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RESEARCH ARTICLE

A multidimensional examination of affective and cognitive empathy in anorexia nervosa

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Abstract

Socio-emotional features are crucial in the development and maintenance of anorexia nervosa (AN). The present study investigates the patterns of altered and preserved empathic abilities in AN. Empathy is an umbrella term that comprises the ability to recognise another's emotional state, take another's perspective, and fantasise (cognitive empathy), as well as the ability to experience vicarious emotions and signal them (affective empathy). These empathic abilities were measured in 43 AN patients and 33 healthy women through a multi-method approach comprising self-report measures, behavioural tasks and bodily correlates. Further, we assessed self-reported approach-avoidance attitudes towards suffering others. Results showed that, within the domain of cognitive empathy, AN patients reported impairment in recognising emotional expressions of anger and fantasising. Concerning affective empathy, they manifested lower sharing of others' positive emotions, higher self-reported distress, and higher facial expressiveness during a video depicting a suffering person. Finally, AN patients reported lower motivation to approach suffering others. Our results draw a complex picture of preserved and altered empathic abilities in AN and capture which are the deficits mediated by the higher levels of anxiety and depression reported by the AN population and those that seem to persist independently from these co-morbid conditions.

KEYWORDS
Anorexia Nervosa, Approach Avoidance, Emotional Facial Expression, Empathy

Highlights

- Concerning cognitive empathy, anorexia nervosa (AN) inpatients reported impairments in fantasising and in decoding facial emotional expressions of anger. These results were independent from the higher level of depression and anxiety found in this clinical group.

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- Concerning affective empathy, AN inpatients manifest lower sharing of others' positive emotions, but higher self-reported distress and higher facial expressiveness during a task inducing social emotions. These results suggest that affective empathy abilities are valence-dependent in AN.
- Excessive levels of distress cause lower pro-social behaviour in AN, thus, predicting their lower motivation to approach a suffering other and the higher attitude to escape from the situation causing the negative feeling.

1 | INTRODUCTION

Prevalence studies suggest that anorexia nervosa (AN) affects up to 4% of females and 0.3% of males, and there is an increasing incidence of this condition among young adolescents (van Eeden et al., 2021). To provide an understanding of the core mechanisms underlying AN symptomatology, researchers developed the Cognitive-Interpersonal Maintenance Model for AN (Treasure et al., 2020). According to this model, inherited cognitive and socio-emotional features predispose to the onset and maintenance of AN symptoms. In this study, we will concentrate mainly on those socio-emotional features that apply to the interpersonal sphere. Therefore, we will closely examine the preserved and altered empathic abilities in AN. Empathy is an umbrella term that can summarise a number of interpersonal abilities that pertain to interpreting and sending social communication signals. Deficits in some of these abilities represent predisposing factors causing the development and maintenance of AN symptomatology, or they are the consequence of AN symptomatology (Treasure & Schmidt, 2013).

Notably, many alternative definitions of empathy are used in the psychological literature (Cuff et al., 2016). Here, we will conceptualise empathy in terms of its subcomponents. Specifically, we will refer to ***cognitive empathy*** as the ability to decode another's emotional state (from different sources such as faces, voices, and bodily expressions) and take the perspective of real and fictional individuals (Davis, 1980). These abilities involve higher cognitive functions, including mental state attribution and can be measured explicitly, via self-report measures, or implicitly, assessing accuracy in behavioural tasks. On the other hand, we will refer to ***affective empathy*** to identify the ability to experience an emotional reaction in response to another's emotional experience. It is noteworthy that to properly speak about affective empathy, such an emotional response should be adapted or isomorphic to the one of the observed person, but also with a sufficient degree of self-other distinction (De Vignemont & Singer, 2006). Consequently, the role of feelings of distress in response to others' suffering is still disputed. Some authors included these in measures of affective empathy (Davis, 1983), while others opted to exclude them. For instance, following Batson's theory of empathy (1987), only empathic concern (EC) should be included in the definition of empathy since it is the only one that properly refers to other-oriented feelings of warmth, sympathy and consequent altruistic behaviours. On the contrary, feelings of distress are considered self-oriented since they primarily drive individuals to search for solutions for reducing their own distress. Following Batson, this objective can motivate the individual to avoid the suffering person, as long as this behaviour is not too costly.

Overall, a differentiation between cognitive and affective empathy has been supported by neuroimaging and lesion studies, which highlighted different neural substrates for the two dimensions (Shamay-Tsoory, 2011). Nevertheless, research has also suggested that cognitive and affective types of empathy cannot be considered in isolation (Decety & Jackson, 2004; Goubert et al., 2005) and that a mature empathic response emerges from the interaction between the two empathy systems (Shamay-Tsoory, 2011). Consequently, it has been proposed that a dissociation between the two dimensions of empathy might manifest the presence of a clinical disorder (Harari et al., 2010). Indeed, evidence for a dissociation between impaired cognitive empathy and preserved affective empathy has been found in Huntington's disease (Maurage et al., 2016), autism spectrum disorders (Baron-Cohen & Wheelwright, 2004; Dziobek et al., 2008; Mazza et al., 2014; Poustka et al., 2010; Rueda et al., 2015), and alcohol-use disorders (Maurage et al., 2011). Vice versa, there is evidence for impaired affective empathy and preserved cognitive empathy in psychopathy (Blair, 2005; Campos et al., 2022; Vyas et al., 2016), borderline personality disorder (Harari et al., 2010), and euthymic bipolar disorder (Shamay-Tsoory et al., 2009). This clinical evidence overstates the importance of exploring the pattern of preserved and altered empathic abilities in individuals with eating disorders and AN. However, the empirical literature on empathic abilities in these populations is still contaminated by contradicting results, and not all domains of empathy have been equally well explored so far.

