RESEARCH ARTICLE

A network analysis of borderline personality disorder symptoms and disordered eating

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Abstract

Objective: The current study used network analysis to explore associations between specific groupings of borderline personality disorder (BPD) and eating disorder (ED) symptoms, and other transdiagnostic variables including insecure attachment, rejection sensitivity, emotion dysregulation, a theory of mind, and emotion recognition.

Method: Network analysis was undertaken on self-report data from 753 adults (81.5% women), of whom 109 reported a lifetime ED diagnosis.

Results: Comorbidity between BPD and ED symptoms was only partially conceptualized through the transdiagnostic variables. The centrality indices from the network analysis indicated that emotion dysregulation and abandonment were the most central elements in the network. Conversely, the theory of mind and emotion recognition had very few connections with the other transdiagnostic variables in the network.

Discussion: The findings provide empirical insight into the nature of the observed co-occurrence between BPD and ED symptoms and serve to improve clinical decision-making regarding psychological interventions for both problem sets.

KEYWORDS
attachment, borderline personality disorder, eating disorder, emotion dysregulation, emotion recognition, network analysis, rejection sensitivity, theory of mind

1 | INTRODUCTION

Research evidence indicates a high prevalence of comorbid borderline personality disorder (BPD) and BPD symptoms in eating disorder (ED) samples, including symptoms of interpersonal difficulties, unstable self-image, marked impulsivity, and emotion dysregulation (e.g., Martinussen et al., 2017). BPD rates are generally found to be higher in bulimia nervosa (BN) and the anorexia binge-purge (AN-BP) subtype than patients with anorexia nervosa-restrictive (AN-R), suggesting common characteristics between BPD and bulimic symptoms, including impulsivity and emotion dysregulation (e.g., Farstad, McGeown, & von Ranson, 2016) as well as anger (e.g., Miller, Racine, & Klonsky, 2019). Thus, it is possible that these BPD symptoms may not only be more prevalent in EDs but that they may also have some causative effect on ED symptoms. However, attempts to identify candidate symptoms that may be most influential in this comorbidity is complicated as symptoms within a condition often co-occur, leading to diffuse patterns of association when attempting to correlate with symptoms from another condition. The current study attempts to better identify the key symptoms linking BPD and ED by using a novel technique (network analysis) to visualize the direct and indirect associations among variables involved in BPD and ED symptomatology.

1.1 | Attachment and emotional processing difficulties as transdiagnostic features

Bowlby's (1973) theory of attachment addresses the underlying systems and processes involved in close interpersonal bonds. According to attachment theory, a child's attachment is gradually shaped by experiences with caregivers in the form of internal working models related to the self and others. These early experiences eventually result in a stable attachment style, which can be conceptualized as secure or insecure. Empirical studies consistently find high rates of insecure attachment in both ED populations (Caglar-Nazali et al., 2014) and BPD samples (Badoud et al., 2018), indicating potential transdiagnostic difficulties with attachment.

A substantial body of research implicates attachment styles in socio-emotional processing, such as emotion regulation (e.g., Moutsiana et al., 2014) and emotion recognition (Cooke, Stuart-Parrigon, Movahed-Abtahi, Koehn, & Kerns, 2016). Individuals with secure attachment have been found to be comfortable with seeking support from others in times of adversity and use self-efficacy and problem-solving strategies to reduce their own distress (e.g., Pascuzzo, Cyr, & Moss, 2013). In contrast, individuals with insecure attachment experience greater difficulty in regulating their emotions, and may respond to adversity in suboptimal ways, such as emotion-focused coping, avoidance, or aggression (e.g., Ma, Ma, Chen, Ran, & Zhang, 2017).

Difficulties in regulating emotions are considered a core feature of BPD (Daros & Williams, 2019), and are also frequently observed in clinical ED populations (Prefit, Cândea, & Szentagotai-Tătar, 2019), with patients with ED reporting more emotion regulation difficulties including higher levels of emotion intensity, lower acceptance of emotions, less emotional awareness and clarity, and increased use of dysfunctional emotion regulation strategies when compared to healthy controls (Lavender et al., 2015).

