		Recovered[a]AN versus HC[b]	
				F	η^2_p	F	η^2_p
Positive emotions							
Joy	2.58 (1.18)	3.67 (0.87)	4.25 (0.74)	14.57***	0.45	7.28**	0.14
Interest	3.46 (1.14)	4.38 (0.71)	4.21 (0.72)	19.15**	0.39	1.28	0.03
Surprise	2.46 (0.98)	3.13 (0.85)	3.29 (0.69)	7.36*	0.24	0.70	0.02
Externally negative emotions							
Disgust	2.33 (1.27)	1.75 (1.03)	1.29 (0.86)	19.21***	0.23	4.06*	0.08
Contempt	2.63 (1.38)	1.83 (0.92)	1.33 (0.64)	6.75**	0.27	4.19*	0.09
Anger	2.92 (1.44)	1.71 (0.86)	1.33 (0.70)	8.66**	0.46	3.24	0.07
Internally negative emotions							
Guilt	4.00 (1.32)	2.75 (1.36)	1.67 (0.87)	4.60*	0.41	10.73**	0.19
Sadness	3.88 (1.23)	2.96 (1.04)	2.13 (0.85)	9.86**	0.27	8.90**	0.17
Shame	3.58 (1.32)	2.58 (1.21)	1.83 (0.96)	8.62**	0.30	6.08*	0.12
Fear	3.67 (1.31)	3.00 (1.06)	2.17 (0.87)	15.83***	0.17	8.63**	0.16

Abbreviations: AN, anorexia nervosa; HC, healthy control group.

[a]One-way repeated measures MANOVA; Positive Emotions Model: $F(3, 21) = 9.65$, $p < 0.001$, Wilks' $\Lambda = 0.47 = 0.42$, $\eta^2_p = 0.58$; Externally Negative Emotions Model: $F(3, 21) = 7.10$, $p = 0.002$, Wilks' $\Lambda = 0.50$, $\eta^2_p = 0.50$; Internally Negative Emotions Model: $F(4, 20) = 6.16$, $p = 0.002$, Wilks' $\Lambda = 0.45$, $\eta^2_p = 0.55$.

[b]MANCOVA (covariate: education); Positive Emotions Model: $F(3, 43) = 4.49$, $p = 0.008$, Wilks' $\Lambda = 0.76$, $\eta^2_p = 0.24$; Externally Negative Emotions Model: $F(3, 43) = 1.78$, $p = 0.165$, Wilks' $\Lambda = .89$, $\eta^2_p = 0.11$; Internally Negative Emotions Model: $F(4, 42) = 3.23$, $p = 0.021$, Wilks' $\Lambda = 0.77$, $\eta^2_p = 0.24$.

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

TABLE 4 Comparison of intensity of experience of basic emotions felt between anorexia nervosa, recovered anorexia nervosa and healthy control groups

Measure	AN (n = 24) M (SD)	Recovered AN (n = 24) M (SD)	HC (n = 24) M (SD)	AN versus Recovered AN[a]		Recovered[a] AN versus HC[b]	
				F	η^2_p	F	η^2_p
AN stimuli							
Positive emotions	11.58 (2.96)	10.92 (3.67)	10.25 (2.51)	0.75	0.03	0.09	0.00
Negative emotions	10.13 (2.19)	21.46 (6.97)	17.50 (6.20)	52.31	0.71	3.10	0.06
General stimuli							
Positive emotions	12.92 (2.45)	8.75 (0.85)	8.71 (0.81)	55.28***	0.70	0.19	0.00
Negative emotions	27.67 (5.11)	29.04 (3.98)	26.25 (4.93)	1.88	0.08	4.00	0.08

Abbreviations: AN, anorexia nervosa; AN stimuli = stimuli describing situations directly associated with anorexia nervosa; HC, healthy control group; General stimuli: stimuli concerning general daily situations.

