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Research Paper

A network model of borderline personality traits, aggression, and self-harm

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Background: Cluster B personality disorders (PDs), which include borderline, antisocial, histrionic, and narcissistic PD, are characterized by impulsivity, emotionality, and dramatic behavior. Cluster B PDs are therefore associated with increased aggression, suicidal behavior, and non-suicidal self-injury. However, estimates of the associations between PD dimensions and these behaviors can potentially differ for men and women.
Method: A network analysis was used to examine relations between Cluster B PD dimensions, gender, and self-harm and aggressive behavior. In the current study, a community sample of 197 individuals (98 women) completed a self-report measure of PD dimensions and measures of aggression and self-harm.
Results: Results indicated that borderline personality disorder (BPD) traits play a central role in the nexus between Cluster B symptoms and self-injurious behavior and aggression towards others. Gender was not related to any nodes in the model. Network estimates suggest stable associations between variables.
Limitations: Limitations worth noting are the exclusion of individuals with a past year suicide attempt to minimize risk associated with alcohol administration, as well as the individuals who self-select into an alcohol administration study.
Conclusions: Given the overlap and comorbidity among Cluster B PDs, there results support the notion that that BPD plays a unique role in the expression of aggression, as well as self-harm.

1. Introduction

Cluster B pesonality disorders (PDs) are characterized by impulsive, emotional, and dramatic behaviors, and include antisocial, borderline, histrionic, and narcissistic PD (American Psychiatric Association, 2013). Cluster B PDs are associated with a greater risk of death by suicide. The majority of studies on suicide and personality disorders focus on borderline PD, antisocial PD, and narcissitic PD (Pompili et al., 2004).

Borderline PD is characterized by impulsivity, mood instability, and problems with relationships (American Psychiatric Association, 2013). Borderline PD is a prevalent disorder among psychiatric inpatient and outpatient populations (Ellison et al., 2018).Robust research has linked borderline PD with increased self-harm behaviors, including suicide, suicide attempts, and non-suicidal self-injury (NSSI) (Beautrais et al., 1996; Black et al., 2004; Brickman et al., 2014). In a longitudinal study of personality disorders and suicide risk, borderline personality disorder is a significant risk factor of ever attempting suicide (Ansell et al., 2015). In a community population, self harm was moderately realted to antisocial and histrionic PD (Casillas and Clark, 2002). Antisocial PD is associated with a significant risk for suicide attempts. Having comorbid psychiatric conditions also increased risk for suicide attempts (Beautrais et al., 1996). Cluster B PDs are also associated with increased anger and aggression (Genovese et al., 2017; Posternak and Zimmerman, 2002).

Gender patterns in PD diagnosis have the potential to impact associations between PDs, aggression, and self-harm. Although at one time it was believed that borderline PD and histrionic PD predominantly affected women, and ASPD predominantly affected men, more recent research suggests that much of these apparent differences may be influenced by gender differences in treatment seeking and rater bias (Jane et al., 2007). However, men with BPD did evidence more externalizing comorbid disorders (e.g., substance use, conduct disorder) while women evidenced more internalizing disorders, consistent with gender patterns in comorbidity generally (Kramer et al., 2008; Sansone and Sansone, 2011).

Although PD diagnostic criteria treat PDs as discrete entities, evidence from taxometric and other research suggests that these disorders

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show dimensional rather than categorical latent structure and the latest edition of the DSM has included a hybrid model of personality disorders to reflect this more recent concepualization of PDs as extreme representations of personality traits (American Psychiatric Association, 2013; Arntz et al., 2009; Marcus et al., 2006; Rothschild et al., 2003; Turner et al., 2018). The current edition of the DSM includes categorical models, which retains clustering of specific disorders, and the hybrid model which focuses on personality functioning and pathological personality traits. This research has implications in understanding the relation between aggression and self-aggression on disorders that are thought to co-occur to describe a discrete group of impulsive, emotional, and dramatic pathological personalities.

Recent advances in statistical techniques may provide a unique opportunity to explore the unique dimensions of different PDs, as well as areas where they might overlap. Network theories of psychopathology may be more consistent with dimensional conceptualizations of PDs than other classifcation methods. Network theories posit that it is the interaction of symptoms with each other that constitutes psychological disorders, and moves away from viewing psychiatric disorders as having a "central disease mechanism" (Borsboom, 2017). Psychopathology conceptualization is complex as disorders and their symptoms have overlapping biological, psychological, and sociocultural underpinnings. Network models allow for moving away from reductionism and provide a simple or "lower bound" model in understanding the multifacted nature of disorders (Borsboom et al., 2019). Drawing from network theories, network analysis can be used to examine the associations among PD traits and the behaviors associated with them using a partial correlations. Network models may also be useful in clinical applications, as specific symptom clusters can be identified and targeted interventions can be developed (Knefel et al., 2016).