Regarding cognitive empathy, the current literature can be organised based on the specific abilities explored (e.g., the ability to recognise/decode complex emotions, the ability to take the perspective of others) and the type of measure adopted to assess them (self-report or performance-based measures). Several meta-analyses (Bora & Köse, 2016; Caglar-Nazali et al., 2014; Leppanen et al., 2018; Preti et al., 2022) converged in revealing that AN patients show decreased performance in recognising complex emotional expressions, although this has been mainly assessed by the Reading in the Mind test (Baron-Cohen et al., 2001). Two meta-analyses (Bora & Köse, 2016; Leppanen et al., 2018) also found that individuals with AN have lower performance in tasks assessing perspective-taking (PT), that is, tasks where it is asked to correctly attribute mental states to fictional characters in cartoons or verbal stories (e.g., Faux Pas Test). However, two more recent studies (Leslie et al., 2020; Sedgewick et al., 2019) did not entirely confirm these results. Further, a recent meta-analysis (Kerr-Gaffney et al., 2019) failed to find significantly lower PT abilities in AN when measured via a famous self-reported measure, that is, the Interpersonal Reactivity Index (IRI). We might also highlight that the author of the IRI questionnaire (Davis, 1983) included the ability to fantasise among the dimensions of cognitive empathy. This inclusion is still dubious. Nevertheless, Kerr-Gaffney's meta-analysis (2019) showed lower self-reported fantasising ability in AN. Summarising findings about cognitive empathic abilities in AN, we can state that there is evidence of lower fantasising and emotional decoding abilities in this population. At the same time, a deficit in PT is not well supported.

While cognitive empathy is related to the ability to interpret social signals correctly, affective empathy assesses the ability to experience vicarious emotions and the ability to signal these emotions. Regarding the experience of vicarious emotions, a recent meta-analysis (Kerr-Gaffney et al., 2019) failed to show that AN patients score significantly lower in self-reported measures of this dimension. However, the results for the subdimension of the IRI called personal distress (PD) are inconclusive. Indeed, individuals with AN reported higher PD in two studies, lower PD in one, and no significant differences in three studies. This result opens the possibility that AN individuals do not present impairments in the experience of vicarious emotions, and they might even experience enhanced vicarious negative emotions. A further point of reflection is provided by Nandrino et al. (2012), who found that exposure to emotional pictures causes a disconnection between physiological and self-reported activation in individuals with AN, in the direction of higher self-reported arousal than controls, despite an equivalent level of electrodermal activation. Consequently, it could be this dissociation between objective and self-report measures to characterise the specific AN deficit in vicarious emotional experiencing. Further, some studies reported a dissociation between self-report emotional reactions and emotional signalling during emotion induction tasks, with evidence of reduced facial expressivity despite normal or higher scores in self-report measures (Cardi et al., 2015; Claes et al., 2012; Davies et al., 2011).

Overall, this corpus of evidence was not conclusive and called for new multi-method investigations of empathy in AN, overcoming possible response biases in self-report measures, and validity issues of some performance-based tasks. One recent study (Konstantakopoulos et al., 2020) partially responded to this exigence, although it applied performance-based measures only for cognitive empathy but not for the less studied affective empathy. Our study could be considered complementary to this previous one in that it pursued a multidimensional examination of cognitive and empathic abilities in AN using data from self-report, behavioural tasks, and bodily correlates (see Figure 1). Consequently, we aimed to test the hypothesis of a dissociation between cognitive and affective empathy in AN. Specifically, For **cognitive empathy**, we predicted to find lower performance in tasks requiring decoding emotional expressions. This hypothesis was tested across different domains, naming facial, vocal and bodily expressions. We also predicted finding lower self-reported fantasising ability in the group with AN, given the previous results from Kerr-Gaffney et al. (2019). Given the previous mixed results, no specific hypothesis was formulated for self-reported PT.

For **affective empathy**, we predicted finding higher self-reported emotional distress in the AN group but no differences in self-reported EC. Further, we expected higher bodily correlates—facial expressiveness—in the AN group during a task inducting social emotions. Similarly, we predicted that patients with AN would have also reported a higher sharing of others' negative emotions but a lower sharing of others' positive emotions within a behavioural task using emotional and social pictures.

Finally, we aimed to test differences in prosocial behaviour, namely in avoidance/approach attitudes towards suffering others. Specifically, given the expected higher PD in AN, we also predicted that this group would report a lower willingness to approach a suffering other, in line with Batson's proposition that feeling of PD can result in lower pro-social behaviour.

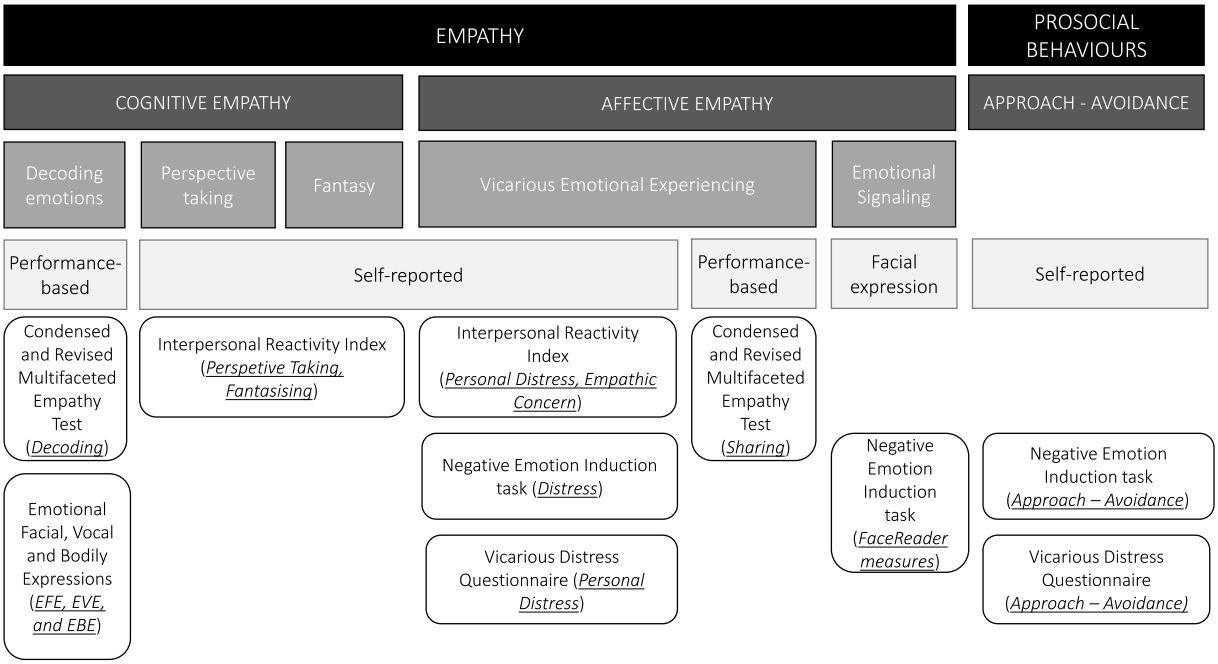

FIGURE 1 Illustration of the type of tasks used to assess the different dimensions of empathy and the consequent behavioural attitudes.

