Network Structure of Callous-Unemotional Traits and Conduct Disorder Symptoms Among At-Risk Youth: Multi-Informant Reports and Gender Differences

Natalie Goulter[1] · Marlene M. Moretti[1]

Abstract

Network analytic techniques examine how items used to measure underlying constructs are related to one another and identify core characteristics. While many studies have examined the covariance of callous-unemotional (CU) traits or features and conduct disorder (CD) symptoms, the inter-item relations of these constructs and the core characteristics of the CU construct are unclear. The present study aimed to examine the network connectivity of, and between, CU features and CD symptoms. We also examined both parent-reports and youth self-reports and gender differences. CU features and CD symptoms were rated by parents ($n = 814$; 74% mothers; age 23–73, M age $= 43.86$, $SD = 8.13$) and their child ($n = 608$; 57% female; age 7–19, M age $= 13.98$, $SD = 2.36$). Network plots depicted greater connectivity (i.e., density and weights) for CU features relative to CD symptoms across both informants. However, youth-reported CU features and CD symptoms were less densely connected than parent-reports. Items commonly comprising the callousness subscale were more central and linked the two constructs together, relative to uncaring items, across informant and gender. Gender related effects indicated lower centrality for male versus female youth, and this finding was particularly evident in youth-reports. Our findings highlight relations between CU features and CD symptoms, and point to the importance of callousness items in conceptualizations of CU features among high-risk youth from both the perspective of the parent and child. We also inform understanding of gender differences in CU features for which the literature is currently limited.

Keywords Network structure · Callous-unemotional traits · Conduct disorder symptoms · Multi-informant · Gender

A core theoretical and statistical framework in the field of psychopathology is that psychopathological constructs can be represented by latent factors underpinned by shared features or symptoms—known as a latent factor or latent variable model. Factor analytic techniques identify *which* symptoms, or items, may be related to each other based on shared variance identifying overarching latent factors. While a latent factor may exist, the a priori assumption that one will be identified is not always theoretically and empirically supported (Borsboom & Cramer, 2013). Factor analyses also do not clarify how symptoms are related to one another. Another approach for understanding the relations between symptoms of a construct is *network theory*. Network theory posits that associations between symptoms characterize the disorder itself (Borsboom & Cramer, 2013). Network analytic techniques examine *how* symptoms, or items, are related to one another identifying the core characteristics of a construct. This approach also assumes symptoms are mutually interacting and reinforcing elements of the broader construct—perhaps a more accurate representation of complex psychopathology. Using a network approach, items of a construct are plotted as *nodes* and the inter-item relations as *edges*. The stronger the association between nodes, the larger the *weight* of their edges (displayed as width and saturation of color). This type of modeling also provides indicators of centrality, describing which items are most central to a given construct. Centrality can be assessed by *strength,* which is the sum of correlations between a node and other nodes; *closeness,* which is the distance between a node and other nodes; and *betweenness,* which is the count of a node being the shortest path between two other nodes (Costantini et al., 2015).

✉ Natalie Goulter
  ngoulter@sfu.ca

[1] Department of Psychology, Simon Fraser University, Vancouver, Canada

The use of network approaches in the field of psychopathology has only emerged in the past decade; however, they have now been applied to a few psychopathological constructs, including anxiety (Beard et al., 2016), depression (Burger et al., 2020), posttraumatic stress (Fried et al., 2018), psychosis (Murphy et al., 2018), substance use (Rhemtulla et al., 2016), and psychopathy (Preszler et al., 2018; Veschuere et al., 2018). These studies help to identify which items are core characteristics for a given construct and how items within these constructs may be related to one another. In doing so, studies using network analytic approaches may further inform theoretical models in the field of psychopathology. One construct yet to be examined through a network approach is conduct disorder (CD), and particularly the relation of CD symptoms to callous-unemotional (CU) traits or features. This is an important limitation given the recent addition of the 'with limited prosocial emotions' specifier to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) CD criteria (American Psychiatric Association [APA], 2013).

Callous-Unemotional Features and Conduct Disorder

Conduct problems (e.g., aggression, destructiveness) during childhood and adolescence represent a broad range of behaviors that vary significantly in form and severity (Kimonis et al., 2014). They also mark heightened risk for criminality and mental and physical health problems throughout the life-course (Goulter et al., 2020; Moffitt, 2018; Odgers et al., 2008). Thus, understanding conduct problems in childhood and adolescence has important implications for intervention development. Given the extensive heterogeneity in the presentation and clustering of these behaviors, there have been attempts to identify subtypes. One approach was the addition of a specifier to the CD criteria in the most recent DSM-5 (APA, 2013). This specifier labelled as 'with limited prosocial emotions', describes children and adolescents who display a lack of remorse or guilt, a callous lack of empathy, shallow or deficient affect, and reduced concern with regards to performance at school or work. In research settings, this specifier is more commonly described as CU traits or features, as they will be referred to hereafter. The addition of the CU specifier to the CD criteria, stemmed from a burgeoning body of work that found some children and adolescents showed distinct environmental, biological, and cognitive-emotional features, relative to other antisocial youth (Frick et al., 2014). For example, individuals scoring highly on measures of CU features show reduced amygdala activation while processing fearful expressions (Viding et al., 2012), reduced fear-potentiated startle (Fanti et al., 2016), and lower autonomic activity when viewing emotionally evocative scenes (de Wied et al., 2012), compared with their low CU counterparts. Further, youth reporting high levels of CU features are less accurate in recognizing others' distress cues (Kimonis et al., 2006), than those reporting low levels of CU features. It is theorized that this fearless temperament and emotional hyperreactivity may represent a unique factor that contributes to the development and maintenance of maladaptive conduct problems (Marsh & Blair, 2008).

