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RESEARCH ARTICLE

Reduced emotion recognition from nonverbal cues in anorexia nervosa

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Abstract

Objective: Recent models of anorexia nervosa (AN) emphasise the role of reduced emotion recognition ability (ERA) in the development and maintenance of the disorder. However, methodological limitations impede conclusions from prior research. The current study tries to overcome these limitations by examining ERA with an audio-visual measure that focuses strictly on multimodal nonverbal cues and allows to differentiate between ERA for different emotion categories.

Method: Forty women with AN and 40 healthy women completed the Geneva Emotion Recognition Test. This test includes 83 video clips in which 10 actors express 14 different emotions while saying a pseudo-linguistic sentence without semantic meaning. All clips contain multimodal nonverbal cues (i.e., prosody, facial expression, gestures, and posture).

Results: Patients with AN showed poorer ERA than the healthy control group ($d = 0.71$), particularly regarding emotions of negative valence ($d = 0.26$). Furthermore, a lower body weight ($r = 0.41$) and longer illness duration ($\rho = -0.32$) were associated with poorer ERA in the AN group.

Conclusions: Using an ecologically valid instrument, the findings of the study support illness models emphasising poor ERA in AN. Directly addressing ERA in the treatment of AN with targeted interventions may be promising.

KEYWORDS
eating disorder, emotion recognition, social cognition, socio-emotional processing, theory of mind

Abbreviations: 5-HT, serotonin; 5-HT1A, serotonin 1A receptor; 5-HT2A, serotonin 2A receptor; AN, anorexia nervosa; ANX, anxiety disorder; BMI, body mass index; CI, confidence interval; DSM-5, Diagnostics and Statistical Manual of Mental Disorders (5th edition); ED, eating disorders; EDE-Q8, Eating Disorder Examination Questionnaire-8; ERA, emotion recognition ability; FEEL, Facially Expressed Emotion Labelling Test; GEMEP, Geneva Multimodal Emotion Portrayals; GERT, Geneva Emotion Recognition Test; HC, healthy control; MASC, Movie for the Assessment of Social Cognition; MDD, major depressive disorder; OCD, obsessive-compulsive disorder; PHQ-9, Patient Health Questionnaire-9; PTSD, posttraumatic stress disorder; RME, Reading the Mind in the Eyes Test; SD, standard deviation; TERA, Training for Emotion Recognition Abilities.

Highlights

- Patients with anorexia nervosa (AN) show poorer emotion recognition ability (ERA) than healthy controls
- Emotion recognition ability in patients with AN was particularly reduced regarding emotions of negative valence
- Poorer ERA was associated with a lower body mass index and longer illness duration in patients with AN

1 | INTRODUCTION

Although anorexia nervosa (AN) is a debilitating and life-threatening disorder, with standardised mortality rates being the highest amongst all mental disorders (Arcelus et al., 2011), still relatively little is known about the causal mechanisms involved in the development and maintenance of the disorder (Brockmeyer et al., 2018). Recent models of AN emphasise the role of poor social cognition including difficulties in recognising emotions (emotion recognition ability [ERA]) in this regard (Schmidt & Treasure, 2006; Treasure et al., 2012).

Emotion recognition ability difficulties in AN are related to a poorer prognosis and treatment outcome (Zipfel et al., 2000; Zucker et al., 2007) and might represent not only a problem in the acute phase of the illness, but a more stable trait. There is, for instance, some evidence that ERA is still reduced in women who have recovered from AN (Harrison, Tchanturia & Treasure, 2010; Oldershaw et al., 2010). Furthermore, diminished ERA in monozygotic twins of patients with AN (Kanakam et al., 2013), in children at increased risk for developing AN (Kothari et al., 2015), and associations between genetic polymorphisms and ERA (Kucharska et al., 2019) suggest that weak ERA could be an endophenotype.

Although meta-analyses and systematic reviews have corroborated reduced ERA in AN (Caglar-Nazali et al., 2014; Oldershaw et al., 2011), there seems to be a large heterogeneity in effects, depending on the experimental paradigms and measures used (e.g., basic or complex emotions and static or dynamic emotion portrayals) and regarding the studied population (adolescents or adults).