In a partial correlation network, constructs of interest are represented as individual nodes, which are connected to each other through edges. The value of each edge obtained from a covariance matrix that is calculated by examining the pairwise interaction of two nodes (e.g., Node A →B and Node B → Node A) while controlling for all of the other nodes in the network. For example, in a network comprised of four nodes: A, B, C, and D, the edge between Node A and Node B would be a combination of the A →B, B →A, controlling for the effects of Node C and Node D. This statistcal method may be particularly helpful when examining PD symptomotology, as it is able to account for the significant overlap among symptoms of different disorders through the use of partial correlations, and is able to calculate a network that shows the unique interactions of each node in the network with the other nodes.

Network analyses have already been proven to be beneficial in PD research through the examination of constructs related to borderline personality disorder. For example, network analysis was used to examince specific relations between BPD features and early maladaptive schemas rather than examine BPD features as a whole (Esmaeilian et al., 2019). Network models have also been used to examine the structure of BPD in high-BPD and non-BPD participants. Differences in feature relationships were found in those that would likley meet diagnostic critera for BPD versus those that would likely be below the diagnostic threshold (Southward and Cheavens, 2018). This suggests that major symptom features, such as emotional dysregulation, may be a central feature across BPD severity; whereas impulsivity and lonelieness may be more central for those high in BPD features and identity disturbance and socialization difficulties are central to those that are below the diagnostic threshold. Traits underlying pathological narcissim have also been examined using a network model. Grandiose fantasies, entitlement rage, and contingent self-esteem were found to be central traits in pathological narcissim (Di Pierro et al., 2019).

The goal of the current study was to examine the associations among Cluster B traits, aggression, and self-harm behaviors in a community sample. We used network analysis to identify the unique and overlapping associations between PD traits, aggressive behaviors, and self-harm behaviors. We hypothesized, broadly, that positive associations would exist between BPD and deliberate self-harm across the spectrum of lethality, as well as aggressive behavior. We further predicted associations between antisocial and narcissistic PD traits and aggression and self-harm behaviors. Because of past work indicating gender differences among PD diagnoses (Skodol and Bender, 2003; Jane et al., 2007), and prior work specifically calling for gender to be examined within a network model of Cluster B traits (Southward and Cheavens, 2018), gender was included as a node, allowing us to explore its associations with Cluster B dimensions and their associated behaviors.

2. Method

2.1. Participants

Variables of interest were retrieved from an existing data-set from a previously published paper exploring the role of experimentally manipulated alcohol on deliberate self-harm (Berman et al., 2017). Participants were recruited from the community ($N = 197$; 98 women, 21-54 years old) for a study on "the effects of alcohol on motor skills". Potential participants were excluded if they had a suicide attempt in the past year or a current mood or psychotic disorder. Self-identified race/ethnicity of the sample was 65.2% Caucasian, 23.9% African American, 4.0% Hispanic, and 6.9% identified as "Other."

Participants were community volunteers who completed a self-report assessment of PD syptoms to yield a dimensional PD score for each Cluster B PD. This sampling and assessment approach mitigates sampling biases that may be present in clinical samples. Additionally, the use of non-clinical samples is particularly important in network analysis to avoid issues associated with Berkson's Bias, which can lead to the presence of spurious negative edges (de Ron et al., 2019)

2.2. Measures

Schedule for Nonadaptive and Adaptive Personality – 2 (SNAP-2; Clark et al., 2009). The SNAP was published in 1993 as a result of content- and factor- analytic studies of personality pathology. The first edition included 375 true-false items which produced 12 trait dimension scales, three temperament dimension scales, six validity indicators, and diagnostic scales corresponding to DSM-III-R personality disorder criteria (Clark et al., 1993). The SNAP. The SNAP-2 was developed to assess traits associated with personality disorder criteria as outlined in the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) and included updated norms to reflect representative sampling of the United States population (Clark et al., 2014). The second edition retained the items of the trait and temperament scales and a new validity scale was added, bringing the second edition to 390 items.