[a]One-way repeated measures MANOVA; AN stimuli Model: F (2, 22) = 27.96, $p < 0.001$, Wilks' $\Lambda = 0.28$, $\eta^2_p = 0.72$; General stimuli Model: F (2, 22) = 33.41, $p < 0.001$, Wilks' $\Lambda = 0.28$, $\eta^2_p = 0.75$.

[b]MANCOVA (covariate: education); AN stimuli Model: F (2, 44) = 1.80, $p = 0.178$, Wilks' $\Lambda = 0.93$, $\eta^2_p = 0.08$; General stimuli Model: F (2, 44) = 1.97, $p = 0.151$, Wilks' $\Lambda = 0.92$, $\eta^2_p = 0.08$.

***$p < 0.001$.

According to Becker-Stoll and Gerlinghoff (2004), the difficulty in verbally expressing emotions may not decrease during the treatment because, with the progress in emotional awareness, patients begin to realize how difficult it is to find the right words for their feelings. Thus, it is possible that the impact of the treatment in DDF only manifests in the long-term, when isolation–a typical feature in the acute phase of the illness (Levine, 2012)–diminishes, making room for social interactions. Nevertheless, the decrease of alexithymia in AN recovered phase is a robust finding in the literature and indicates that this cognitive-affective disturbance is likely to change with treatment.

Based on alexithymia previous longitudinal findings we were inclined to consider emotional processing impairments in AN to be a state-dependent condition. However, comparative analysis between AN recovered patients and a HC group shows that increased difficulties in identifying and regulating emotions tend to persist. Our study does not permit for conclusions about the evolution of ER difficulties over the course of the disorder, by means of the DERS, but does provide evidence of the reduced ability to manage emotions in the long-term. Increased difficulties were observed in most ER facets in AN recovered participants. The literature using both longitudinal (Haynos et al., 2014) and case control (Brockmeyer, Holforth, et al., 2012) methodologies, indicate no reduction in the DERS (total and subscales) with treatment, and higher scores relative to controls during the recovery phase. Notably, contrasting results suggest a significant improvement in the DERS total following treatment (Ben-Porath et al., 2014; Rowsell et al., 2016), and comparable scores with control groups (Harrison et al., 2010). It is plausible that such differences in longitudinal findings (Ben-Porath et al., 2014; Haynos et al., 2014; Rowsell et al., 2016) are likely to be influenced by the nature of treatment. In fact, researchers who reported a significant improvement in participants' ability to regulate emotions after treatment (Ben-Porath et al., 2014; Rowsell et al., 2016) employed emotion-focused treatment approaches with their studies. This suggests that ER competences may be fostered with an intervention targeted to improve the ability to modulate emotional responses. AN patients, in our study, have undergone a behaviourally based treatment program with nutritional rehabilitation and psychiatric management valences, with no specific focus on ER. As such, if no systematic work on emotional domain is done during treatment, it is possible that increased difficulty regulating emotions tends to manifest over time.

Managing emotions, especially those internally based, remains a challenge for individuals recovered

from AN. Despite the experience of guilt, shame, sadness, and fear showing decline in longitudinal assessment, these emotions are still more frequently experienced in the daily life of the AN recovered participants than HCs. According to the EEQ-AN results, these emotions may also be felt with more intensity after recovery than in the acute phase of the disorder, in particular if the emotions are associated with food and body weight (i.e., AN stimuli). This is of particular interest, as it suggests that, with recovery, there may be an increase of emotional intensity. In practice, it can be a consequence of greater introspection and reduced emotion suppression/avoidance, as evidenced by the improvement of the TAS-EOF factor, but also by the normal levels (when compared to HC individuals) of the Awareness subscale observed in recovered phase. This change makes the individuals more open to the emotional experience, which can be both a positive result but a challenge as well, considering that recovered participants have greater difficulty in using adaptive strategies to regulate emotions (relative to HCs). In this context, maladaptive eating behaviour can ultimately serve an affect regulatory function, increasing the risk of relapse. It is thus important that ER abilities be addressed as a key component of relapse prevention.