Many studies (e.g., Kessler et al., 2006; Mendlewicz et al., 2005) employed measures in which basic emotions (fear, anger, disgust, happiness, sadness and surprise) are to be recognised based on static photographs of facial expressions, for example the *Facially Expressed Emotion Labelling Test* (FEEL, Kessler et al., 2002), sometimes with varying levels of expression intensity (Dinkler et al., 2019; Wyssen et al., 2019). However, tasks that only consider the recognition of basic emotions may not be sensitive enough, as patients with AN seem to have difficulty recognising more complex emotions (e.g., pride and relief) in particular (Harrison, Sullivan, et al., 2010; Harrison et al., 2012; Oldershaw et al., 2010; Russell et al., 2009). Recognition of complex emotions has frequently been assessed using the *Reading the Mind in the Eyes Test* (RME, Baron-Cohen et al., 2001). In the RME, participants are asked to infer cognitive or affective mental states based on pictures of only the eye area of a given face. However, merging cognitive (e.g., 'playful', 'reflective') and emotional items limits the utility of the RME to specifically measure ERA. This is important since patients with AN might experience particular difficulties with inferring emotional but not cognitive mental states in others (Brockmeyer et al., 2016; Renwick et al., 2015). Furthermore, some studies suggest that patients with AN have particular difficulty with the recognition of negative emotions (Kucharska et al., 2004; Pollatos et al., 2008), although no clear trends for valence-based differences could be identified in a systematic review (Oldershaw et al., 2011).

In order to capture the multimodal portrayal of complex emotions, we used the *Movie for the Assessment of Social Cognition* (MASC, Dziobek et al., 2006) in a previous study and found that women with AN had more difficulties with inferring emotional mental states than healthy women (Brockmeyer et al., 2016). In the MASC, participants watch videotaped conversations among four actors. The task includes social cognition concepts such as false belief, faux pas, metaphor and sarcasm. However, this measurement tool is more suitable for studying the decoding of cognitive and affective states in complex social interactions and less suitable for the specific study of ERA from nonverbal cues as the actors are exchanging verbal emotional cues. In addition, it appears somewhat suboptimal for research in AN because of the overt display of food and eating in some scenes and the relatively prominent role of romantic issues. This might distract participants with AN since they feature attentional biases towards food stimuli (Brooks et al., 2011) and often report discomfort with closeness in interpersonal relationships (Illing et al., 2010; Troisi et al., 2005).

Another way to measure ERA from nonverbal cues is provided by body motion paradigms. In these, for example, video clips are used in which actors equipped with small lights on their bodies, walk through a room in the dark and express one of four emotions (anger, fear, happiness and sadness) with their gait (Atkinson et al., 2004). Study participants are then asked to rate which of the emotions was expressed by the body movements. It has been shown that patients with AN have more difficulty in recognising sadness in this paradigm (Lang et al., 2015). However, this paradigm is limited to only a small number of basic emotions and to a single nonverbal modality (i.e., body motion), resulting in a reduced scope and ecological validity.

Furthermore, evidence is sparse and inconsistent regarding possible moderators of reduced ERA in AN, such as illness duration or body mass index (BMI). Studies with null findings often examined adolescents and young adults (e.g., Adenzato et al., 2012; Kessler et al., 2006; Mendlewicz et al., 2005), whereas studies that found an effect typically investigated ERA in adults (e.g., Harrison, Sullivan, et al., 2010; Russell et al., 2009). Considering that the onset of AN is most common around adolescence (Hudson et al., 2007), this pattern of findings could (at least partly) be due to different illness durations in the studied samples. One study directly compared ERA in adolescent and adult patients and could not confirm associations between reduced ERA and illness duration (Zonnevylle-Bender et al., 2004). Harrison et al. (2012) found in a mixed sample of patients with various eating disorders that those with marked difficulties in emotion recognition, set-shifting and central coherence ($n = 11$) had a longer illness duration and a lower BMI compared to the rest of the sample ($n = 81$). Still, absence of significant associations in previous research (Brockmeyer et al., 2016; Oldershaw et al., 2010; Russell et al., 2009) might have been due to insufficient statistical power or less sensitive (and less emotion-specific) measures of ERA.