2 | MATERIALS AND METHODS

2.1 | Participants

2.1.1 | Clinical group

Forty-three female inpatients with AN were recruited in inpatient units of four psychiatric clinics (Clinique La Ramée, Brussels, Belgium; Le Domaine Psychiatric Hospital, Braine-l'Alleud, Belgium; Clinique des 4 Cantons, Lille, France; Clinique Belmont, Geneva, Switzerland) from 2013 to 2015. The diagnoses were obtained from patients' medical records (derived from clinical interviews) and were based on DSM-5 criteria (American Psychiatric Association, 2013).

In our sample, 33 patients belonged to the restricting type (AN-R; weight loss essentially achieved through diet, fasting and/or excessive physical exercise) and 10 to the purging type (AN-B; anorexic episodes associated with recurrent hyperphagic crisis and/or use of purgative behaviour). Since the two groups did not significantly differ in the measured psychological dimensions, the whole clinical group was considered jointly. Patients presented a duration of anorexia symptoms ranging from 1 to 18 years ($M = 4.40$, $SD = 4.60$). The number of previous hospitalisations ranged from 0 to 5 ($M = 0.69$, $SD = 1.41$).

2.1.2 | Control group

Thirty-three healthy women were recruited through the social network accounts of investigators. The inclusion criteria included: (i) body mass index (BMI) ranging between 18.50 and 27 kg/m^2 (e.g., Kerr-Gaffney et al., 2020), (ii) no reported history of eating disorders, and (iii) absence of current eating disorders behaviours indicated by low scores at three subscales of the Eating Disorders Questionnaire (EDI 64-item, Garner et al., 1983; French version: Criquillion-Doublet et al., 1995): Drive for Thinness (<6), Bulimia (<3), and Body Dissatisfaction (<17) (Garner, 1991; Nyman-Carlsson et al., 2015) and by a score lower than 21 at the sum of these subscales which is considered an optimal means of detecting the risk of binge eating disorders (Mustelin et al., 2016).

2.2 | Tasks

2.2.1 | Performance-based measures

Condensed and revised multifaceted empathy test

MET-Core (Edele et al., 2013). The multifaceted empathy test (MET) is an ecological task that measures one's ability to decode the others' affective (mental) states and the tendency to feel with the people involved in a certain

affective state. The test includes the presentation of 40 photographs depicting adults or children of both genders expressing either negative (20) or positive (20) affective states within a specific social context (e.g., a person getting a massage). To assess abilities in decoding these mental states, we asked participants to select the label (out of four, e.g., serene, enthusiastic, curious, in love) that best corresponded to the affective state depicted in each picture. To assess the tendency to empathise with others, we asked participants to evaluate on a Likert scale ranging from 1 (not at all) to 9 (strongly) whether they shared the affective state of the person in the picture (i.e., how sad they felt in response to a person expressing sadness). During the decoding subtask, participants received no feedback on their performance.

Emotional facial expressions

The emotional facial expressions (EFE) stimuli consisted of pictures of 12 actors (6 females and 6 males) expressing the 5 basic facial expressions ('happiness', 'fear', 'disgust', 'anger', 'sadness') (Radboud faces Database; Langner et al., 2010), and a neutral facial expression. Each of the depicted EFE was also morphed with the actor's neutral facial expression (MorphMan 2000 software, STOIK) to create intermediate images displaying the emotional expression at 30% or 70% of intensity. Therefore, in each trial, an EFE stimulus was presented for 5000 ms on a white background. Participants were instructed to select with the mouse which of the six labels appearing under the picture ('happiness', 'fear', 'disgust', 'anger', 'sadness', and 'neutral') better matched with the stimulus. The 240 trials (12 identities/actors × 5 emotional expressions × 4 intensities) contained in each session were fully randomised. In total, there were 36 pictures for each emotion, plus 60 neutral expressions. After controlling that the accuracy decoding rate for each intensity level was above the chance level (1/6 labels = 0.17), we computed a total accuracy score for each facial expression, combining the different intensity levels at which the expression was displayed (30%, 70%, 100%). An accuracy score was also computed for the neutral expressions (0% intensity levels).

Emotional vocal expressions

The emotional vocal expressions (EVE) stimuli come from the Montreal Affective Voices (Belin et al., 2008). They consist of five men and five women, each expressing vocally nonverbal affective bursts corresponding to eight emotions (anger, disgust, fear, pain, happiness, pleasure, sadness, surprise) and a neutral vocal expression. Participants were asked to select the emotion expressed by each vocal stimulus before proceeding to the following listening trial. In total, there were 90 trials (10 identities × 9 expressions). Analyses were performed by combining expressions of the same valence, thus resulting in a total accuracy score for negative, positive and neutral expressions.

Emotional bodily expressions

The emotional bodily expressions (EBE) stimuli consist of pictures of 8 actors' (4 females and 4 males) bodily expressions. Each actor was captured while showing six EBE ('fear', 'disgust'; 'anger'; 'sadness'; 'happiness'; 'surprise') and one neutral expression from the BESST—Bochum Emotional Stimulus Set (Thoma et al., 2013). Each EBE was presented either frontal (90°) or at 45°. In each trial, an EBE stimulus was presented for 2000 ms on a white background. Then the picture disappeared, and participants were instructed to select which of the seven labels appearing under the picture ('fear', 'disgust'; 'anger'; 'sadness', 'happiness', 'surprise', 'neutral') corresponded to the emotional expression of the stimulus. The overall 112 trials (8 identities × 7 bodily expressions × 2 orientations) were displayed in a fully randomised order. Analyses were performed by combining the two different orientations and the bodily expressions of the same valence, thus resulting in a total accuracy score for bodily negative, positive and neutral expressions.