Approximately 25% to 30% of children with conduct problems also show high levels of CU features (Frick et al., 2014). Many studies have now examined the covariance of CU features and CD symptoms. Indeed, research has implicated the presence of CU features in severe and persistent antisocial behaviors, relative to the presence of CD symptoms alone (Frick & White, 2008; Frick et al., 2005). While it is often found that children and adolescents with CU features also present with CD symptoms, not all youth with CD symptoms have CU features, and some studies indicate the presence of CU features in the absence of CD symptoms (Fanti, 2013; Frick et al., 2003a, b). However, what is currently unclear is the interconnectedness of specific CU features and CD symptoms. In network analytic approaches, symptoms that connect or increase risk of contagion are known as 'bridge symptoms' (Cramer et al., 2010). Given that theory and research suggest that CU features are a risk factor for conduct problems, examining associations (or bridge symptoms) between CU features and CD symptoms may provide greater insight into which CU features are linked to which CD behaviors.

Previous factor analytic studies of the 24-item *Inventory of Callous-Unemotional Traits* (ICU; Frick, 2004)—a commonly used informant and self-report assessment of CU features—have generally supported a three-factor bifactor structure, including an overarching CU factor and three independent dimensions: callousness, uncaring, and unemotional (Ray & Frick, 2018). The callousness factor is often strongly associated with external measures of aggression and violent delinquency, the uncaring factor more commonly correlates with measures of nonviolent delinquency, and the unemotional factor is less consistently associated with antisocial behavior but rather has shown to be associated with low levels of empathy (Cardinale & Marsh, 2017; Kimonis et al., 2008, 2013; Kimonis et al., 2016a, b;). However, it is important to note that recent meta-analytic results ($k = 12$) showed that the unit-weighted score of the ICU is predominantly supported by a general latent CU factor rather than the three-factor bifactor structure (Ray & Frick, 2018). The authors also argued that there is not a strong theoretical foundation for distinct dimensions, and these dimensions may, in part, be due to methodological artefacts. Only one study has examined the network structure of CU features. Bansal and colleagues (2020) examined the factor structure (i.e., confirmatory factor analysis) and network structure of

the ICU in a sample of preschool children (*M* age = 4.76). The authors identified 12 items loading on to two factors operationalized as callousness and uncaring, and four clusters of symptoms characterized as uncaring, lack of remorse, unconcerned, and callousness with items representing callousness demonstrating the highest centrality values. While this study provides an important initial contribution to understanding network connectivity of CU features, this study did not include symptoms of CD (nor examine gender differences), and so the connection between CU features and CD symptoms is currently unknown. This is an important limitation of the field given theory purporting that CU features may underpin severe conduct problems, the clinical significance of these two constructs (i.e., the CU specifier to the DSM-5 CD criteria), and the extensive research on the covariance of CU features and CD symptoms.

Parent-Reports Versus Youth Self-Reports

There are other important considerations for clinical and empirical work on CU features and CD symptoms, and here we note two. First, different patterns of co-occurring symptoms may emerge from parent-report versus child self-report information. A recent meta-analytic review found that clinical child (< 18 years) assessments produce low-to-moderate cross-informant correspondence ($r = 0.28$), with higher correspondence occurring for observable behaviors (e.g., externalizing vs. internalizing) or when the behaviors are within the same context (e.g., mother and father; De Los Reyes et al., 2015). In the case of CU features versus CD symptoms, it may be argued that cross-informant scores could be higher for CD symptoms than CU features given that CD comprises observable behaviors. It may also be more difficult for parents to report on CU features given these symptoms are related to emotion (or lack thereof), and thus, less easily visible. With regards to youth self-reporting on CU features, there may be issues of reluctance to disclose, lack of insight, and semantic aphasia (i.e., the ability of an individual to report on the absence of a symptom) (Sellbom et al., 2018). Alternatively, it may also be argued that youth are more knowledgeable and 'in tune' with their own emotions and behaviors. Indeed, research has found that the validity of self-report measures of CU features tends to increase in adolescence relative to childhood, whereas it decreases over this developmental period for parent- and other informant reports due to greater autonomy (Frick et al., 2010). Few studies have included both parent- and child or adolescent-reports of CU features. One study with community children (*M* age = 9.06 years), found higher correlations between parent-reports of CU features and CD symptoms, compared with child-reports (parent, $r = 0.36$, $p < 0.001$;

child, $r = 0.08$, $p = n.s$) (Gao & Zhang, 2016). While informative, this research employed a latent factor approach to examine these constructs, and it is currently unknown whether certain items are more important for conceptualizing CU features and CD symptoms from the perspective of the parent versus child.