In summary, previous research on ERA in AN has been limited primarily by the following four factors: (i) limitation to a few (basic) emotions; (ii) use of static photographs which limits content and ecological validity (since naturally occurring emotion expression is manifold and of dynamic nature); (iii) use of tasks that confound the recognition of emotions and the recognition of cognitive mental states and (iv) small (and sometimes ambiguous/mixed) samples.

The current study extends previous research in that we aimed to examine ERA in patients with AN using a measure that is specifically tailored to capture the recognition of 14 different emotions from dynamic multimodal nonverbal (i.e., facial, gestural, vocal and body language) cues.

In light of the literature summarised in two meta-analyses (Caglar-Nazali et al., 2014; Oldershaw et al., 2011), we expected to observe poorer ERA in patients with AN than in healthy women. In addition, we wanted to explore whether there are certain emotions (or categories of emotions) that patients with AN have particular difficulty recognising, and whether ERA is related to clinical parameters such as symptom severity, body weight or illness duration. Due to the lack of specific theoretical models and empirical evidence, the latter two research questions were exploratory in nature.

2 | METHODS

2.1 | Participants

Women with AN were recruited from a German inpatient clinic specialised in eating disorder (ED). Inclusion criteria were a diagnosis of AN according to the Diagnostics and Statistical Manual of Mental Disorders-5th edition (DSM-5; American Psychiatric Association, 2013) at admission and a minimum age of 16 years. Exclusion criteria for the AN group were a currently life-threatening condition, schizophrenia, bipolar disorder, current or past substance use disorder, borderline personality disorder according to DSM-5 and insufficient knowledge of the German language to complete the tasks and questionnaires. Healthy control (HC) women were recruited through advertisements at the university campus and in social media. Exclusion criteria for the HC group were a current or lifetime diagnosis of an eating disorder, positive screening for core symptoms of depression and anxiety, posttraumatic stress disorder or borderline personality disorder or insufficient knowledge of the German language to complete the tasks and questionnaires. Potential participants for the HC group were screened with the ED section of the Structural Clinical Interview for DSM-5 Disorders (First, 2014), the Patient Health Questionnaire-4 (Löwe et al., 2010), the Primary Care posttraumatic stress disorder Screen (Prins et al., 2015) and the MacLean Screening Instrument for Borderline Personality Disorder (Zanarini et al., 2003). All participants provided written informed consent and received either course credit (for undergraduates) or financial compensation for their participation. Participants younger than 18 years provided written assent with parental consent. The study was approved by the local ethics committee of the Institute of Psychology at the University of Goettingen.

An a priori power analysis was conducted. In a previous study, we found a medium effect size for the difference in ERA between patients with AN and HC when using a measure encompassing dynamic portrayals of complex emotions ($d = 0.64$, Brockmeyer et al., 2016). Similarly, two meta-analyses found medium to large effect sizes ($d = 0.44$ for basic facial ERA and $d = 1.07$ for understanding mental states, Caglar-Nazali et al., 2014 and $d = 1.01$ for complex ERA, Oldershaw et al., 2011). Thus, a total sample size of $N = 80$ was deemed sufficient to detect a medium-sized effect of $d = 0.64$ with $\alpha = 0.05$ (two-tailed) and power at 0.80 using an independent samples t-test.

2.2 | Measures

Participants completed the measures in a single session in a quiet room (i.e., in the therapists' office at the inpatient clinic or in the lab at the university), which lasted in total about 45 min. Both the questionnaires and the emotion recognition test had been carried out on a computer with a screen size of 14 inches and a resolution of 1920 × 1080. The questionnaires had been programmed using OpenSesame (Mathôt et al., 2012), and the emotion recognition test was performed in a web browser.

2.2.1 | Eating disorder psychopathology

The German version of the *Eating Disorder Examination Questionnaire-8* (EDE-Q8, Kliem et al., 2016) was used to assess self-reported global ED psychopathology. The EDE-Q8 is the short form of the commonly used EDE-Q (Fairburn & Beglin, 1994), with excellent internal consistency (Kliem et al., 2016) keeping the structure of the four subscales 'Restraint', 'Eating Concern', 'Weight Concern' and 'Shape Concern'. Scores range between 0 and 6 with higher values indicating more severe symptomatology. In addition, weight and height of participants were assessed. The BMI was calculated by body weight in kg divided by height in m squared (kg/m^2). Body height and weight were objectively assessed by clinic staff. Illness duration was operationalised as time elapsed (years) since the patient had been first diagnosed with AN.