In the current study the diagnostic scales were examined. The variables examined were Antisocial PD (ANT), Borderline PD (BDL), Histrionic PD (HIS), and Narcissistic PD (NAR). The SNAP diagnostic scales are reported to have good internal consistency and convergent validity with other psychometrically sound instruments measuring personality pathology, such as the International Personality Disorder Examination (Wolf et al., 2011).

Deliberate Self-harm Inventory (DSHI; (Gratz, 2001)). The DSHI is a 17-item questionnaire that assesses frequency, severity, duration, and type of deliberate self-harm (NSSI) (Gratz, 2001). The DSHI is a behavioral measure, which allows researchers to know precise behaviors being measured. Psychometric characteristics of the inventory suggest adequate reliability and validity in student (Gratz, 2001) as well as clinical and community samples (Latimer et al., 2013). The DSHI was used in the current study to measure frequency of deliberate self-harm behaviors.

Life History of Aggression (LHA, (Coccaro et al., 1997)). The LHA is a self-report measure that includes a five-item aggression scale (LHA AGG) and a two-item self-injurious behavior scale (LHA SIB). The LHA SIB scale items measure number of suicide attempts and number of

non-suicidal self-injurious acts. The LHA also includes a four-item antisocial behavior subscale which measures history of school discipline problems, problems with work supervisors, antisocial behaviors not involving police (e.g. lying, stealing, DUI), and antisocial behaviors involving the police (e.g. warnings, arrests, convictions). Items on the LHA are rated as the number of occurrences since age 13, thusly: 0 = *no events*, 1 = *1 event*, 2 = *2-3 events*, 3 = *4-9 events*, 4 = *10+ events*, 5 = *so many events that they can't be counted*. Psychometric evaluation indicates the LHA is a reliable and valid measure in clinical and non-clinical populations (Coccaro et al., 1997).

2.3. Procedure

After obtaining informed consent, the participant completed a battery of questionnaires, including the SNAP, DSHI, and LHA. All measures were computer-administered.

2.4. Data Analytic Plan

Network analysis was used to examine the relationships among variables in our study. In network models, each variable is represented as a single node, which is connected to other nodes by edges. The thickness of an edge represents the strength of the relationship between two nodes, with thicker lines representing stronger relationships.

All analyses were completed using R, version 3.6.2. For this network model we evaluated 9 potential nodes: Traits (Antisocial, Borderline, Histrionic, and Narcissistic), gender, instances of deliberate self-harm (DSHI), LHA-Aggression (LHA-AGG), LHA- Self-injurious behavior (LHA-SIB), and LHA- Consequences/Antisocial (LHA-ANTI). Missing data were handled via listwise deletion. Sociodemograpic covariate data such as ethnicity, socio-economic status, and mental health treatment history were not included in the model in order to preserve power (a model would include these covariates as separate nodes in the network).

Node Selection. The goldbricker function from the package *networktools* was used to minimize redundant nodes (Jones, 2017). The Hittner method was used to examine correlations between variables (Hittner et al., 2003). Within the goldbricker function, the Hittner method stipulated that any nodes that have less than 25% unique correlations with other nodes and have a correlation of at least 0.5 would be considered redundant, which are the default values of this function and have been used in previous psychopathology networks (Bernstein et al., 2019)

Network Estimation. Mixed graphical modeling (MGM) was used to estimate relationships between continuous (traits), interval (history of aggression) and categorical (gender) variables in the model. The mgm function from the *mgm* package was used to estimate the model (Haslbeck and Waldorp, 2020). Within the mgm function, we used the Extended Bayesian Information Criteria (EBIC) to select the tuning parameters used in the network. Using the EBIC helps to reduce the likelihood of potentially spurious edges in the network(Foygel and Drton, 2010). We used the qgraph function from the *qgraph* package to visualize the network (Epskamp et al., 2012). The *resample* function from the mgm package was used to estimate bootstrapped distributions of the data and report summaries of sampling distribution edge parameters (Hesterberg, 2015). See Supplemental Materials section for *R* code used in the analyses and a description of steps taken in the analyses and parameter estimates.

3. Results

3.1. Descriptive Statistics

Means and standard deviations for personality traits, self-harm, and aggression variables are presented in Table 1.