Attachment insecurity may also play a role in emotion recognition difficulties. Cooke et al. (2016) conducted a meta-analysis and found that secure infant-mother attachment was linked to emotion understanding. Conversely, Colle and Del Giudice (2011) found that children with disorganized attachment scored lower on discrimination of facial emotions compared to children of different attachment orientations. Difficulties with emotion recognition and theory of mind (ToM; the ability to make inferences about another person's mental state) have also been found across ED (Caglar-Nazali et al., 2014; Oldershaw, Hambrook, Tchanturia, Treasure, & Schmidt, 2010) and BPD populations (Mitchell, Dickens, & Picchioni, 2014). Furthermore, studies have shown that these emotion recognition difficulties are present even in recovered ED patients (e.g., Harrison, Tchanturia, & Treasure, 2010; Oldershaw et al., 2010) and in nonclinical disordered eating populations (e.g., Ridout, Thom, & Wallis, 2010), suggesting a relationship between general eating pathology and emotion recognition deficits.

1.2 | The role of rejection sensitivity

Rejection sensitivity (RS) is involved in the misinterpretation of ambiguous social cues (Downey & Feldman, 1996), and may serve as a transdiagnostic link between the observed deficits in ToM and emotion recognition in ED and BPD. RS is defined as an individual difference in the tendency to anxiously expect, readily perceive, and overreact to real or imagined rejection (Downey & Feldman, 1996). Individuals with high RS demonstrate poor emotion regulation, responding to perceived rejection or threats of rejection in contradictory ways, including behaviors marked by extreme attentiveness and accommodation, to extremes of hostility or avoidant reactions (Gao, Assink, Liu, Chan, & Ip, 2019). While RS has consistently been linked with BPD (Staebler, Helbing, Rosenbach, & Renneberg, 2011), the relationship between RS and eating pathology remains relatively under-explored. One study by Selby, Ward, and Joiner (2010) utilized a BPD-enriched community sample to investigate BPD symptoms, RS, emotion dysregulation, and bulimic pathology concurrently. Selby et al. (2010) found that emotion dysregulation mediated the relationship between BPD symptoms and bulimic symptoms. Furthermore, they also found an indirect effect for RS on bulimic symptoms through emotion dysregulation. Taken together, insecure attachment and socio-emotional processing difficulties including emotion dysregulation, ToM, emotion recognition, and RS, maybe potential linking variables that may explain comorbidity between BPD and ED symptoms.

1.3 | The current study

There are several limitations within the literature that warrant further investigation. First, the model proposed by Selby et al. (2010) linking BPD symptoms with bulimic pathology has only been run in a BPD-enriched community sample, where participants were chosen as a result of an intensive screening process designed to employ those with high levels of BPD symptomatology. Second, studies that have observed comorbidity between EDs and BPD have typically been prevalence studies (e.g., Miller et al., 2019), which provide an indication of the extent to which symptoms co-occur, but do not necessarily explain why this comorbidity may arise or give an indication that symptoms across conditions are directly related. For example, emotion regulation difficulties have been reported across all ED subtypes (Prefit et al., 2019), thus investigation into the interrelationships between EDs and BPD symptoms is important. Identification of potential bridging variables (or transdiagnostic features) that serve to connect the two conditions may enable targeting of these in treatment contexts to reduce comorbidity and, in turn, symptom severity for each condition. The limited available evidence suggests that insecure attachment and socio-emotional processing constructs, such as RS (Selby et al., 2010; Staebler et al., 2011), emotion dysregulation (e.g., Daros & Williams, 2019; Prefit et al., 2019), ToM, and emotion recognition (e.g., Caglar-Nazali et al., 2014; Mitchell et al., 2014), may act in this capacity, explaining co-occurrence of BPD and ED symptoms.

Thus, the aim of the current study was to explore whether the transdiagnostic features of insecure attachment, emotion dysregulation, ToM, emotion recognition, and RS linked to ED and BPD symptoms. Network analysis, a statistical, and visual method of modeling interrelationships among a collection of variables of interest were used for the current study. Network analysis provides centrality statistics that indicate how variables are related to others in the network. As such, a symptom may be identified as statistically influential, because it has strong and/or diffuse connections with many other symptoms in the model. A symptom may also be influential by connecting two variables that are not directly related. In both cases, reducing this target symptom may have the effect of limiting the severity of other symptoms in the network.

Under the assumption that BPD and ED symptoms correlate, we anticipated that a network analysis would show links within and between the two conditions. Further, we predicted that insecure attachment, emotion dysregulation, ToM, emotion recognition, and RS would act as transdiagnostic features that connect the two conditions. In network analysis, this may be shown in one of at least two ways; by these variables having: (a) high betweenness values if they connect symptoms across the conditions, and/or (b) high strength values because these

symptoms connect to a large number of symptoms across the two conditions. More broadly, network analysis can show clusters of symptoms that tend to co-occur. This visual display helps to identify the symptoms within and across conditions that may be most highly related.