2.2.2 | Symptoms of depression

Since depressive disorders have also been found to be associated with reduced emotion perception (Surguladze et al., 2004), comorbid symptoms of depression were assessed using the German version of the *Patient Health Questionnaire-9* (PHQ-9), a commonly used measure with good internal consistency and high validity (Kroenke et al., 2001). The PHQ-9 assesses symptoms of major depressive disorder (MDD) throughout the last 2 weeks. Total scores can range between 0 and 27 with higher scores reflecting more severe depressive symptoms.

2.2.3 | Emotion recognition ability

To measure ERA, the *Geneva Emotion Recognition Test* (GERT, Schlegel et al., 2014) was used. This task includes 83 brief video clips (1–3 s long) extracted from the Geneva Multimodal Emotion Portrayals database (Bänziger et al., 2012). In these video clips, 10 actors express 14 different emotions that cover the four quadrants of the emotional valence-arousal space (Bänziger et al., 2012): joy, amusement, pride, pleasure, relief, interest, anger, fear, despair, irritation, anxiety, sadness, disgust and surprise. Every clip shows the head and upper body of 1 out of 10 actors (5 women, 5 men; younger, middle-aged and older individuals) expressing a particular emotion while voicing a pseudo-linguistic sentence (i.e., a sentence without meaning) to avoid inferences from the semantic content. Emotions were acted out under the supervision of a professional film director, embedded in real-life scenarios to ensure high authenticity of the portrayals. All clips provide multimodal nonverbal cues (i.e., prosody, facial expression, gestures and posture), adding to the ecological validity of the task. After each video clip, patients were asked to choose from 14 given emotions which one they thought was expressed by the actor. The GERT score is calculated as the mean of all correct responses and can range from zero to one. Recognition performance for individual emotions is calculated as arcsine-transformed unbiased hit rates (Wagner, 1993). Unbiased hit rates represent ERA scores which are corrected for biased response patterns or 'overuse' of certain response options (specific emotions). For instance, a participant correctly choosing 'anger' for all videos displaying anger but also for many videos showing a different emotion will get a lower unbiased hit rate than a participant who only chooses anger correctly. Unbiased hit rates are calculated as the squared frequency of correct responses for a target emotion divided by the product of the number of stimuli representing this emotion and the overall frequency of this emotion being chosen. The GERT is a rather new instrument. However, previous studies have already demonstrated the good internal consistency and construct validity of the GERT (Costabile et al., 2018; Schlegel et al., 2014; Schlegel, Vicaria, et al., 2017). Furthermore, highly positive correlations with other performance-based tests for ERA and measures of empathy and socio-emotional functioning have been reported in a series of studies investigating the nomological network of ERA using the GERT (Schlegel, Fontaine & Scherer, 2017). The GERT takes about 20 min to complete. A demo version is available at the website of the University of Geneva: https://www.unige.ch/cisa/emotional-competence/home/exploring-your-ec/.

2.3 | Statistical analysis

Statistical analyses were conducted using R (Version 3.6.3). Group comparisons were conducted using t-tests with $\alpha = 0.05$ (two-tailed). Distribution of normality was checked through inspection of histograms, boxplots and Shapiro–Wilk tests. If the assumption of normality had been violated, Mann–Whitney U-tests were conducted instead. For exploring possible associations between ERA and clinical parameters, a correlational analysis was run. Pearson's r was computed for parametric and Spearman's rho (ρ) for nonparametric data. Exploratory valence-specific analyses are based on multilevel models with random effects on the participant level.

3 | RESULTS

3.1 | Sample characteristics

Demographic and clinical data of the sample are summarised in Table 1. Age and EDE-Q8 scores were not normally distributed in either group, as was BMI in the HC group and illness duration in the AN group.