Gender and Sex Differences

Second, another important consideration when examining CU features and CD symptoms are gender and sex differences. We note gender and sex here to incorporate both the role socio-cultural factors play through the lens of gender differences when examining and reporting behavior, and sex to underpin some biological findings of CU features. While some research supports greater prevalence of externalizing problems (including CD symptoms) among boys than girls who tend to report higher rates of internalizing and co-occurring psychopathology, others have shown that this evidence is less consistent than previously thought (Solomon & Herman, 2009; Zahn-Waxler et al., 2015). Research has also found gender differences in the form of aggression, such that girls tend to display more indirect over direct aggression (Marsee et al., 2005). With regards to the literature on CU features, the majority of studies include male samples or studies fail to differentiate gender or sex in analyses. Of research that has examined these features in female samples, they tend to not show core emotional deficits (e.g., attenuated emotion startle reflex) commonly identified in male populations (Justus & Finn, 2007; Vitale et al., 2011), and recent research has also found distinct neuroanatomical correlates of CU features in a sample of community male children versus female children (Raschle et al., 2018). In addition, boys tend to receive higher scores on measures of CU features than girls (Ciucci & Baroncelli, 2014; Fanti et al., 2009); however, evidence supports the clinical utility of the CU specifier in identifying a subgroup of girls with CU features and high levels of externalizing symptoms (Pardini et al., 2012). Differences may also be dependent on the informant. Past research has found poor intraclass correlation coefficients (ICC) for both adolescent boys and girls on CU features (boys, ICC = 0.02; girls, ICC = 0.02), but greater informant discrepancies for impulsivity (boys, ICC = 0.16; girls, ICC = 0.01) more strongly associated with CD symptoms (Barry et al., 2008). As previously noted, parent and youth agreement on CU features is generally low (and this includes across gender samples); however, these findings showed greater agreement on impulsive features for boys but not girls. Further research among girls may provide a clearer understanding of the phenotypic expression of CU features in these samples.

The Present Study

The present study aimed to examine the network connectivity of, and between, CU features and CD symptoms. In doing so, we aimed to inform current understanding of the core characteristics of these two constructs that commonly covary. The present study used well-validated measures of CU features (i.e., ICU; Frick, 2004) and CD symptoms (i.e., Brief Child and Family Phone Interview, BCFPI; Cunningham et al., 2000) to plot networks of symptoms and examine: (a) network structure; (b) indices of symptom centrality including strength and closeness; (c) bootstrapped significance of centrality; (d) within-sample stability; and (e) bridge centrality. Importantly, we also examined CU features and CD symptoms based on parent- and youth self-reports, and gender differences between male and female youth (using terminology consistent with our protocol). By examining the networks across these sources of information (i.e., parent-versus youth-reports, and male versus female youth), we are better equipped to provide a more nuanced understanding of the connectivity and core characteristics of CU features and CD symptoms.

Method

Participants and Procedure

Baseline data was used from participants in an implementation evaluation of an evidence-based manualized program to support parents of youth with serious behavioral and social-emotional problems ("Connect"; Moretti et al., 2017). Caregivers were referred by urban and rural community mental health agencies, schools, or hospitals due to concerns about serious mental health and behavioral problems in their child. Exclusion criteria were a diagnosis of psychosis, schizophrenia or other serious mental health disorder in the youth that impaired their ability to participate or those with low intellectual functioning (IQ < 70). The present study included biological parents and other caregivers ($n = 814$; 86% biological; 74% mothers; age 23–73, M age = 43.86, $SD = 8.13$) and their child ($n = 608$; 57% female; age 7–19, M age = 13.98, $SD = 2.36$). Among parents, 75% identified as White, 10% Indigenous (e.g., First Nations, Metis, Inuit, Other: Indigenous), 6% Asian, 4% were categorized as "Other" (e.g., infrequent responses) or Mixed identity, and 5% did not report information. Parent education (reported by $n = 753$) ranged from partial high school (9%), high school completion (18%), partial college/university (16%), college/university completion (46%), and post-graduate education (4%). Parents reported youth demographics: 64% as White,

14% Indigenous (e.g., First Nations, Metis, Inuit, Other: Indigenous), 5% Asian, 8% were categorized as "Other" (e.g., infrequent responses) or Mixed identity, and 8% did not report information. Parents provided informed consent and youth assent to participate in the program and for research publication before data collection. All research protocols and procedures received approval from the University Office of Research Ethics at Simon Fraser University.

Measures

Callous-Unemotional Features. A shortened 12-item version (Hawes et al., 2014) of the 24-item Inventory of Callous-Unemotional Traits (ICU; Frick, 2004) was used to assess parent- and youth self-reports of CU features. For the 24-item version, factor analytic studies mostly find support for a three-factor bifactor model including a general overarching CU factor and three independent dimensions (callousness, uncaring, unemotional; Kimonis et al., 2008). The 12-item version in the present study assessed callousness (7-items; e.g., '*my child does not care who they hurt to get what they want*'/'*I do not care who I hurt to get what I want*') and uncaring (5-items; e.g., '*my child feels bad or guilty when they have done something wrong*'/'*I feel bad or guilty when I do something wrong,*' reverse coded). Items are scored on a 4-point scale (0 '*not at all true*' to 3 '*definitely true*'). This abbreviated 12-item scale has shown good psychometric properties in clinical and normative samples (Hawes et al., 2014), among adolescent samples including girls (Colins et al., 2016), and across both parent- (Kimonis et al., 2016a, b; Ueno et al., 2019) and youth self-reports (Paiva-Salisbury et al., 2017; Thøgersen et al., 2020). The present study used 12-items for both parent- and youth self-reports, which demonstrated good internal consistency (parent: α = 0.89; youth: α = 0.80).