2.2.2 | Social emotions induction task

Among the overall sample, 44 participants (24 AN patients, 20 controls) completed a social emotions induction task. In this task, participants watched a 4-min video depicting a person in distress (i.e., a woman who describes how she was attacked by her ex-boyfriend with acid). After the video, we asked participants to rate on a 9-point Likert scale (1 = totally disagree; 9 = totally agree) their feelings of 'distress', 'preoccupation', 'worry', 'being overwhelmed' (composing a total distress score; internal consistency: 0.82) and 'compassion', 'sympathy', 'tenderness', 'moved' (composing a total compassion score; internal consistency: 0.67). Before playing the video, it was mentioned that the video was going to be presented in two parts and that they were watching the first part. Therefore, at the end of the video, it was also asked to report on a 9-point Likert scale (1 = not at all; 9 = totally) the extent to which they were willing to watch the second part of the video before being informed that there was none. This question was hypothesised to evaluate participants' tendency to avoid the person in distress. Before playing the video, the participants were informed that they could stop the video anytime if it was too difficult to watch. Because we aimed to collect data

from channels other than subjective reports, we also recorded participants' facial expressions while filming them when watching the video.

Facial expressions recordings

The facial expressions of participants watching the distressing video were videotaped and analysed by the FaceReaderTM software. This latter determines the percentage of neutral and emotional expressions (i.e., happiness, sadness, anger, surprise, fear, and disgust) displayed dynamically on one's face. It also calculates the arousal and valence of the emotional expression and the quality of the estimation. Prior to analysis, the recording of each participant was calibrated to her own neutral expression in order to correct for person-specific biases towards a certain facial expression.

2.2.3 | Questionnaires

The **Interpersonal Reactivity Index, IRI** (Davis, 1983; French translation by; Guttman & Laporte, 2002), is a multidimensional empathy questionnaire. It includes four subscales: PT evaluates attempts to take into consideration the point of view of others (e.g., '*When I am upset at someone, I usually try to put myself in his shoes for a while*'); Fantasy (F) measures the propensity to identify with fictional characters (e.g., '*When I watch a good movie, I can very easily put myself in the place of the leading character*'); PD assesses the tendency to feel anxious when confronted with negative situations (e.g., '*Being in a tense emotional situation scares me*'), and EC assesses feelings of sympathy and concern for unfortunate others (e.g., '*I often have tender, concerned feelings for people less fortunate than me*'). Perspective-taking and Fantasy are generally considered as cognitive dimensions of empathy while EC and PD refer to affective empathy. In this study, the internal consistency of IRI subscales ranged from low to satisfactory (*PT: 0.61; F: 0.80; PD: 0.81; EC: 0.50*).

Vicarious Distress Questionnaire, VDQ (Grynberg et al., 2012), focuses on distress experience in response to another's distress (e.g., '*It takes a lot of my energy*', '*It takes me time to recover*'), and on the potential consequences of feelings of distress, namely avoidance (e.g., '*I run away*', '*I change the subject*'), and support (e.g., '*I am able to comfort the person experiencing difficulties*'). Exploratory and confirmatory factor analyses conducted on the original French version of the questionnaire supported a three-factor structure of the VDQ. In this study, the internal consistencies ranged from low to satisfactory (*Distress: 0.85; Avoidance: 0.76; Support: 0.91*).

The Spielberger's Trait Anxiety Inventory, STAI-T (Ferreira & Murray, 1983; French version: Bruchon-Schweitzer & Paulhan, 1993) includes 20 items measuring the level of anxiety in general (trait) with a 4-point Likert scale. **The 13-item Beck Depression Inventory; BDI** (Beck & Beamesderfer, 1974, French version: Collet & Cottraux, 1986) measures the level of current depression. It includes 13 assertions for which participants have to choose among four possible options related to how they felt over the past week. Their internal consistencies were respectively 0.96 and 0.94.

2.3 | Data analysis

Statistical analyses were performed using the Rstudio (version 3.6.2 for Windows) software package. The significance level was set at $p < 0.05$. To avoid multiple-comparison problems, we adjusted *p*-values using the Benjamini–Hochberg procedure, which controls for false discovery rate (FDR). The normality of data and homogeneity of variance were checked. When the assumption of normality was respected, we performed Welch's *t*-test, which is a robust alternative to the independent sample *t*-test in the presence of unequal variances. Otherwise, Wilcoxon signed rank tests were performed. Effect sizes have been calculated using *R*-squared. Mediation models were, therefore, conducted to investigate the indirect effect of depression or anxiety on the link between group membership (AN vs. Control) and those empathy scores significantly different between the two groups after correcting for multiple comparisons. The mediation models' parameters were computed using a non-parametric bootstrap method.

2.3.1 | Facial expressions data analysis

Data from FaceReader recordings were analysed from the second 00:16 to the second 4:00 of the video, thus excluding the very first and last moments since participants were moving or were less focused on the task. In accordance with Gandolphe et al. (2018), the total emotions score was computed by summing the percentage of sadness, anger, surprise, fear and disgust reported by the subject. Because of the negative valence of the stimulus, the intensity of happiness expressions was not considered when computing this total score. Further, we considered the percentage of arousal computed by the FaceReader software considering the overall activation level of the action units (Aus) of the Facial Action Coding System. Before applying any statistical analysis, we transformed the percentage data using the arcsine transformation, as in Leppanen et al. (2017).

3 | RESULTS

3.1 | Sample characteristics

Table 1 provides information about the population's demographic and clinical characteristics.

Overall, the AN patients presented significantly lower BMI, higher anxiety (STAI-T) and higher depression symptoms (BDI-13) than healthy controls. Age did not significantly differ in the two groups.

3.2 | Questionnaires

Table 2 shows the results of the two questionnaires assessing empathic ability (i.e., the IRI and the VDQ). Patients scored significantly higher than healthy controls in the PD subscales of the IRI ($p_{adj} = 0.016$) and in the Distress subscale of the VDQ ($p_{adj} = 0.007$). They also show lower fantasising ($p_{adj} = 0.028$). No significant differences were found for the other two dimensions of the IRI, namely PT and EC. Finally, patients showed higher scores in the Avoidance dimension of the VDQ ($p_{adj} = 0.008$) and lower scores in the Approach dimension ($p_{adj} = 0.007$).