Groups did not differ in terms of age, but the HC group had a significantly higher proportion of A-Level education. As per definition, patients with AN had a lower BMI and reported more ED symptoms than healthy controls. Five patients had a BMI >18.5 kg/m^2 at the time of assessment and thus, strictly speaking, no longer met DSM-5 criteria of AN (American Psychiatric Association, 2013). In line with the inclusion criteria, however, these five patients had been diagnosed with AN at admission and despite having reached normal weight through refeeding, they still showed severe ED symptomatology with a median EDE-Q8 score of 3.75. Nevertheless, we conducted all of our analyses for the second time after excluding these patients (see Section 3.5). As to be expected, patients with AN also reported more symptoms of depression than the HC group. Almost half of the patients were taking psychotropic medication (mainly antidepressants).

3.2 | Group differences in emotion recognition

Patients with AN had poorer ERA than the HC group as indicated by the total GERT score, $t(78) = 3.20$, $p = 0.002$

TABLE 1 Demographic and clinical characteristics of the sample

	AN (n = 40)	HC (n = 40)	Test statistic	p
Median age in years (CI)	19.50 (18.00, 22.00)	21.00 (21.00, 22.00)	$U = 137.50$	0.128
Educational level (%)				
A-Level[a]	50	100	$\chi^2(1) = 26.67$	<0.001
Still in school	45	–	–	–
AN subtype (% restricting)	62.50	–	–	–
Comorbid diagnoses (%)				
ANX	22.50	–	–	–
MDD	55.00	–	–	–
OCD	27.50	–	–	–
Psychotropic medication (%)	42.50	–	–	–
Median years of illness (CI)	2.67 (1.42, 5.00)	–	–	–
Mean BMI (SD)	15.91 (0.08)	20.84 (1.42)	$U = 1573$	<0.001
Median EDE-Q8 (CI)	3.75 (2.50, 4.34)	0.69 (0.50, 1.23)	$U = 583.50$	<0.001
Mean PHQ-9 (SD)	15.30 (6.20)	3.00 (1.94)	$t(78) = 11.99$	<0.001

Abbreviations: AN, anorexia nervosa; ANX, anxiety disorder; BMI, body mass index; CI, confidence interval; EDE-Q8, Eating Disorder Examination Questionnaire-8; HC, healthy control; MDD, major depressive disorder; OCD, obsessive-compulsive disorder; PHQ-9, Patient Health Questionnaire-9 (Depression Module); SD, standard deviation.

[a]A-Level education represents at least 12 years of regular schooling.

(AN: M = 0.68, standard deviation [SD] = 0.08; HC: M = 0.74, SD = 0.07), with a medium effect size of $d = 0.71$ confidence interval ([CI]: 1.17, 0.26).

3.3 | Valence-specific analyses

Participants significantly varied in their ERA performance, $SD = 0.20$, CI: 0.16, 0.25, $\chi^2(1) = 84.08$, $p < 0.001$. Besides main effects for both group, $F(1, 78) = 11.89$, $p < 0.001$ and emotion, $F(13, 1014) = 38.81$, $p < 0.001$, the analysis yielded a significant group × emotion interaction effect, $F(13, 1014) = 2.51$, $p = 0.002$. Figure 1 displays the data for specific emotions according to emotional valence (note that surprise is excluded since it is the only emotion of neutral valence). Valence classification is in line with descriptions of the GERT (Schlegel et al., 2014). To test for differences of the group effect between emotions of negative and positive valence, a contrast analysis was performed using generalised linear hypothesis testing, which proved to be significant, $Z = 2.32$, $p = 0.02$, with a small effect size of $d = 0.26$ (CI: 0.04, 0.48).

3.4 | Associations between ERA and patient characteristics

In the AN group, ERA was significantly and positively associated with BMI, $r(38) = 0.41$ ($p = 0.009$, CI: 0.11, 0.64), and negatively with illness duration, $\rho(38) = -0.32$ ($p = 0.04$, CI: −0.57, −0.01), indicating that patients with a lower BMI, and patients with longer illness duration showed poorer ERA. Symptoms of depression (PHQ-9) and eating disorder psychopathology (EDE-Q8) were not significantly correlated with ERA ($p > 0.36$). Patients with a comorbid MDD (M = 0.70, SD = 0.09) did not differ from those