Conduct Disorder Symptoms. The Brief Child and Family Phone Interview (BCFPI; Cunningham et al., 2000) is a standardized tool that assesses problem behaviors among children and adolescents referred for mental health services (Cook et al., 2013). Factor analytic studies have identified six mental health subscales, with six items each, tapping different domains of functioning related to Diagnostic and Statistical Manual-IV (DSM-IV; APA, 1994) diagnoses, including; conduct disorder (CD; 6-items, e.g., '*steals things at home*'), attention-deficit/hyperactivity disorder (ADHD; 6-items, e.g., '*easily distracted*'), oppositional defiant disorder (ODD; 6-items, e.g., '*defiant, talks back to people*'), generalized anxiety disorder (GAD; 6-items, e.g., '*worries about past behavior*'), separation anxiety disorder (SAD; 6-items, e.g., '*worries about being separated*'), and major depressive disorder (MDD; 9-items, e.g., '*has no interest*

in usual activities'; Cunningham et al., 2009). The present study used items from the CD subscale. Parents and youth were asked to rate the frequency that their child/themselves engaged in each behavior during the past six months on a 3-point scale (1 '*never*' to 3 '*often*'). The BCFPI has shown good psychometric properties across both parent- (Vaillancourt et al., 2014) and youth self-reports (Yeung & Leadbeater, 2010; Yeung Thompson & Leadbeater, 2013. BCFPI CD subscales showed acceptable internal consistency based on parent-report (α = 0.71) and youth-report (α = 0.68).

Data Analyses

Items from the CU (i.e., ICU) and CD (i.e., BCFPI) scales are shown in Table 1. Here we also report corresponding abbreviations used throughout analyses. We have indicated which items loaded onto the Hawes et al. (2014) ICU subscales (i.e., callousness and uncaring) for ease of interpretation and discussion. In addition, five reverse coded items on the ICU that commonly comprise the uncaring dimension were recoded so all items were in the same direction for ease of interpretability.

Network Plots. The network structures of CU features and CD symptoms were constructed in R version 3.6.1 using R Studio (R Core Team, 2016). Items of the constructs are plotted as nodes and the inter-item relations as edges. In the present study, the nodes representing items of CU features and CD symptoms are depicted as gray and white, respectively. The weight, or correlation, between items are represented by the thickness and saturation of the edges. Our network analyses are graphically represented by zero-order correlations. While some studies construct networks using the partial-correlation Gaussian Models with the Least Absolute Shrinkage Operator (Epskamp et al., 2012), we selected zero-order correlations to examine both direct and indirect relations between items. This approach is in line with other research using similar constructs with high item covariance—by controlling for the variance with other items and examining only unique variance removes possible meaningful associations (Verschuere et al., 2018).

Centrality Indices. Using the *qgraph* package (Epskamp et al., 2012), we calculated two indices of centrality; namely, strength and closeness. Centrality provides important information with regards to items. Specifically, strength indicates the sum of correlations between a node and other nodes, and closeness indicates the distance between a node and other nodes (Costantini et al., 2015). One further centrality index; that is, betweenness (i.e., the count of a node being the shortest path between two other nodes), is also sometimes examined in network analyses. However, some have argued that this index is less stable than other centrality indices, and thus, we have used only centrality strength and closeness

Table 1 CU Features and CD Symptoms Items and Abbreviations

Abbreviation	Item Description	Subscale (Hawes et al., 2014)
CU Features		
Care	Does not care who I/they hurt to get what I/they want	Callousness
Guilt	Feels bad or guilty when I/they have done something wrong*	Uncaring
Emot	Does not show emotions	Callousness
Conc	Concerned about the feelings of others*	Uncaring
Trou	Does not care if I/they am/are in trouble	Callousness
Well	Does not care about doing things well	Callousness
Cold	Seems very cold and uncaring	Callousness
Apol	Apologizes to persons I/they have hurt*	Uncaring
Hurt	Tries not to hurt others' feelings*	Uncaring
Remo	Shows no remorse when I/they have done something wrong	Callousness
Feel	Feelings of others are unimportant	Callousness
Good	Does things to make others feel good*	Uncaring
CD Symptoms		
Stea	Steals things at home	-
Dest	Destroys things belonging to others	-
Vand	Engages in vandalism	-
Brok	Broken into house, building, or car	-
Phys	Physically attacks people	-
Weap	Uses weapons when fighting	-

*Indicates reverse coded items

given the poorer stability of this index and consistent with other research (Verschuere et al., 2018).

Centrality Differences. Using the *bootnet* package (Epskamp & Fried, 2015), we conducted bootstrapped difference tests on the centrality indices (i.e., strength and closeness) to examine whether there were significant differences in item centrality.

Within-Sample Stability. Also using the *bootnet* package (Epskamp & Fried, 2015), we estimated the stability of centrality strength and closeness. Stability refers to whether the network structure remains stable while removing participants from the analyses. These analyses also produce a correlation stability (CS) coefficient, which at 0.70 reflects the maximum number of participants that can be dropped to retain 95% probability between the calculated centrality and that of the subsets. The authors recommend that the CS should be above 0.50 and not below 0.25 (Epskamp et al., 2018).