Table S1 reports results from correlation analyses between questionnaire subscales conducted separately for the AN and the CLT group. Given the low sample size, only correlation with medium-high magnitude resulted as significant. Notably, results were not always consistent between the AN and the CTL group. Specifically, a significant positive correlation was found between IRI PT and IRI EC in CTL ($r = 0.53$*) but not in patients with AN ($r = 0.07$). In CTL, VDQ Avoidance was

TABLE 1 Sample demographic and clinical characteristics of the patient group.

	Control				Patient						
	N	*M*	*SD*	Min-max	*N*	*M*	*SD*	Min-max	*t*	*p*	Cohen's *d*
Age	33	22.39	(3.22)	17–33	43	24.16	(8.24)	16–49	−1.29	0.20	−0.28
BMI	**33**	**21.30**	**(1.96)**	**18.37–26.30**	**40**	**16.57**	**(2.31)**	**12.88–21.76**	**9.47**	**<0.001**	**2.21**
STAI-T total	**32**	**41.12**	**(8.13)**	**28–60**	**35**	**60.03**	**(12.36)**	**34–78**	**−7.45**	**<0.001**	**−1.81**
BDI-13 total	**32**	**8.84**	**(6.96)**	**0–23**	**35**	**17.17**	**(9.83)**	**1–36**	**−4.03**	**<0.001**	**−0.98**

Note: Bold font indicates statistical significance.

Abbreviations: BDI, Beck Depression Inventory; BMI, body mass index; STAI-T, Spielberger's Trait Anxiety Inventory.

TABLE 2 Group comparison in empathy questionnaires.[a]

	Control			Patient			Welch *t*-test/Wilcoxon rank sum test				
	N	*M*	*SD*	*N*	*M*	*SD*	*t*/*w* statistic	*p*	H1	*p* adj.	Cohen's *d*
IRI											
PT	31	25.35	(4.76)	35	25.51	(3.51)	$t = -0.15$	0.879	CTL≠P	0.923	−0.04
EC		28.9	(2.98)		28.79	(3.67)	$w = 551.5$	0.912	CTL≠P	0.935	0.04
PD		**21.1**	**(5.23)**		**25.27**	**(5.17)**	**$t = -3.25$**	**0.002****	**P > CTL**	**0.016***	**−0.80**
F		**25.65**	**(6.47)**		**22.6**	**(5.39)**	**$w = 741$**	**0.011***	**CTL > P**	**0.028***	**0.51**
VDQ											
Approach	**32**	**30.72**	**(3.66)**	**36**	**25.08**	**(7.25)**	**$t = 4.11$**	**<0.001*****	**CTL > P**	**0.007****	**0.98**
Distress		**17.03**	**(4.00)**		**21.28**	**(5.45)**	**$t = -3.69$**	**<0.001*****	**P > CTL**	**0.007****	**−0.89**
Avoidance		**6.38**	**(1.86)**		**9.11**	**(3.82)**	**$w = 320$**	**<0.002****	**P > CTL**	**0.008****	**−0.91**

Note: Bold font indicates statistical significance.

Abbreviations: EC, Empathic Concern; F, Fantasising; IRI, Interpersonal Reactivity Index; PD, Personal Distress; PT, Perspective-Taking; VDQ, Vicarious Distress Questionnaire.

[a]Different sample sizes are due to missing values for a few participants. Welch *t*-test was performed instead of *t*-Student assuming unequal sample sizes. Column H1 reports research hypothesis for each variable. Directional research hypotheses were formulated for all subscales, with the only exception of IRI Perspective-Taking and IRI Empathic Concern, where no specific hypotheses were settled. *p* adj. refers to *p*-values adjusted using the Benjamini–Hochberg procedure which controls for false discovery rate. *p*-values are adjusted considering all the comparisons ($n = 42$) of variables performed in the study.

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

negatively correlated with both IRI EC ($r = -0.61$**) and VDQ Distress ($r = -0.54$*) while, in the AN group, no significant correlation was found between these subscales and, on the contrary, the relation between VDQ Distress and VDQ Avoidance was positive ($r = 0.27$). Finally, the positive correlation between VDQ Distress and IRI PD was higher in the AN group ($r = 0.60$**) than in the CLT group ($r = 0.40$).

3.3 | Experimental tasks

Table 3 reports the results of the four behavioural tasks used to measure the ability to decode emotions and the tendency to share another's emotions.

At the MET, patients showed a significantly lower tendency to share others' positive emotions ($p_{adj} = 0.007$) but no significant differences in sharing others' negative emotions. Contrary to expectations, the two groups did not differ in the decoding condition, requiring participants to label the positive and negative emotions observed in the pictures.

Patients showed slightly lower accuracy in decoding emotional expressions across different modalities, namely bodily (EBE), vocal (EVE) and facial expressions (EFE). However, the only significant result after applying the Benjamini-Hochberg method for multiple comparisons correction was circumscribed to the detection of facial expressions of anger, which resulted extremely lower in patients ($p_{adj} = 0.017$). Table S2 shows separate analyses for the three intensity levels (30, 70, 100) of each facial emotional expression. Accordingly with the results of total accuracy scores, the only significant group differences were found in decoding facial expressions of anger at 70% and 100% intensity levels.

A further unexpected result was the significant higher accuracy of patients in recognising neutral vocal expressions ($p_{adj} = 0.041$).

Table 4 shows the results of the social emotions induction task. By analysing participants' facial expressions with the FaceReader software, we could highlight a significant difference in expressiveness between the two groups. Specifically, patients showed overall higher facial expressiveness while watching the distressing video: they scored significantly higher in the total negative emotions index ($p_{adj} = 0.018$). They also showed a tendency towards higher arousal, but this result was not anymore significant after correcting for multiple comparisons ($p = 0.044$; $p_{adj} = 0.152$). No significant differences were found in the three subjective judgements asked at the end of the video (i.e., compassion, distress, and desire to watch the second part of the video).