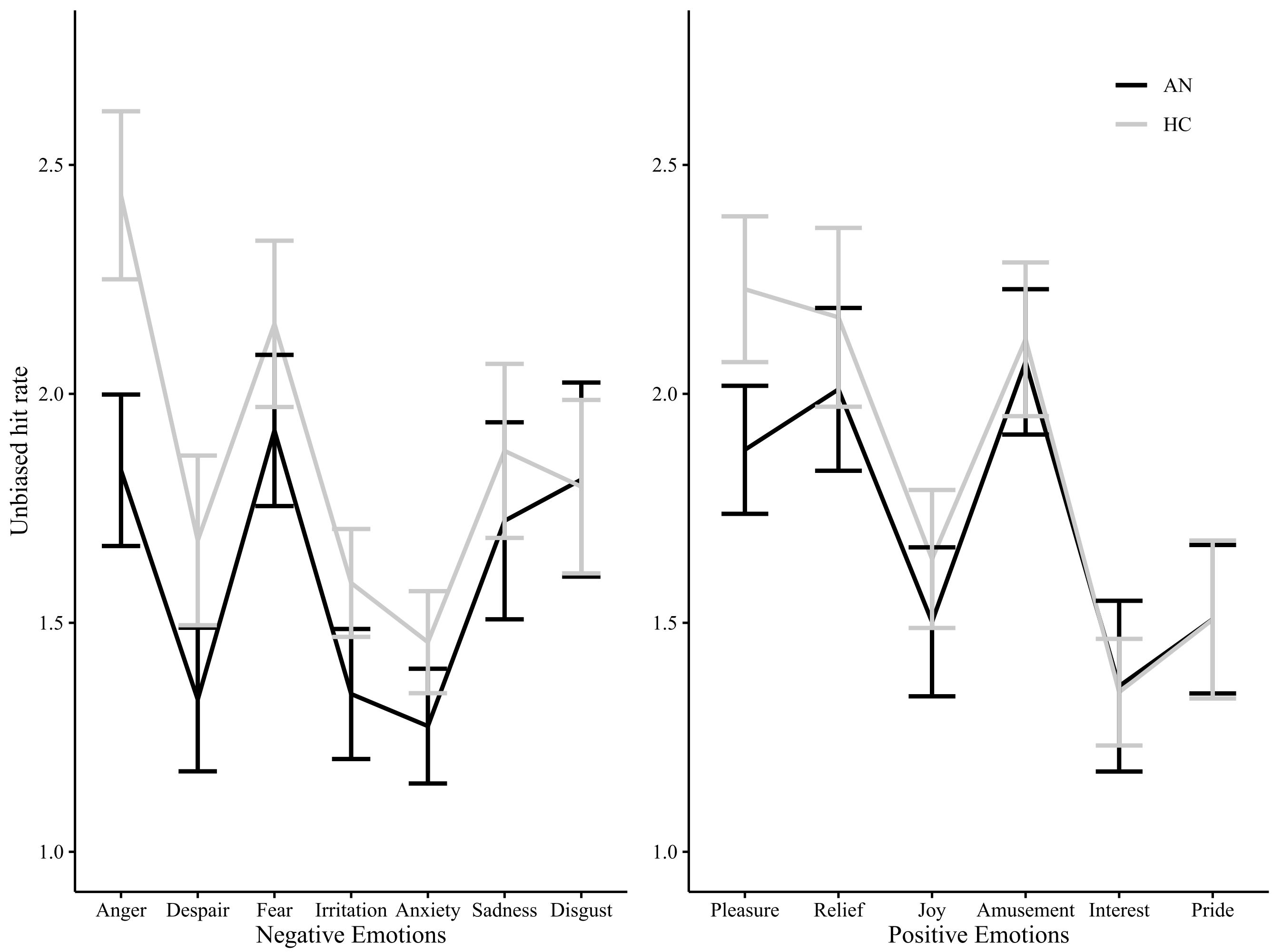

FIGURE 1 Recognition performance for specific emotions. Mean values of arcsine-transformed unbiased hit rates (Geneva Emotion Recognition Test Score) displayed for negative (left) and positive (right) emotions according to groups. Error bars indicate 95% CI. AN, patients with anorexia nervosa; CI, confidence interval; HC, healthy control group

without (M = 0.67, SD = 0.07) in their ERA, $t(38) = 1.14$, $p = 0.26$. Likewise, patients who took psychotropic medication (M = 0.68, SD = 0.10) did not differ from those who did not (M = 0.69, SD = 0.07), $t(38) = 0.10$, $p = 0.92$. The same was true for patients with (M = 0.66, SD = 0.08) and without (M = 0.70, SD = 0.08) A-Level education, $t(38) = 1.57$, $p = 0.13$.