2 | METHODS

2.1 | Participants

The sample comprised 753 adults (81.5% women), with an average age of 22.36 (standard deviation [SD] = 8.20) drawn largely from the general community, a first-year psychology course, and several ED clinics and ED organizations within Australia. Targeted recruitment of individuals with a probable ED was designed to ensure enough spread in ED symptom severity in the overall sample, thus reducing the likelihood of negative effects in our network analyses due to range restriction in correlations among modeled variables. This yielded a total of 109 participants reporting a lifetime ED diagnosis and included 52 AN-R, 14 AN-BP, 18 BN, 15 other specified feeding and eating disorders, and 10 binge eating disorder diagnoses. The average age of ED onset for the ED group was 15.39 years (SD = 4.46), and 37 (34%) of the ED participants reported that they were currently recovered. Formal ED diagnosis was determined from psychiatrist reports in tertiary settings according to the diagnostic and statistical manual of mental disorders (DSM; American Psychiatric Association, 2013) criteria, and by self-report in other settings. Sociodemographic variables and clinical information for the overall sample are presented in Table 1. Results are presented for the overall sample throughout this paper, though group difference results may be obtained from the corresponding author upon request.

2.2 | Measures

2.2.1 | Sociodemographic and clinical information

Information on participant age, gender, ethnicity, employment status, marital status, highest completed education, lifetime ED status, and age of ED onset were obtained. Information on weight and height was collected, from which body mass index was calculated.

2.2.2 | Disordered eating

Disordered eating was assessed using the eating disorder inventory (EDI-3; Garner, 2004). The EDI-3 is a 91-item measure that assesses ED symptomatology on a 6-point rating scale, which is then scored using a 0–4 system. The current study used the subscales of the eating disorder risk composite: drive for thinness, bulimia, and body dissatisfaction. Cronbach's α for the current study was driven for thinness ($\alpha = .91$), bulimia ($\alpha = .88$), and body dissatisfaction ($\alpha = .92$).

2.2.3 | Borderline personality disorder

BPD symptoms were measured using the borderline personality questionnaire (BPQ; Poreh et al., 2006). The BPQ is an 80-item that measures DSM (American Psychiatric Association, 1994) BPD criteria across eight subscales: impulsivity, affective instability, abandonment, relationships, self-image, suicide/self-mutilation, emptiness, intense anger, and quasi-psychotic states. The items are scored on a series of true or false ratings. Cronbach's α for the current study

TABLE 1 Sociodemographic details for sample overall (n = 753)

Variable	Mean (SD)
Age (years)	22.36 (8.20)
BMI	22.27 (6.02)
Variable	**N (%)**
Ethnicity	
Caucasian	330 (43.8)
Aboriginal/Torres Strait	1 (0.1)
Asian	290 (38.5)
European	86 (11.4)
Middle-Eastern	13 (1.7)
African	8 (1.1)
Hispanic	2 (0.3)
Other	23 (3.1)
Highest completed education	
Primary	3 (0.4)
Secondary	375 (49.8)
Undergraduate	305 (40.5)
Postgraduate	70 (9.3)
Marital status	
Single	508 (67.5)
In a relationship	191 (25.4)
Married	42 (5.6)
Separated	5 (0.7)
Divorced	5 (0.7)
Widowed	2 (0.3)
Employment status	
Working full-time	69 (9.2)
Working part-time	182 (24.2)
Unemployed	47 (6.2)
Student	455 (60.4)

Abbreviations: BMI, body mass index; SD, standard deviation.

was impulsivity (α = .64), affective instability (α = .83), abandonment (α = .80), relationships (α = .80), self-image (α = .83), suicide/self-mutilation (α = .84), emptiness (α = .86), intense anger (α = .84), and quasi-psychotic states (α = .61).

2.2.4 | Attachment style

Attachment style was assessed using the revised experiences in close relationships questionnaire (ECR-R; Fraley, Waller, & Brennan, 2000). The ECR-R is a 36-item measure based on a dimensional model of attachment from attachment anxiety to attachment avoidance. The items are scored on a 7-point rating scale from 1 (strongly disagree) to 7 (strongly agree). Cronbach's α in the current study was attachment anxiety (α = .94) and attachment avoidance (α = .94).

2.2.5 | Emotion dysregulation

Emotion dysregulation was measured using the difficulties in emotion regulation scale (DERS; Gratz & Roemer, 2004). The DERS is a 36-item measure with six subscales. The items are scored on a 5-point rating scale from 1

(almost never) to 5 (almost always). The current study only used the total DERS score, which was calculated by the sum of the subscales. Cronbach's α for the current study for the total DERS was .96.