Finally, we performed mediation models to understand the possible role of anxiety and depression in estimating the significant differences in empathy scores between the two groups of participants. Mediation models were run for all variables for which the two groups scored significantly different, even after controlling for multiple comparisons. Results from mediation models failed to show a significant indirect effect of anxiety or depression on the relationship between group membership (CONTROL vs. Anorexia Nervosa) and scores at (i) MET sharing positive E., (ii) EFE anger, (iii) Total facial expressiveness in the social emotions induction task, and (iv) IRI fantasising. Mediation demonstrated for IRI PD, VDQ distress and VDQ approach when the mediator was anxiety or depression. Mediation was also demonstrated for VDQ avoidance, but only when the mediator was depression. The results of significant mediations are displayed in Table 5.

4 | DISCUSSION

In this study, we evaluated empathic abilities in AN patients using self-reported measures, performance-based measures, and bodily correlates (facial expressiveness). The discussion of the results will be organised to highlight altered and preserved abilities in the cognitive and affective dimensions of empathy.

Regarding cognitive empathy, our results confirmed previous findings obtained assessing fantasising and PT with self-report measures. Still, they were not totally in line with previous findings obtained assessing emotion recognition with performance-based measures. Indeed, we found significantly lower fantasising ability in AN, but no differences in PT, as already shown in a recent meta-analysis (Kerr-Gaffney et al., 2019). On the contrary, our results did not confirm a generally lower ability to decode complex emotions, which was previously identified in individuals with AN especially based on the Reading the Mind in the Eyes Test (Bora & Köse, 2016; Caglar-Nazali et al., 2014; Leppanen et al., 2017; Preti et al., 2022). The incongruency between our results and the results obtained in past studies with performance-based measures of emotion recognition is not surprizing, given recent evidence that various theory-of-mind tasks fail to relate to each other (Gernsbacher & Yergeau, 2019) and that the popular Reading the Mind in the Eyes Test is not unanimously considered as a reliable measure of mentalising abilities (Olderbak et al., 2015). When we measured accuracy in recognising emotional expressions based on four different tasks (MET, EFE, EBE, and EVE), we found only a few significant differences between AN patients and controls. Specifically, individuals with AN

TABLE 3 Group comparison for behavioural tasks measuring empathic abilities.[a]

	Control			Patient				Welch *t*-test/Wilcoxon rank sum test			
	N	***M***	***SD***	***N***	***M***	***SD***	***t*/*w* statistic**	***p***	**H1**	***p* adj.**	**Cohens' *d***
MET											
Decoding negative E.	32	0.73	(0.12)	41	0.73	(0.09)	$t = 0.28$	0.388	CTL > P	0.540	0.07
Decoding positive E.		0.66	(0.08)		0.66	(0.10)	$w = 703.5$	0.295	CTL > P	0.459	0.08
Sharing negative E.		4.53	(2.17)		5.10	(1.91)	$t = -1.17$	0.123	P > CTL	0.348	−0.28
Sharing positive E.		**5.69**	**(1.33)**		**4.41**	**(1.68)**	***w* = 961.5**	**<0.001*** **	**CTL > P**	**0.007** **	**0.84**
EBE											
Happy	33	0.95	(0.07)	36	0.91	(0.17)	$w = 672.5$	0.158	CTL > P	0.349	0.27
Neutral		0.96	(0.06)		0.95	(0.07)	$w = 669.5$	0.321	CTL≠P	0.465	0.23
Negative E.		0.76	(0.07)		0.74	(0.15)	$w = 605.5$	0.447	CTL > P	0.569	0.19
Anger		0.87	(0.10)		0.82	0.2	$w = 647.5$	0.259	CTL > P	0.452	0.33
Disgust		0.51	(0.14)		0.52	0.22	$w = 546.5$	0.719	CTL > P	0.814	−0.07
Fear		0.76	(0.14)		0.75	0.19	$w = 595$	0.498	CTL > P	0.615	0.10
Sad		0.89	(0.10)		0.85	0.17	$w = 670.5$	0.174	CTL > P	0.365	0.25
Surprise		0.72	(0.14)		0.67	0.21	$w = 662.5$	0.205	CTL > P	0.392	0.29
EVE											
Positive E.	33	0.79	(0.17)	34	0.69	(0.22)	$w = 721$	0.022*	CTL > P	0.091	0.50
Neutral		**0.73**	**(0.40)**		**0.96**	**(0.09)**	***w* = 380**	**0.009** **	**CTL ≠ P**	**0.041***	**−0.79**
Negative E.		0.70	(0.07)		0.69	(0.08)	$w = 605.5$	0.290	CTL > P	0.459	0.10
Anger		0.60	(0.22)		0.61	(0.24)	$w = 538$	0.617	CTL > P	0.720	−0.03
Disgust		0.90	(0.10)		0.84	(0.12)	$w = 710.5$	0.024*	CTL > P	0.091	0.53
Fear		0.59	(0.18)		0.63	(0.2)	$w = 484.5$	0.836	CTL > P	0.900	−0.19
Pain		0.47	(0.15)		0.46	(0.13)	$w = 606.5$	0.283	CTL > P	0.459	0.06
Sadness		0.94	(0.10)		0.93	(0.11)	$w = 610$	0.247	CTL > P	0.452	0.12
Surprise		0.46	(0.23)		0.39	(0.21)	$w = 650$	0.132	CTL > P	0.326	0.29
Pleasure		0.69	(0.21)		0.58	(0.28)	$w = 688$	0.054	CTL > P	0.152	0.44
Happiness		0.89	(0.17)		0.81	(0.26)	$w = 683$	0.050	CTL > P	0.152	0.39
EFE											
Happy	29	0.9	(0.10)	28	0.91	(0.12)	$w = 215.5$	0.946	CTL > P	0.946	−0.17
Neutral		0.9	(0.14)		0.88	(0.13)	$w = 427.5$	0.737	CTL ≠ P	0.814	0.12
Negative E.		0.73	(0.06)		0.69	(0.08)	$w = 508.5$	0.052	CTL > P	0.152	0.48
Fear		0.69	(0.10)		0.65	(0.10)	$w = 491$	0.088	CTL > P	0.232	0.40
Sadness		0.72	(0.09)		0.71	(0.11)	$t = 0.48$	0.315	CTL > P	0.512	0.13
Disgust		0.79	(0.09)		0.76	(0.14)	$w = 420.5$	0.412	CTL > P	0.540	0.20
Anger		**0.72**	**(0.06)**		**0.66**	**(0.10)**	***t* = 2.74**	**0.004** **	**CTL > P**	**0.017***	**0.73**

Note: Bold font indicates statistical significance.