Bridge Symptoms. Using the *networktools* package (Jones et al., 2017), we estimated bridge centrality, including bridge strength and closeness. Bridge strength indicates a node's connectivity with another syndrome, and bridge closeness indicates the distance between a node from one syndrome to all nodes of another syndrome (Jones et al., 2019).

Informant and Gender Differences. We conducted the above statistical analyses (i.e., network plots, centrality indices, centrality differences, within-sample stability, and bridge symptoms) for parent- and youth self-reports, and male and female youth. In line with other research (Verschuere et al., 2018), we focused on the relative, rather than absolute, differences in findings across these analyses to make conclusions with regards to replicability across informant and gender.

Results

Network Plots

Network plots are displayed in Fig. 1 (see online article for color version). The left column of the figure depicts parent-report of the full sample, the male sample, and the female sample; the right column displays youth-report of the full sample, the male sample, and the female sample. All further plots are presented in this order too.

Parent-Report

With regards to parent-report, CU features were strongly associated with each other as indicated by the densely connected nodes and high weight loadings of the edges (i.e., thickness and saturation of edges). This was particularly relevant for the five reverse-coded items that comprise the commonly identified uncaring dimension (i.e., '*feels bad or guilty when I/they have done something wrong*'; '*concerned about the feelings of others*'; '*apologizes to persons I/they have hurt*'; '*tries not to hurt others' feelings*'; '*does things to make others feel good*'). The callousness item '*does not show emotions*' was the least connected of CU features showing the lowest weights. A similar patterning of CU features was also identified for parent-report of male and female samples.

The connectivity between CD symptoms was less dense with lower edge weights; however, of note, '*destroys things belonging to others*' and '*engages in vandalism*' were connected to the majority of other CD symptoms and were represented by the greatest weights. These findings were replicated for the male sample, and to a lesser degree (i.e., lower edge weights) the female sample.

Youth-Report

With regards to youth-report, the items comprising the uncaring dimension were, similarly, most densely connected with the greatest edge weights. However, in contrast to parent-report the '*feels bad or guilty when I/they have done something wrong*' node was less strongly connected in this uncaring cluster of the plot. This was replicated across the gender subsamples. Similar to parent-report, the connectivity between CD symptoms was also less dense, in comparison to CU features, with lower edge weights.

Overall, when comparing across informants, the connectivity was more densely populated and with greater edge weight loadings for parent-report relative to youth-report.

Centrality Indices

Centrality strength (i.e., sum of correlations between a node and other nodes) and closeness (i.e., the distance between a node and other nodes) are displayed in Fig. 2. Items are plotted in descending alphabetical order.

Parent-Report

With regards to parent-report, two CU features were the most central items for both strength and closeness; '*concerned about the feelings of others*' and '*does not care who I/they hurt to get what I/they want*'. This was replicated in the male sample. In contrast, for the female sample, the
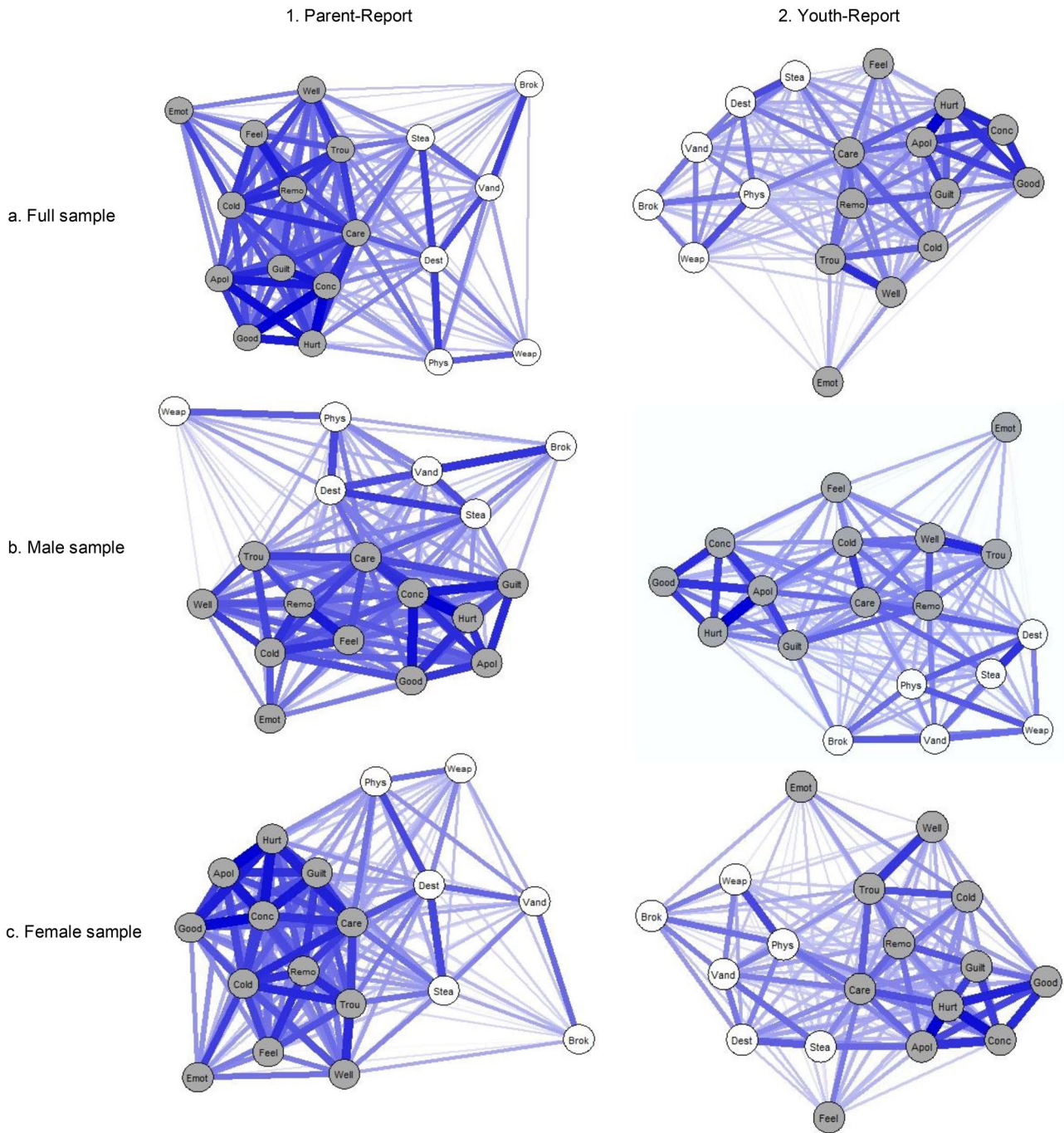
Fig. 1 Network structure for (1) parent-report and (2) youth-report CU features depicted in gray and CD symptoms depicted in white for the (a) full sample, (b) male sample, and (c) female sample. See online article for color version