2.2.6 | Theory of mind

ToM was assessed using the reading the mind in the eyes task (RME; Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001). The RME is a 36-item measure that presents sets of eyes, depicting the face from the brow down to the middle of the nose. The participant is required to choose one of four words that most closely resembles what the person in the picture is thinking or feeling. The total score was calculated by the sum of the correct answers. Cronbach's α for the current study was .64.

2.2.7 | Emotion recognition

Emotion recognition was measured using the Ekman 60 Faces Test (Ekman & Friesen, 1976). The test consists of 60 faces derived from Ekman and Friesen's Pictures of Facial Affect (1976) and tests six basic facial emotional expressions: anger, disgust, fear, happiness, sadness, and surprise. The total score was calculated by the sum of the correct answers. Cronbach's α for the current study was .74.

2.2.8 | Rejection sensitivity

RS was measured using the rejection sensitivity questionnaire (RSQ; Downey & Feldman, 1996). The RSQ is an 18-item measure that presents scenarios to assess RS along two dimensions: rejection concern (concern about a significant other's response to an important request) from 1 (very unconcerned) to 6 (very concerned), and acceptance expectancy (expectation that a significant other would honor their request) from 1 (very unlikely) to 6 (very likely). In accordance with the test authors' adoption of an expectancy-value model, acceptance expectancy was reversed scored to index rejection expectancy (rejection expectancy = 7 − acceptance expectancy). The total RS score was then calculated as the product of rejection concern and rejection expectancy. Cronbach's α for the current study was .91.

2.3 | Procedure

Ethical approval was obtained from a university in Melbourne and the hospitals from where the clinical ED sample was recruited. All participants read a consent form informing them of the voluntary nature of the study and the freedom to withdraw at any time. Consenting adults were then given access to an online questionnaire via Qualtrics software. The participants were asked to complete the sociodemographic questions and the self-report measures related to the variables of interest.

2.4 | Analytic strategy

2.4.1 | Network analyses

Network analyses were conducted using the statistical platform R. The adaptive least absolute shrinkage and selection operator (LASSO) approach was implemented using the R package parcor (Krämer, Schäfer, & Boulesteix,

2009). The adaptive LASSO assigns different penalty weights for different coefficients (Zou, 2006) and relies on partial correlations instead of correlation. Adaptive LASSO removes any relationships from the network that is close to zero, thus reducing the likelihood of false positives (Type 1 error) (Krämer et al., 2009). Therefore, if an edge is present in the network, one can reasonably trust that there is a structural relationship between the variables (Costantini et al., 2015).

The data were visualized using network modeling techniques in the R package qgraph (Epskamp, Cramer, Waldorp, Schmittmann, & Borsboom, 2012). The generated network consists of nodes, connected by lines (edges). Nodes cluster within the network when they are strongly correlated, with green lines indicating positive correlations and red lines indicating negative associations. The wider and more saturated an edge is drawn, the stronger the correlation. The centrality of nodes was quantified based on three commonly reported metrics: betweenness (if a node controls the flow between others), closeness (how quickly a node may reach others), and strength (a node's number of edges) (Freeman, 1978).

While the three centrality metrics mentioned above are derived for each node in the network, characteristics at the level of the network were also explored. First, the potential clustering of nodes into groups was evaluated using exploratory graph analysis (EGA), implemented using the EGA package in R (Golino & Epskamp, 2017). This works by identifying communities of nodes that are related, analogous to item loadings on factors in exploratory factor analysis. Second, in light of ongoing discussions in psychological research about the replicability of findings across studies (e.g., Asendorpf et al., 2013), it is increasingly common in network analysis to evaluate the stability of results within samples as an indicator of possible replicability. To that end, the stability of centrality metrics was evaluated using the correlation stability (CS) coefficient implement via the bootnet package in R (Epskamp, Borsboom, & Fried, 2018). The CS coefficient indicates the proportion of cases (participants) that can be dropped from the original sample whilst maintaining a correlation of 0.70 or above for centrality metrics between the full and subsetted samples. For instance, a CS coefficient value of 0.80 would indicate that even after dropping 80% of the sample, there is a correlation of .70 between the original centrality statistics for the sample overall and the retained 20% of this sample. Epskamp et al. (2018) recommend a CS coefficient of at least 0.25 (and, ideally 0.50 or above) to ensure enough stability in centrality metrics to interpret from one's sample but note these are provisional until more definitive guidelines are established.