Abbreviations: EBE, Emotional Bodily Expressions; EFE, Emotional Facial Expressions; EVE, Emotional Vocal Expressions; MET, Multifaceted Empathy Test.

[a]Mean accuracy rate [range 0–1.00] in decoding emotional expressions is displayed for MET decoding, EBE, EFE, EVE. Mean self-reported sharing of emotion [range 1–9] is displayed for the MET Sharing task. Welch *t*-test or Wilcoxon rank sum test were performed based on the results at normality test (i.e. Shapiro test). Column H1 reports research hypotheses for each variable. For all emotional conditions, we hypothesised that control score higher than patients, while the opposite hypothesis was formulated for the MET Sharing Negative Emotions condition. No specific direction was predicted for neutral conditions. *p* adj. refers to *p*-values adjusted using the Benjamini–Hochberg procedure. *p*-values are adjusted considering all the comparisons ($n = 42$) of variables performed in the study.

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

TABLE 4 Results of the social emotions induction task.[a]

	Control			Patient				Welch *t*-test/Wilcoxon rank sum test			
	N	***M***	***SD***	***N***	***M***	***SD***	***t/w* statistic**	***p***	**H1**	***p* adj.**	**Cohens' *d***
Social emotions induction task: Self-report											
Approach 2nd part	18	8.61	(0.85)	24	8.5	(0.78)	$w = 8.61$	0.195	CTL > P	0.390	0.14
Distress		27.72	(5.40)		27.25	(6.1)	$t = 27.72$	0.604	P > CTL	0.709	0.08
Compassion		29.17	(4.22)		28.25	(5.23)	$t = 29.17$	0.267	CTL > P	0.464	0.19
Social emotions induction task: Facereader											
Negative emotions	20	**4.38**	**(4.40)**	24	**8.47**	**(9.11)**	**$w = 125$**	**0.003****	**P > CTL**	**0.018***	**−0.71**
Arousal		**24.94**	**(3.86)**		**27.16**	**(2.87)**	**$w = 167$**	**0.044***	**P > CTL**	**0.152**	**−0.65**

Note: Bold font indicates statistical significance.

[a]Welch *t*-test or Wilcoxon rank sum test were performed based on the results at normality test (i.e. Shapiro test). Column H1 reports research hypotheses for each variable. *p* adj. refers to *p* values adjusted using the Benjamini–Hochberg procedure. *p* values are adjusted considering all the comparisons ($n = 42$) of variables performed in the study.

*$p < 0.05$; **$p < 0.01$.

TABLE 5 Results of mediation analysis.[a]

Model			Indirect effect (a × b)				Total effect (c = c′ + a × b)			
				95% C.I.				95% C.I.		
DV	**IV**	**Mediator**	***b***	**Lower**	**Upper**	***p* value**	***b***	**Lower**	**Upper**	***p* value**
Group	IRI PD	Anxiety	5.80	3.94	7.96	<0.001	4.18	1.69	6.63	<0.001
		Depression	2.76	1.32	4.36	<0.001				
	VDQ distress	Anxiety	3.79	1.70	5.80	0.002	4.23	1.84	6.55	<0.001
		Depression	1.66	0.37	3.20	0.010				
	VDQ approach	Anxiety	−3.04	−6.19	−0.10	0.046	−5.26	−7.76	−2.68	<0.001
		Depression	−2.31	−4.72	−0.49	0.008				
	VDQ avoidance	Anxiety	-	-	-	ns	2.48	1.12	3.86	<0.001
		Depression	1.00	0.16	2.31	0.026				

Abbreviations: C.I. confidence intervals; IRI, Interpersonal Reactivity Index; PD, Personal Distress; VDQ, Vicarious Distress Questionnaire.

[a]Group contrasts are the following: CTL group = 0, Patient group = 1. 95% C.I. are computed with bootstrap method. Only significant (partial) mediations are displayed.

showed a higher accuracy in recognising neutral emotional expressions, which might be explained by the fact that patients generally tended to perceive emotional expressions as more neutral. Therefore, patients' higher selection of the neutral option increased the probability of obtaining a correct result for the neutral case.

However, the most relevant deficit in cognitive empathy found in AN patients was limited to the recognition of facial expressions of anger. Here, patients showed an extremely lower accuracy than controls (Cohen's $d = 0.73$). This result is in line with evidence that AN patients are less accurate in decoding ambiguous facial expressions of anger morphed with neutral facial expressions (Fujiwara et al., 2017). Experimental studies also showed lower regulation of anger in individuals with AN (Abbate-Daga et al., 2012; Harrison et al., 2011; Perthes et al., 2021). These findings corroborate the hypothesis that AN individuals might show specific deficits in processing anger-threatening emotional cues. However, we also need to highlight that in some studies, AN individuals showed greater attention to anger faces (Cserjési et al., 2011; Harrison et al., 2010), as well as a response bias towards anger in emotion recognition tasks (Dapelo et al., 2016). Future research should clarify how to conciliate the lower accuracy in recognising anger facial expressions with AN patients' greater attention to threatening-anger stimuli.

Regarding affective empathy, our results attested that AN patients were not indifferent to others' suffering. That is to say that they were able to experience vicarious

negative emotions and signal them with bodily or facial expressions. Indeed, in our study, AN patients did not differ from controls for self-report EC or for the tendency to share others' negative emotions in the MET–Sharing Task. They also scored even significantly higher than controls in self-reported measures of PD. Further, they manifested higher facial expressiveness than controls in the social emotions induction task. This last result contradicted previous evidence about the AN patients' deficit in signal emotional expressions (Treasure & Schmidt, 2013). However, our results were not, per se, a sufficient indicator of overall higher affective empathy in AN. Rather, they highlighted higher negative emotional contagion in this population. Further insights derived from the analysis of the only test that explicitly separates the vicarious emotional experience from negative and positive emotions. Indeed, the results from the MET-Sharing Task suggested no difference in sharing the other's negative emotions between the two groups but a lower attitude toward sharing the others' positive emotions in patients with AN. This finding was in accordance with the previous literature already showing the presence of sentiments of envy and *Schadenfreude* in the AN population (Grynberg et al., 2020) and fewer expressions of positive emotions in this population (Leppanen et al., 2017).