3.5 | Repeating the analysis after excluding weight-restored patients

We conducted all analyses for the second time after excluding the five patients who had reached normal weight during refeeding. To equalise sample sizes, we randomly excluded five participants from the HC group and repeated the analyses with 10,000 runs. A significant ERA difference (t-test) emerged in 100% of these simulations, with over 98% showing a power of >0.80. The emotion-specific valence contrast remained significant in over 94% of these simulations (see Supporting Information S1 for the simulation analysis). The correlation between the BMI and ERA in the AN group remained significant after excluding the five normal weight patients, $r(33) = 0.41$ ($p = 0.02$, CI: 0.09, 0.65). The correlation between illness duration and ERA, however, did not remain significant, $\rho(33) = -0.27$ ($p = 0.12$, CI: −0.55, 0.08). Emotion recognition ability was still not different between patients with or without comorbid MDD or medication, $t(33) = 1.27$, $p = 0.21$ (AN-MDD: M = 0.69, SD = 0.09; AN-non-MDD: M = 0.66, SD = 0.06), $t(33) = 0.69$, $p = 0.50$ (AN-MED: M = 0.67, SD = 0.10; AN-non-MED: M = 0.69, SD = 0.07), respectively.

4 | DISCUSSION

In accordance with our main hypothesis, patients with AN showed weaker ERA than healthy controls. This finding extends the existing literature for the following reasons: (i) we considered the recognition of both basic and complex emotions, (ii) we used dynamic and exclusively nonverbal multimodal stimuli that are ecologically valid and unconfounded by semantic information and (iii) we studied an unambiguous and sufficiently large sample of patients with AN.

Furthermore, the valence contrast in the present study indicating that patients with AN have greater difficulty in recognising negative emotions is in line with tentative evidence from earlier studies (Kucharska et al., 2004; Pollatos et al., 2008). A previous systematic review could not find any clear trends for emotion-specific effects (Oldershaw et al., 2011). However, this might have been due to an under-representation of positive emotions in the tasks used in previous studies which mostly focused on basic emotions only (e.g., happiness as the only positive emotion in the FEEL; Kessler et al., 2002). A potential explanation of the valence effect may include heightened emotional arousal elicited by the stimuli and attentional biases for (certain) negative emotions. Patients with AN have been shown to feature attentional biases towards and away from facial expressions of specific emotions, respectively (Cardi et al., 2013; Harrison, Tchanturia & Treasure, 2010). Such attentional biases may impede proper processing and interpretation of nonverbal cues for certain negative emotions. Future studies may combine eye-tracking with ERA assessment in order to examine whether there is an association between attentional biases and reduced recognition of negative emotions.

In addition, we found weaker ERA in patients with a longer illness duration and a lower BMI. This is in accordance with illness models stressing deteriorated socio-emotional functioning over the course of the illness. Poor socio-emotional functioning may result in interpersonal distress which may then in turn worsen the symptomatology (Treasure et al., 2012; Treasure & Schmidt, 2013). However, measurement of illness duration remains difficult because of vague identifications of the initial occurrence and because of temporary remission and relapse (Currin & Schmidt, 2005). The correlation between ERA and BMI could result from brain changes in response to starvation and irregular nutrition. Psychobiological illness models suggest that individuals who are vulnerable for developing AN have increased extracellular serotonin (5-HT) concentrations and an imbalance in postsynaptic 5-HT1A and 5-HT2A receptor activity, leading to an increased intensity of negative affect (Kaye, 2008; Kaye et al., 2003). In turn, as self-starvation reduces serotonin production, excessive dieting might serve as a maladaptive coping mechanism to modulate such aversive affective states (Brockmeyer et al., 2013, 2019). However, this blunted emotional processing might also hamper the recognition of emotions in others since ERA is considered to be, at least partly, based on mimicry (i.e., synchrony/mirroring) processes (Iacoboni, 2009). This potential neurobiological explanation is in accordance with findings of changed ERA in women after tryptophan (a precursor of 5-HT) alteration (Attenburrow et al., 2003; Harmer et al., 2003).