Node Selection

Analyses revealed two sets of nodes to be redundant with each other. The first set of redundant nodes contained the narcissistic and histrionic traits subscales of the SNAP-2. These nodes were combined using the net_reduce function from the *networktools* package. The second set of redundant nodes contained the antisocial traits subscale of the SNAP-2 and the history of antisocial behaviors scale from the LHA. Because the ANT is a continuous scale and the LHA-ANTI scale is ordinal, it was unclear whether or not these two scales could reasonably be combined using the net_reduce function as one would with scales of the variable-type[1], and there was no prior work known to the authors to provide a precedent for doing so. Because these nodes were considered redundant and do not differentially relate to any of the other nodes in our network (using the values described previously), and there was not a precedent for combining the nodes, the LHA-ANTI scale was removed from future analyses (i.e. the mixed graphical model).

Table 1
Means and Standard Deviations of Variables

Variable	*M*	*SD*
ANT	50.76	9.86
BDL	51.52	9.91
HIST	53.26	11.24
NAR	54.75	10.65
DSHI	.47	1.40
LHA_SIB	.39	1.13
LHA_AGG	10.12	4.48

Mixed Graphical Model

Figure 1 illustrates the estimated network. Green lines indicate positive associations between nodes. The thickness of lines between relationships indicates the magnitude of partial correlations. Gender was not connected to any other nodes in the network. Additionally, antisocial traits were not directly connected to any nodes representing a history of aggressive behaviors; rather, the node representing antisocial traits was only associated with the node representing borderline traits, which then connected to aggressive behaviors. See Table 2 for edge weights.

Stability of edges was calculated using the resample function of the *mgm* package. This analysis showed that, in 500 bootstrapped samples, the overall stability of the network was adequate. See supplementary materials for results of the stability analysis.

4. Discussion

Results of our network analysis showed that borderline traits were directly associated with antisocial traits, narcissistic and histrionic traits, severe self-injurious behavior, and aggression towards others. Additionally, borderline traits were essential in linking antisocial traits to aggressive behaviors. This may be due to the relevance of impulsivity and emotion dysregulation associated with BPD. Previous research indicates that aggressive behavior is related to negative affectivity, which suggests that emotion dysregulation is related to aggression in antisocial behavior (Burt and Donnellan, 2008). Borderline traits were only indirectly associated with frequency of NSSI behaviors as measured by the DSHI. However, borderline traits were directly related to self-harm as assessed by the LHA SIB subscale which includes an item on suicide attempts, whereas the DSHI does not assess suicidality.

Gender was not directly related to any other nodes in the network. Importantly, this does not mean that gender is not correlated with any nodes in the network. Because we used a partial correlation network, the relationship between any two nodes in the network also controls for all of the other nodes in the network. What this means is that there are not any *unique* relationships between gender and any of the nodes in the

[1] To be clear, one *can* combine them using the function, but it is unclear whether one *should*, considering the different variables types and lack of precedent for doing so in the literature.