3 | RESULTS

3.1 | Descriptive statistics

Table 2 provides the mean values, standard deviations, and skew and kurtosis values for all modeled variables. Skew and Kurtosis values were within acceptable limits (Kline, 2011), and thus the transformation of variables or correlation matrix was not undertaken before analyses reported below.

As may be expected, Pearson's correlations showed strong correlations among the ED symptoms. Correlations among the BPD variables were more variable, ranging from small to large, though all relationships were significant and positive. Correlations between ED and BPD variables ranged from small to large as well and were significant and positive. RS and emotion dysregulation both correlated positively with the ED and BPD variables, whereas ToM and emotion recognition were inconsistently related to the ED and BPD variables (see Table 3).

3.2 | Network analysis

The network map is shown in Figure 1. Emotion dysregulation is central in the network map, and also has among the highest values for strength, closeness, and betweenness, reflecting its connection to a wide range of other

TABLE 2 Descriptive statistics for modeled variables

Variable	Mean (SD)	Skew	Kurtosis
1. Rejection sensitivity	10. 34 (4.36)	1.15	3.36
2. Theory of mind	26.49 (4.19)	−0.85	0.87
3. Emotion recognition	48.68 (5.27)	−0.93	2.26
4. Emotion dysregulation	90.47 (26.98)	0.42	−0.50
5. Attachment avoidance	3.38 (1.15)	0.10	−0.28
6 Attachment anxiety	3.57 (1.21)	−0.12	−0.48
7. Drive for thinness	9.93 (8.05)	0.58	−0.76
8. Bulimic symptoms	6.27 (6.87)	1.53	1.88
9. Body dissatisfaction	18.23 (11.59)	0.47	−0.55
10. Impulsivity	1.70 (1.72)	1.11	1.09
11. Affective instability	4.23 (2.99)	0.34	−1.01
12. Abandonment	2.38 (2.42)	1.10	0.39
13. Relationships	2.81 (2.42)	0.65	−0.70
14. Self-image	3.80 (2.84)	0.39	−1.13
15. Suicide/self-mutilation	1.54 (1.98)	1.05	−0.14
16. Emptiness	3.76 (3.11)	0.49	−1.02
17. Intense anger	2.58 (2.73)	0.99	−0.21
18. Quasi-psychotic states	1.65 (1.57)	0.96	0.35

Note: Variables 1–4, socio-emotional processing constructs; variables 5–6, attachment; variables 7–9 eating disorder symptoms; variables 10–18, BPD symptoms.

Abbreviations: BPD, borderline personality disorder; SD, standard deviation.

variables in the overall network. Abandonment also has high values for these centrality indices and a particularly strong association with the BDP symptom of rejection. CS coefficients were acceptable for closeness (CS = 0.438) and strength (CS = 0.517).

EGA further illustrates the connection among modeled variables, identifying four distinct clusters. Clusters 1 and 2 linked nodes related to BPD symptoms, including impulsivity, self-image, suicide/self-mutilation, emptiness, instability, abandonment, relationship, and intense anger. In addition to the BPD symptoms, Cluster 1 also included the following transdiagnostic variables: anxious and avoidant attachment, RS and emotion dysregulation, indicating a more attachment-related cluster than Cluster 2. Cluster 3 comprised nodes reflecting exclusively ED symptomatology namely bulimia, body dissatisfaction, drive for thinness. Finally, Cluster 4 was smaller and reflected emotion recognition and ToM, suggesting that this cluster was less connected to other constructs in the network. The BDP variable quasi-psychotic state did not cluster with any other variables in the model (hence it is shown in white in Figure 1).

Thus, although ED and BPD symptoms clustered separately, the network map identifies several direct connections among ED and BPD symptoms, as well as connections that both sets of variables had to the transdiagnostic constructs in the model. Body dissatisfaction connected to BPD symptoms of self-image, suicide/self-mutilation, emptiness, and affective instability, with the strongest connection being to self-image. Bulimic symptoms related to the BPD symptoms of impulsivity and suicide/self-mutilation, though the latter effect was noticeably weaker. Drive for thinness was associated with suicide/self-mutilation. All three ED symptoms and a range of BPD symptoms were linked to emotion dysregulation. Emotion recognition and ToM were related to each, but only had one additional link in the model, to the BPD symptom of quasi-psychotic states. Rejection sensitivity was related to a range of BPD and ED symptoms.