aforementioned two CU features in addition to '*seems very cold and uncaring*' displayed the highest centrality strength index, and only '*does not care who I/they hurt to get what I/they want*' showed the highest closeness index. Two CD items provided the lowest centrality strength and closeness scores; that is, '*uses weapons when fighting*' and '*broken into house, building, or car*'. Whereas '*uses weapons when fighting*' provided the lowest centrality scores for the male sample, '*broken into house, building, or car*' provided the lowest centrality scores for the female sample.
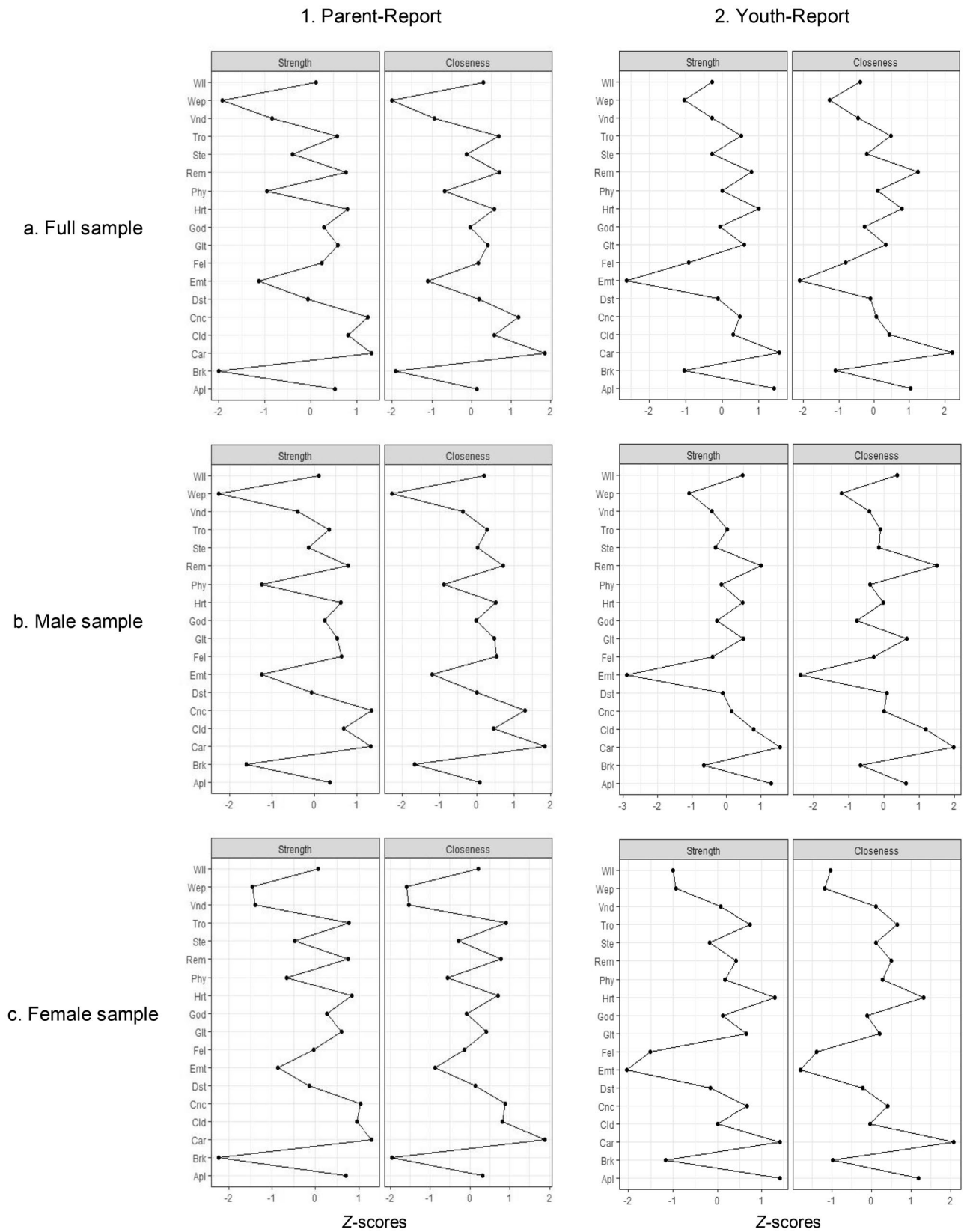
Fig. 2 Centrality strength and closeness as Z-scores for (1) parent-report and (2) youth-report CU features and CD symptoms for the (a) full sample, (b) male sample, and (c) female sample