We now move to the analysis of the role of co-morbid anxiety and depression in affective and cognitive empathy. Mediation analyses showed a significant role of anxiety and depression in self-report measures of PD. On the contrary, there was no intervening role of depression or anxiety in determining the group differences in the ability to share the others' positive emotions (MET Sharing Positive), to decode facial anger expressions (EFE anger), or to fantasise (IRI F). These results suggested that the deficits in decoding anger, the lower sharing of others' positive emotions, and the lower ability to fantasise might be peculiar characteristics of the condition of anorexia (see Treasure et al., 2020), since they were not explained by co-morbid mood and anxiety disorders. However, intervening factors that were not considered in our study could be represented by autism or alexithymia traits, which are usually higher in individuals with AN (Zucker et al., 2007). These personality traits might be compatible with lower emotional recognition ability and imaginal capacity, suggesting that these cognitive-emotional deficits might precede and represent a risk factor for the development of AN illness. Finally, several factors, including longer duration of illness and lower BMI, were previously associated with higher deficits in PT or emotional decoding (Bora & Köse, 2016), suggesting the importance of considering several intervening variables when examining empathy deficits in AN. Overall, the results of mediation analyses were partially in line with recent meta-analyses showing that depression is positively associated with affective empathy but not cognitive empathy (Yan et al., 2021). It can be the case that self-report affective empathy and depression show measurement overlap, given the high focus on PD and sharing negative emotions in self-report measures of affective empathy (Grynberg et al., 2010). This fact could further explain why we failed to find any mediation effect of depression or anxiety in the MET Sharing Positive E, even though this task should be considered to measure affective empathy as well.

Regarding prosocial behavioural attitudes, the AN group showed a lower willingness to approach and a higher willingness to avoid suffering others. These behavioural attitudes might be associated with higher depression and anxiety levels in AN patients and higher self-reported distress in front of a suffering other. Overall, this interpretation is supported by the results of mediation analyses. Group differences in self-reported prosocial behaviour (approach or avoidance) were significantly mediated by anxiety or depression levels. This means that the higher levels of trait anxiety and depression in the AN group might be responsible for higher states of anxiety in front of a suffering other and a higher willingness to escape from this situation. In this regard, insights also come from correlation analyses between self-reported measures conducted separately for the AN and the CTL group (see Table S1). Overall, what emerges is an opposite relation between distress and approach-avoidance motivations across the two groups: while in healthy controls, higher levels of distress were accompanied by a lower willingness to avoid the suffering other, in the group of patients, the higher the levels of distress, the higher was the willingness to avoid the suffering other.

These results point to the possibility that PD can have an ambivalent role in empathy and, specifically, that there is an inverted U-shaped relationship between PD and prosocial behaviour. Following this interpretation, the AN group should situate in that part of the graph showing high levels of perceived distress, accompanied by lower levels of prosocial behaviour. In a not similar but related way, this interpretation is in line with evidence obtained in the framework of Gray's model of the two behavioural motivational systems, namely the behavioural activation system (BAS) and the behavioural inhibition system (BIS). Specifically, our results suggested that AN patients, given their high anxiety and depression profile, might be high BIS and low BAS, thus being more responsive to negative, conflictual situations and less responsive to positive, cooperative ones (Balconi & Bortolotti, 2012). Further, this interpretation of results is in line with a model of empathy proposed by Batson (Batson

et al., 1987), who suggested that distress and discomfort can indeed be self-oriented. When the primary goal of a distressed person is to reduce his/her state of distress, this outcome can be achieved in different ways. For instance, individuals can decide to avoid the distressing situation when avoidance has limited costs, or they can opt for prosocial behaviour when avoidance comes with higher costs. Our results suggested that the PD perceived by patients was, indeed, self-oriented.

Before concluding, we should mention some limitations of our study. A major point to highlight is the low sample size and the numerous multiple comparisons, which lowered statistical power. Specifically, our study detected a general trend versus lower emotional decoding ability in AN, but only a few results were statistically significant. Given the limitations mentioned above, it might be the case that the effect size of the difference between the AN and CTL group was too small to reach the significance level and that significant differences could have been estimated clearly with a higher sample size. Further studies with bigger samples need to be conducted to clarify this point. Moreover, considering the variations regarding the number of emotions assessed across tasks, future studies should improve the comparability of the results obtained measuring emotion recognition accuracy across modalities. Also, given the limited sample size, it was not possible to conduct separate analyses for patients with different types of AN, mainly restrictive and purging types. Further studies could also consider other intervening variables such as the number and type of traumatic events, the quality of the family relationships, or emotional regulation skills, which may affect the overall level of empathic abilities. Finally, we might highlight that the majority of performance-based measures used in this study assessed emotion recognition ability, which is part of the cognitive dimension of empathy. Performance-based measures of affective empathy are still scarce. The 'social emotions induction task' was introduced for this purpose, although future validation studies should clarify whether it is apt to evoke vicarious emotional responses and consequent behavioural attitudes.

Besides its limitations, our study had the merit of offering evidence from a multi-method investigation of empathic abilities in AN. We confirmed the ambivalent role of perceived PD in empathy and, specifically, its dysfunctional character in AN since, in this condition, it is accompanied by lower prosocial behaviour. We also showed the peculiar attitude of individuals with AN to share little others' positive emotions. This attitude might be connected with an altered processing of anger expressions, given the lower ability to decode this emotion in faces. Finally, we confirmed a lower fantasising ability in AN, which is usually linked with lower empathic accuracy (Namba et al., 2021). Overall, our study drew a complex picture of empathic deficits in AN and provided evidence of deficits in the processing of anger expressions and higher experience of distress. Further research should confirm these results and better understand which altered abilities are peculiar to the acute stage of the illness and which instead precede it, representing specific risk factors for the development of AN symptomatology.

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CONFLICT OF INTEREST STATEMENT

None of the authors have a conflict of interest to disclose.

DATA AVAILABILITY STATEMENT

The data underlying the results presented in the study are available from https://osf.io/3temn/?view_only=9e3bf9ff31b54549a4df354d28305a5b.

PATIENT CONSENT STATEMENT

Patients and healthy volunteers completed an informed consent.

PERMISSION TO REPRODUCE MATERIAL FROM OTHER SOURCES

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