One plausible explanation to the greater experience of internally based negative emotions in the long-term recovered phase, relative to comparison participants, may be the presence of anxiety and depressive symptoms. Our findings validate this hypothesis regarding shame, sadness and fear. Anxiety and depression also explained the presence of difficulties in identifying feelings, non-acceptance of emotions, and lack of emotional clarity. Conversely, there are other emotional competences that seem to be underdeveloped over the long-term, regardless of the presence of emotional disturbance, particularly with access to adaptive ER strategies and the ability to control impulses and engage in goal direct behaviour when experiencing negative emotions. Also, the increased rates of guilt and reduction of joy seem to be independent of anxiety and depression. These findings offer important input for AN treatment and relapse prevention. First, anxiety and depression partially explain the presence of difficulties in cognitive processing of emotions. Therefore, it is important to keep anxiety and depression interventions established after recovery. This is due to both their association with the presence of problematic emotions in AN (shame and fear), on the one hand, and decreased emotional clarity, on the other, which substantiate the risk of using food restriction, bingeing, and purging as coping behaviours. Second, our results lend credence to the view that anxiety and depression may account for the largest variance of cognitive-affective disturbances in AN, but are not a complete explanation for their presence, as previously argued by Torres, Guerra, Lencastre, Miller, et al. (2015). The limited access to adaptive ER strategies, in particular, seems to be a long-standing pattern that is difficult to change without explicit treatment. This conclusion converges with several etiological models (e.g., Brockmeyer, Bents, et al., 2012; Heatherton & Baumeister, 1991; Macht, 2008; Wildes et al., 2010) that implicate the inability to find effective strategies do deal with emotions as a core vulnerability trait to the development of AN.

4.1 | Limitations

The current study has some limitations that must be acknowledged. First, the relatively small sample size limits the generalizability of the data. In addition, the small sample size did not allow us to explore whether emotion functioning difficulties in long-term recovery differed between AN subtypes. This is an important question to address in future studies, as there is empirical evidence that, faced with negative emotions, patients with AN binge-purge subtype have more limited access to ER strategies and greater difficulties with impulse control than those with the AN restrictive subtype (e.g., Haynos et al., 2014; Rowsell et al., 2016). Second, the HC group was not assessed longitudinally, which limits control over whether changes observed in the AN sample regarding emotional processing difficulties may be a state-dependent phenomenon related to age (Hiirola et al., 2017). Third, data was collected primarily via self-report measures. This may be problematic because patients recovered from AN have difficulties in the recognition of one's own emotions. Future studies using complementary measures will be beneficial to validate the present findings. Fourth, we did not collect data regarding possible treatments undergone after the active phase of the disease, in particular those focused on the emotional processing modalities. Lastly, we did not control for the use of psychotropic medication. This possible confounding variable should be considered, in addition to anxiety and depression, as it may mask or exacerbate the presence of emotional difficulties (Jänsch et al., 2009; Oldershaw et al., 2011).

4.2 | Conclusions

This is the first longitudinal study to investigate whether difficulties in cognitive processing of emotions persist in long-term AN recovery and their link to anxiety and depression. In brief, we concluded that impaired emotional functioning tends to decrease with long-term recovery. After a 15 year period, individuals are more

open to emotional experiences and, consequently, show an increased ability to identify one's own emotions and verbally express them. In spite of this positive trend, some emotional functioning difficulties did not normalize after recovery. In some competences, such as emotional clarity and acceptance of emotions, improvements may have been limited by the co-occurrence of anxiety and depression. In turn, other ER strategies, such as impulse control, engagement in goal-directed behaviour, and use of ER strategies perceived as effective, difficulties persist regardless of presence of depression and anxiety, suggesting a more stable nature of those traits. Therefore, emotional education and stabilization of depressive and anxious symptomatology after recovery emerge as an important avenue to protect from long-term AN relapse.

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CONFLICT OF INTEREST

The authors have declared that they have no conflict of interest.

DATA AVAILABILITY STATEMENT

There is not overlapping data between this manuscript and any other published, submitted or proposed paper. All authors accept share the data.

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SUPPORTING INFORMATION

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