Youth-Report

With regards to youth-report, the CU features '*does not care who I/they hurt to get what I/they want*' and '*apologizes to persons I/they have hurt*' displayed the greatest centrality strength, and '*does not care who I/they hurt to get what I/they want*' displayed the greatest centrality closeness, for the full sample and the gender subsamples. The CU feature '*does not show emotions*' item provided the lowest centrality strength and closeness for the full sample and the gender subsamples.

Centrality Differences

Bootstrapped differences for centrality strength and closeness are shown in Figs. 3 and 4, respectively. Black boxes indicate a significant difference at least $p < 0.05$, gray boxes indicate a nonsignificant association, and values are plotted in the white diagonal boxes. Items are plotted in order of value.

Parent-Report

Difference tests indicated that for parent-report, the CU features '*does not care who I/they hurt to get what I/they want*' and
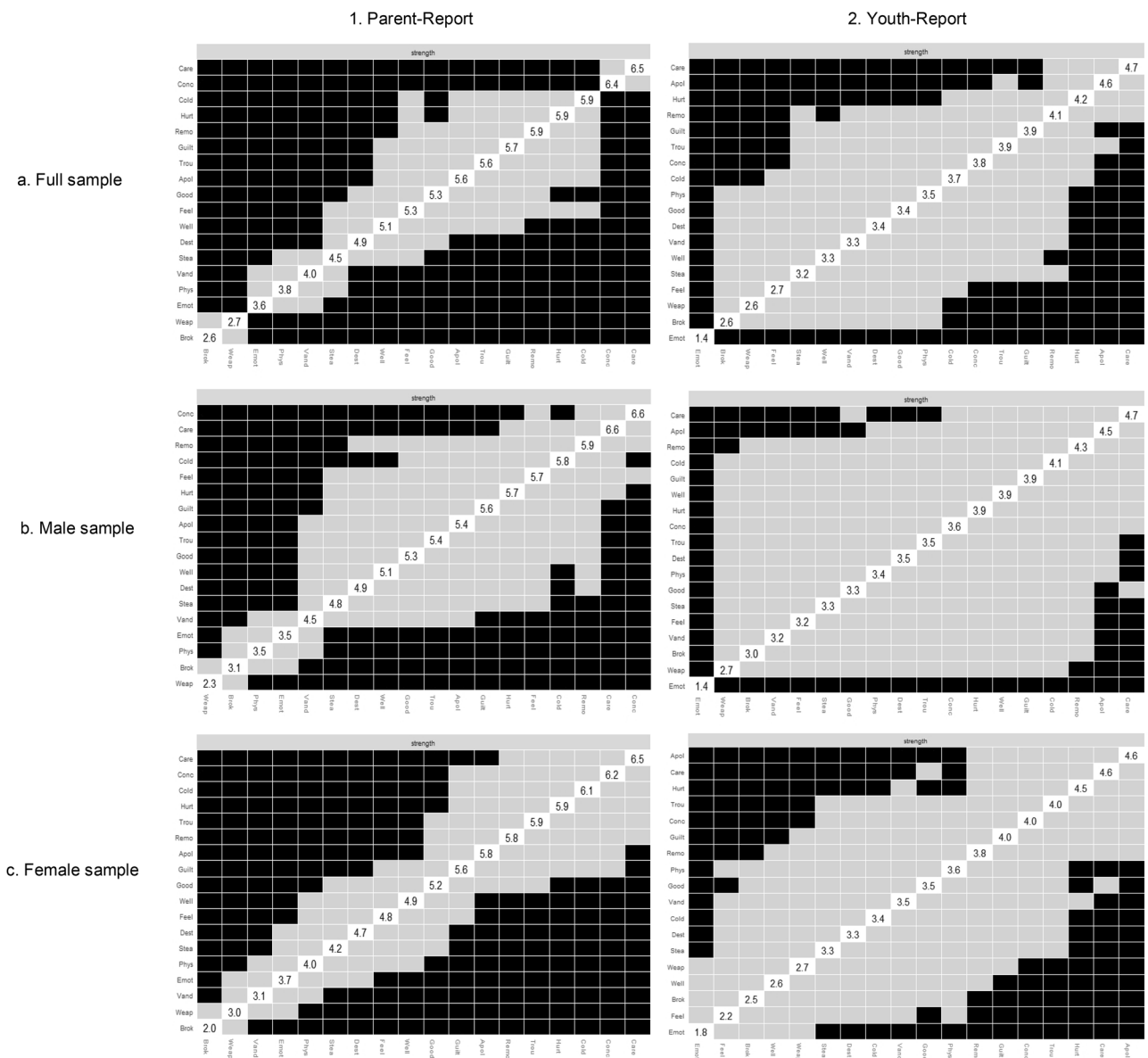