TABLE 3 Correlations among modeled variables

	1	2	3	4	5	6	7	8	9
1. Rejection sensitivity	–								
2. Theory of mind	−.05	–							
3. Emotion recognition	−.05	.42***	–						
4. Emotion dysregulation	.55***	−.12**	−.10**	–					
5. Attachment avoidance	.35***	−.17***	−.09*	.44***	–				
6. Attachment anxiety	.50***	−.04	−.01	.49***	.37***	–			
7. Drive for thinness	.44***	−.06	−.07	.49***	.23***	.33***	–		
8. Bulimic symptoms	.37***	−.06	−.11**	.53***	.28***	.31***	.61***	–	
9. Body dissatisfaction	.48***	−.02	−.03	.53***	.33***	.39***	.75***	.57***	–
10. Impulsivity	.20***	−.11**	−.12**	.41***	.28***	.24***	.29***	.41***	.32***
11. Affective instability	.43***	−.07	−.08*	.68***	.27***	.47***	.41***	.39***	.44***
12. Abandonment	.52***	−.11**	−.09*	.58***	.29***	.53***	.35***	.36***	.38***
13. Relationships	.43***	−.05	−.09*	.51***	.34***	.46***	.27***	.34***	.30***
14. Self-image	.54***	−.01	−.05	.68***	.37***	.52***	.50***	.43***	.56***
15. Suicide/self-mutilation	.47***	.00	−.01	.50***	.27***	.33***	.39***	.37***	.40***
16. Emptiness	.51***	−.03	−.06	.67***	.39***	.53***	.41***	.40***	.51***
17. Intense anger	.33***	−.12**	−.11**	.56***	.23***	.35***	.26***	.31***	.32***
18. Quasi-psychotic states	.25***	−.25***	−.23***	.33***	.19***	.29***	.26***	.27***	.22***
	10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	
10. Impulsivity	–								
11. Affective instability	.36***	–							
12. Abandonment	.36***	.53***	–						
13. Relationships	.33***	.47***	.69***	–					
14. Self-image	.29***	.59***	.55***	.49***	–				
15. Suicide/self-mutilation	.38***	.47***	.49***	.39***	.46***	–			
16. Emptiness	.35***	.64***	.61***	.54***	.81***	.46***	–		
17. Intense anger	.39***	.61***	.45***	.49***	.42***	.35***	.46***	–	
18. Quasi-psychotic states	.29***	.35***	.40***	.32***	.28***	.22***	.35***	.30***	

Notes: Variables 1–4, socio-emotional processing constructs; variables 5–6, attachment; variables 7–9 eating disorder symptoms; variables 10–18, BPD symptoms.

Abbreviation: BPD, borderline personality disorder.

*p < .05.
**p < .01.
***p < .001.

4 | DISCUSSION

The current study is the first of its kind to use network analysis to investigate the comorbidity of ED and BPD symptoms, and the possibility that these two symptom clusters are linked due to transdiagnostic features common to both conditions, including insecure attachment (anxious and avoidant), emotion dysregulation, ToM, emotion recognition, and RS. The results offer partial support for our initial hypotheses, indicating that symptoms of ED and BPD correlated well with each other in the initial correlation analyses, but not all of the proposed transdiagnostic features were supported by the network analysis.
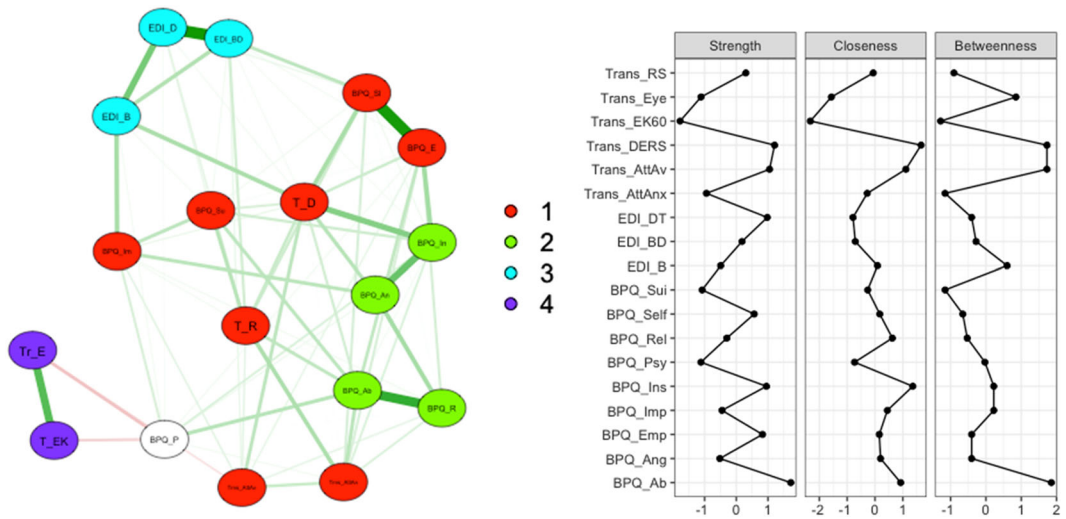
FIGURE 1 Network representation (left panel) and corresponding centrality plot (right panel). Abbreviations for left panel: Nodes/elements represent BPQ, borderline personality questionnaire; BPQ_AB, abandonment; BPQ_AN, intense anger; BPQ_E, emptiness; BPQ_IM, impulsivity; BPQ_P, quasi-psychotic states; BPQ_INaffective instability; BPQ_R, relationships; BPQ_SE, self-image; BPQ_SU, suicide/self-mutilation; EDI, eating disorder inventory; EDI_B, bulimia; EDI_BD, body dissatisfaction; EDI_D, drive for thinness; T_AttAnx, attachment anxiety; T_AttAv, attachment avoidance; T_D, emotion dysregulation; T_EK6, emotion recognition; Tr_E, theory of mind; T_R, rejection sensitivity. Abbreviations for right panel: Nodes/elements represent BPQ_Ab, abandonment; BPQ_Ang, intense anger; BPQ_Emp, emptiness; BPQ_Imp, impulsivity; BPQ_Ins, affective instability; BPQ_Psy, quasi-psychotic states; BPQ_Rel, relationships; BPQ_Self, self-image; BPQ_Sui, suicide/self-mutilation; EDI_B, bulimia; EDI_BD, body dissatisfaction; EDI_DT, drive for thinness; Trans_AttAnx, attachment anxiety; Trans_AttAv, attachment avoidance; Trans_DERS, emotion dysregulation; Trans_Eye, theory of mind; Trans_EK60, emotion recognition; Trans_RS, rejection sensitivity [Color figure can be viewed at wileyonlinelibrary.com]