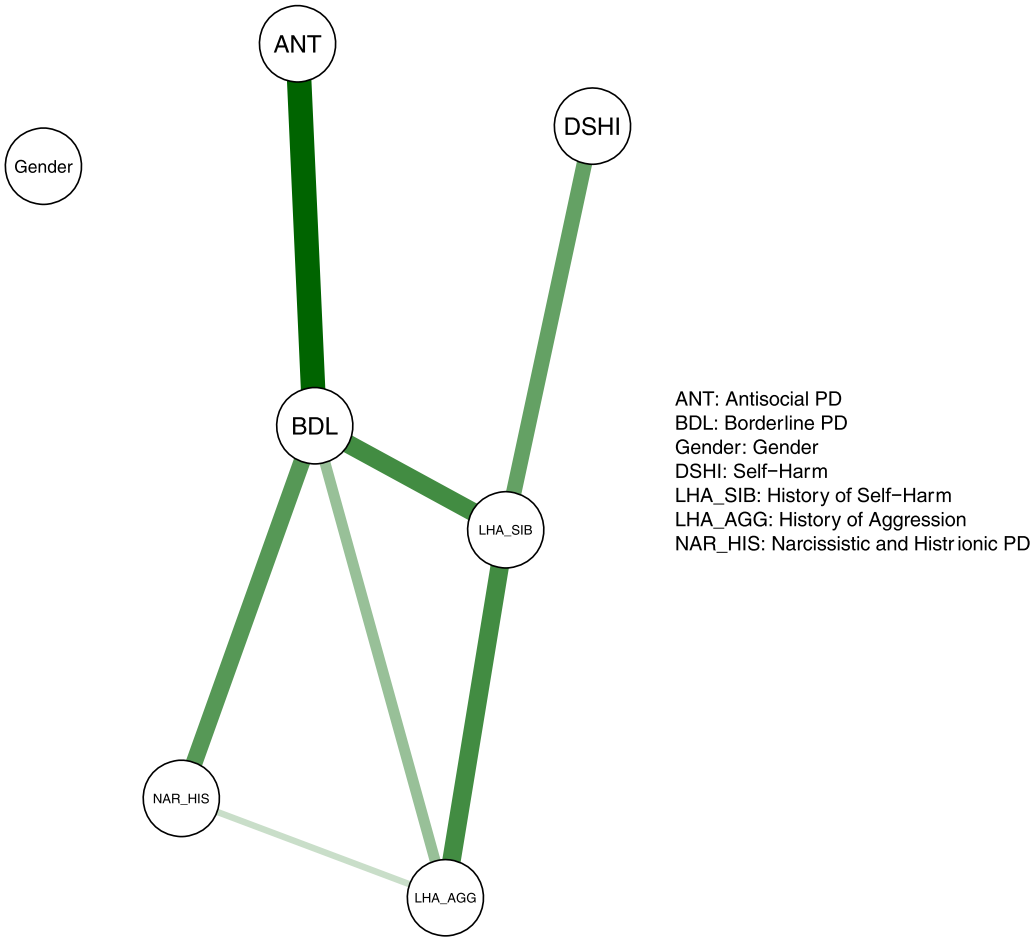

Figure 1. Partial correlation network of Cluster B Traits. Green lines indicate positive associations; thicker edges indicate stronger relationships between nodes.

Table 2
Edge Weights

Edge	Weight
TASP – TBDL	0.43
TBDL – LHA_SIB	0.32
TBDL – LHA_AGG	0.17
TBDL – NAR_HIS	0.28
DSHI – LHA_SIB	0.26
LHA_SIB – LHA_AGG	0.32
NAR_HIS – LHA-AGG	0.09

Note. Edge weights for all of the nonzero edges in the network.

network that cannot be accounted for by the other nodes in the network. The analyses may have been underpowered to detect gender associations as the use of LASSO regularization favors specificity; we are confident that the edges in the model are true, but it comes at the cost of sensitivity of the model.

Another interesting finding in the study is redundancy of the histrionic traits and narcissistic traits nodes in the network model. This suggests collinearity between the two constructs with respect to their associations with the other nodes in the network. This may be related to poor construct validity for histrionic personality disorder, which is highly comorbid with borderline and narcissistic personality disorders (Bakkevig and Karterud, 2010).

A limitation of the current study includes the observation that the power analysis originally conducted was focused on detecting alcohol administration effects on outcome variables not related to this current analyses. However, confidence intervals obtained in the bootstrapping estimates indicated a stable network model. Given that the data set involved community participants, biases related to treatment-seeking self-selection or gender biases related to clinician ascertainment were not applicable. However, the exclusion of individuals with a past year suicide attempt to minimize risk associated with alcohol administration, as well as the individuals who self-select into an alcohol administration study, are limitations worth noting. The sample size may also be a limitation of the current study; however, given the number of nodes in model the estimations are stable. The measures of aggressive behavior and self-harm in the current study rely on self-report data, inclusion of clinician ratings, laboratory measures, and medical chart review may be useful to obtain collateral information on these behaviors in future studies. The current study is cross-sectional, and we are unable to examine the dynamic relationships among Cluster B traits and aggressive behaviors overtime. Thus future studies may benefit from longitudinal investigation.

Areas of future research include: (a) determining if this pattern of results holds in larger samples that include patient samples, (b) if similar results hold for both diagnostic and dimensional assessments, and (c) if the observed patterns hold when including a wider network of disorders.

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Author Contributions

R.K.N. wrote the manuscript and analyzed the data. A. N. S. L.

contributed to the methods section and helped with data analysis coding. J.R.F contributed to the introduction and discussion sections. M.S. M. contributed to the introduction, methods, and discussion sections. E. S.W. provided edits to the manuscript and provided guidance on writing about network analysis. M.E.B. provided edits to the manuscript and his lab conducted the research project.

Declaration of Competing Interest

The authors declare that there is no conflict of interest regarding this publication.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jadr.2022.100330.

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