4.1 | Limitations

The present study has some limitations. First, although the GERT is more ecologically valid than previously used measures, it is still lacking the spontaneity of dynamic face-to-face interactions in which the patient does not merely act as an observer but as an interaction partner. Future studies may thus involve also (i) real social interactions between patients and confederates, actors or family members and (ii) interactions with avatars in virtual reality scenarios.

Second, findings of the present study are restricted to women, which is critical in that there does seem to be a gender effect with respect to ERA from nonverbal cues (Alaerts et al., 2011). However, this should not be of too much importance in this context, since 90% of all AN patients are women (Treasure et al., 2003). Nevertheless, it must, of course, be noted that the findings cannot be transferred to men with AN without further ado. In addition, although the sample was composed of relatively severe inpatients, it still covered a broad range of age, illness duration and BMI levels. Groups did not match for percentage of A-Level education, probably due to the inclusion of underage patients who still went to school (45%) and the recruitment of university students for the HC group. Examining a community rather than a mere student sample as a HC group is advisable for future research.

Third, five patients in the present sample had a BMI >18.5, which is not in line with DSM-5 criteria (American Psychiatric Association, 2013). However, these five patients can be considered partially remitted, that is, they met the BMI criterion at admission but recently gained weight due to refeeding. Still at the time of testing, they reported severe ED symptomatology as indicated by their EDE-Q8 scores. Importantly, excluding these patients from the analysis did not change the pattern of results concerning our main hypothesis and the exploratory valence-specific contrast.

Fourth, due to the cross-sectional design of the study, no conclusions can be drawn regarding causality and long-term effects. This is specifically important for the results of the correlational analyses. While one could argue that a longer illness duration and a lower weight lead to weaker ERA, it is also possible that reduced ERA fuels illness severity since poor ERA relates to problems in social interactions which may result in more negative emotions which may then in turn be modulated by excessive dieting (Brockmeyer et al., 2016; Oldershaw et al., 2011; Schlegel, Boone & Hall, 2017; Treasure et al., 2012). Clearly, prospective longitudinal and experimental research is needed to better understand the interaction and causal mechanisms between ERA deficits, illness chronicity and BMI.

Finally, patients with AN have also shown to resemble traits similar to those reported in autism spectrum disorders, for example similar levels of empathy (Kerr-Gaffney et al., 2019). Since reduced emotion recognition is a feature of autism spectrum disorders as well, future studies may also include the assessment of autistic traits when investigating ERA in patients with AN.

4.2 | Clinical implications

Given that ERA is essential for nonverbal communication and therefore crucial for social interactions (Knapp et al., 2013) and also longitudinal studies emphasise the role of social cognition concepts for poor treatment outcomes (Zipfel et al., 2000; Zucker et al., 2007), it seems advisable to train ERA in AN patients. We recently examined such an intervention in a proof-of-concept study using the *Training for Emotion Recognition Abilities*, a 30-min online training of ERA (Schlegel, Vicaria, et al., 2017). In comparison to an active control group, the training led to greater short-term improvements in ERA and self-reported ED symptoms (Preis et al., 2020). This is all more interesting since other interventions such as *Cognitive Remediation and Emotions Skills Training* (Davies et al., 2012) and administration of oxytocin (Kim et al., 2015) failed to ameliorate ERA in AN. However, more research in larger samples with longer follow-up intervals and a broader spectrum of outcome measures is required to examine the utility of such add-on treatment modules targeting ERA and social cognition in the treatment of AN.

4.3 | Conclusion

To sum up, the present study indicates that people with AN show reduced ERA, and that this effect might be stronger for negative emotions. Emotion recognition ability performance is related to BMI and illness duration, which may represent worsening of socio-emotional functioning over the course of the illness and altered neurobiological processes due to starvation. It is recommended to further investigate this topic in longitudinal and experimental studies to deepen our understanding of causal mechanisms between reduced ERA and AN symptomatology. First results in training ERA seem promising, suggesting useful contributions to existing treatment programs for this disorder.

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CONFLICT OF INTEREST

The authors of the study do not declare any conflict of interest.

DATA AVAILABILITY STATEMENT

The data are available from the first author upon request.

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