Network analyses indicated that there was limited support for the hypothesized link between BPD and ED symptomatology through transdiagnostic variables. Of the transdiagnostic variables, emotion dysregulation showed the highest indices in strength, closeness, and betweenness, suggesting that this variable, was the most important one in maintaining the correlational connectivity of the network. Abandonment, a subscale of the BPQ measure, and therefore a central feature of BPD, also revealed high centrality indices and strong connections with the BPQ rejection subscale.

Overall, the current findings may be seen as a transdiagnostic risk model for the development of ED and/or BPD symptoms, where the shared underlying factors of emotion dysregulation and abandonment, may predispose individuals to develop symptoms for either disorder. These findings are in line with previous research that has shown emotion dysregulation (e.g., Daros & Williams, 2019; Selby et al., 2010) and abandonment (e.g., Al-Salom & Boylan, 2019; De Paoli, Fuller-Tyszkiewicz, & Krug, 2017) to be key predisposing and maintaining factors for ED and BPD symptoms. Interestingly, a new study by Al-Salom and Boylan (2019) found abandonment to fully mediate the relationship between BPD traits and eating pathology, highlighting its importance in explaining the relationship of both problem sets.

In terms of emotion dysregulation, it has been suggested that a function of disordered eating may be to regulate emotions by focusing on eating, weight, and body shape, when more effective coping strategies are unavailable (Ambwani & Morey, 2015). Conversely, in BPD, emotion dysregulation, often considered a core feature of the illness, has generally been observed in the areas of interpersonal relationships, behavior, identity, and cognition (Daros & Williams, 2019). Research has also shown that BPD individuals are emotionally sensitive from birth (Carpenter & Trull, 2013).

In the current study, the DERS total score was used to assess trait-level perceived emotion regulation ability (Gratz & Roemer, 2004). However, given the complexity of emotion regulation, it is not surprising to see that there has been considerable variation as regards how this umbrella term has been studied (Carpenter & Trull, 2013). While some researchers have focused on emotion sensitivity, others have looked at affective intensity, and yet others have assessed emotional vulnerability (Daros & Williams, 2019). One way to comprehend these different approaches better is to regard emotion dysregulation not as a final product, but more of a progression of various interactive and reinforcing factors (Werner & Gross, 2010). The current investigation did not look at the DERS subscales, to preserve model parsimony and because there have been inconsistent findings regarding the factor structure of the DERS (e.g., Fowler et al., 2014). Further research may, therefore, include more in-depth analyses of emotion regulation within the current framework, using psychometrically sound measures of emotion dysregulation.

As regards the abandonment factor, it seems plausible that abandonment leaves individuals feeling insecure, trivial and uncertain of how their necessities are going to be met. This is likely to leave a hallmark for a person's mental health, and thus might increase the likelihood of suffering from a range of psychological problems, not just BPD symptoms, but also eating pathology. In line with previous research (e.g., Al-Salom & Boylan, 2019), in the current network, the BPD symptom of rejection was found to be closely linked to abandonment, indicating that these two BPD symptoms commonly co-occur. However, the two attachment variables (anxious/avoidant), which have theoretically been implicated to abandonment and RS (Bowlby, 1973), were found to be less important in the current network. Further network research would benefit from analyzing exactly how attachment, abandonment, and RS relate to ED and BPD symptoms.

Contrary to expectations, ToM and emotion recognition had very few connections with any of the other transdiagnostic variables in the network analysis and also showed inconsistent relationships with ED and BPD symptoms in the correlational context. This finding is in line with previous research (e.g., Brewer, Cook, Cardi, Treasure, & Bird, 2015; McMahon, Kim, Fang, Neacsiu, & Rosenthal, 2019), that has also found inconsistent findings regarding the relationship between emotion recognition, ToM, eating pathology and BPD symptoms, but contradicts other research supporting such associations (e.g., Cooke et al., 2016; Oldershaw et al., 2010). It is possible that the lower Cronbach's α values for the ToM ($\alpha = .64$) and emotion recognition ($\alpha = .74$) variables might have partially accounted for these findings. Nevertheless, these values were within acceptable values. Future research is therefore needed to disentangle these inconsistent findings.

4.1 | Limitations

The results from the current study should be considered in the context of several study limitations. First, due to the cross-sectional and correlational nature of the analyses, the present findings do not establish causality. Future research should consider the use of longitudinal data to further examine the mechanisms leading to ED and BPD symptoms. Second, despite attempting to incorporate various transdiagnostic features of both disorders, the model may not have fully captured the socio-emotional processing of individuals with ED and/or BPD symptoms. Future research may consider the further development of the proposed model to include other related constructs (i.e., alexithymia; the inability to recognize or describe one's own emotions (Brewer et al., 2019). Third, the current study used a combined sample approach of a community and ED sample but did not recruit a separate clinical BPD sample. This might have caused insufficient spread for the BPD symptoms. It should be acknowledged though that both ED and BPD symptoms are common in normal populations and BPD and ED symptoms frequently co-occur (Farstad et al., 2016). Fourth, the ED diagnoses were derived from both self and clinician reports, which might have caused some variations in the reliability of the derived ED diagnoses. Finally, a third of the patients with ED were in a recovered state, which might have impacted the results further. However, most of the transdiagnostic features included in the current study, are considered endophenotypes and have been found to be present even after

recovery from an ED (e.g., Harrison et al., 2010). Upcoming research should try and replicate the current findings in a large sample of clinical patients with ED and BPD to assess whether the pattern of results generalize across ED subtypes and/or are dependent on whether the patients are currently ill or recovered.

4.2 | Clinical implications

The findings from the current network analysis provide useful information for targeting specific transdiagnostic factors shared between ED and BPD symptoms to help prevent and reduce comorbid symptoms of both problem sets and the negative outcomes related to this co-occurrence. Knowledge of the interrelationships between ED and BPD symptoms may also contribute to improved clinical decision-making regarding psychological treatment. The current findings highlight the importance of emotion dysregulation and abandonment in the co-occurrence of BPD and ED symptoms. This might indicate that individuals suffering from both problem sets may benefit particularly from treatments that focus on emotion regulation strategies and interpersonal strategies that might target fear of abandonment and rejection. Examples of such treatments are dialectical behavioral therapy (DBT; Linehan, 1987), interpersonal therapy (Rieger et al., 2010), and emotion regulation training programs (Berking, Ebert, Cuijpers, & Hofmann, 2013). Therapeutic interventions aimed at correcting cognitive bias towards negative social cues (Cardi et al., 2019), particularly sensitivity to rejection and possibly also fear of abandonment, may also prove helpful for individuals with EDs and/or BPD symptoms.

4.3 | Conclusion

In conclusion, the current study used network analyses to visualize the direct and indirect associations among transdiagnostic variables involved in BPD and ED symptomatology. The results suggest that emotion dysregulation and abandonment appear to be the most central elements in maintaining the correlational connectivity between ED and BPD symptoms. Future research may consider the further development of the proposed model by including other relevant transdiagnostic factors to gain further understanding of the shared difficulties for individuals suffering from ED and BPD symptoms. Such an approach might also inform prevention and treatments targeting interpersonal and emotional functioning for those presenting with ED and BPD symptoms.

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