Fig. 3 Bootstrapped differences of centrality strength for (1) parent-report and (2) youth-report CU features and CD symptoms for the (a) full sample, (b) male sample, and (c) female sample. Black boxes indicate significant difference at least $p < 0.05$. Gray boxes indicate nonsignificant association. Values are plotted in the white diagonal boxes
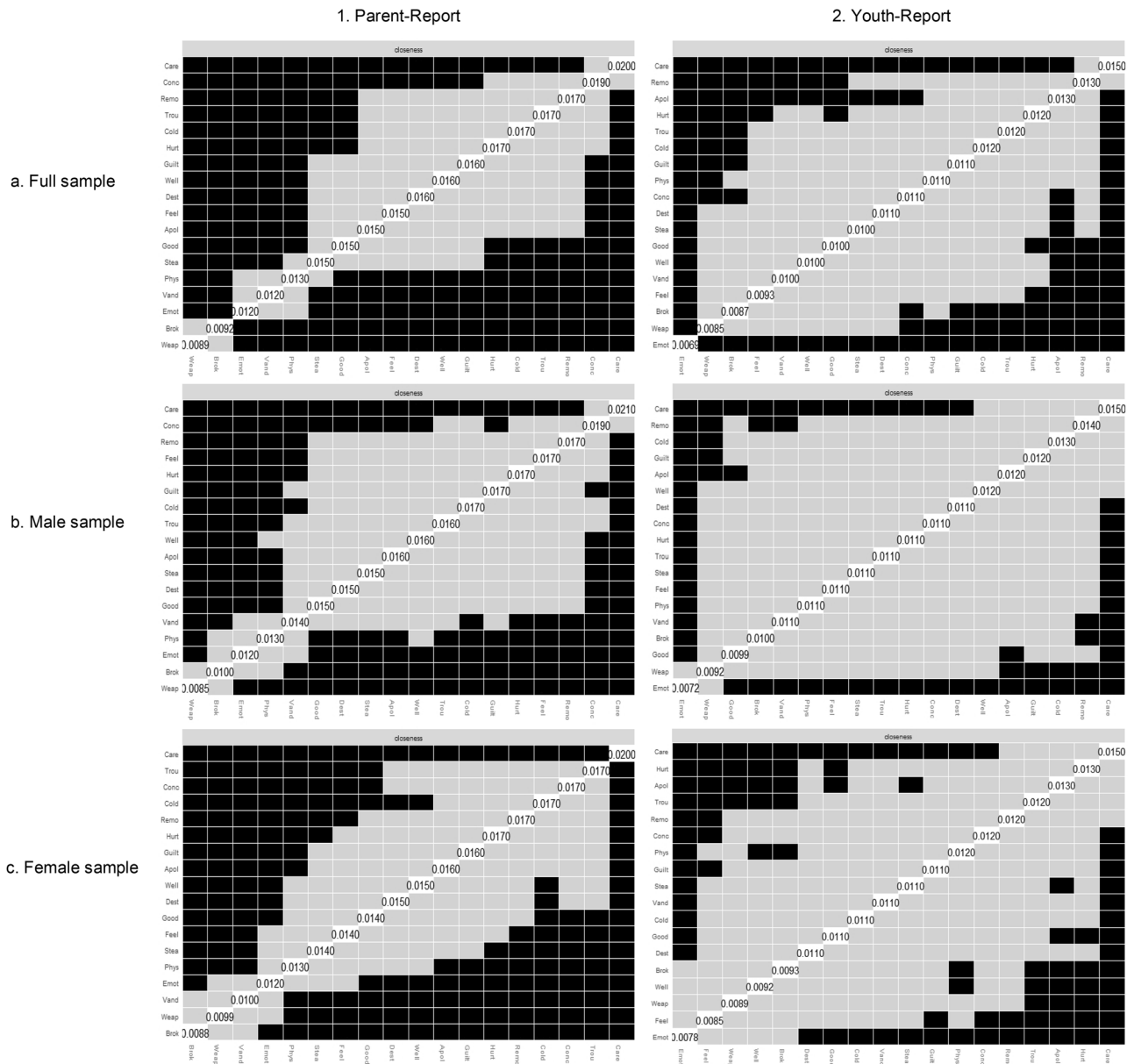
Fig. 4 Bootstrapped differences of centrality closeness for (1) parent-report and (2) youth-report CU features and CD symptoms for the (a) full sample, (b) male sample, and (c) female sample. Black boxes indi-cate significant difference at least $p < 0.05$. Gray boxes indicate non-significant association. Values are plotted in the white diagonal boxes

'*concerned about the feelings of others*' were the most central, and the CD symptoms '*uses weapons when fighting*' and '*broken into house, building, or car*' were the least central, across both strength and closeness for the full sample and both genders.

Youth-Report

In contrast, for youth-report, the CU features '*does not care who I/they hurt to get what I/they want*' and '*apologizes to persons I/they have hurt*' were the most central, and the CU feature '*does not show emotions*' emerged as the least central across both strength and closeness for the full sample and both genders. Of note, the male sample had very few significant effects overall.

Within-Sample Stability

Within-Sample stability of centrality strength and closeness are displayed in Fig. 5, with strength depicted in green and closeness depicted in red (see online article for color version).
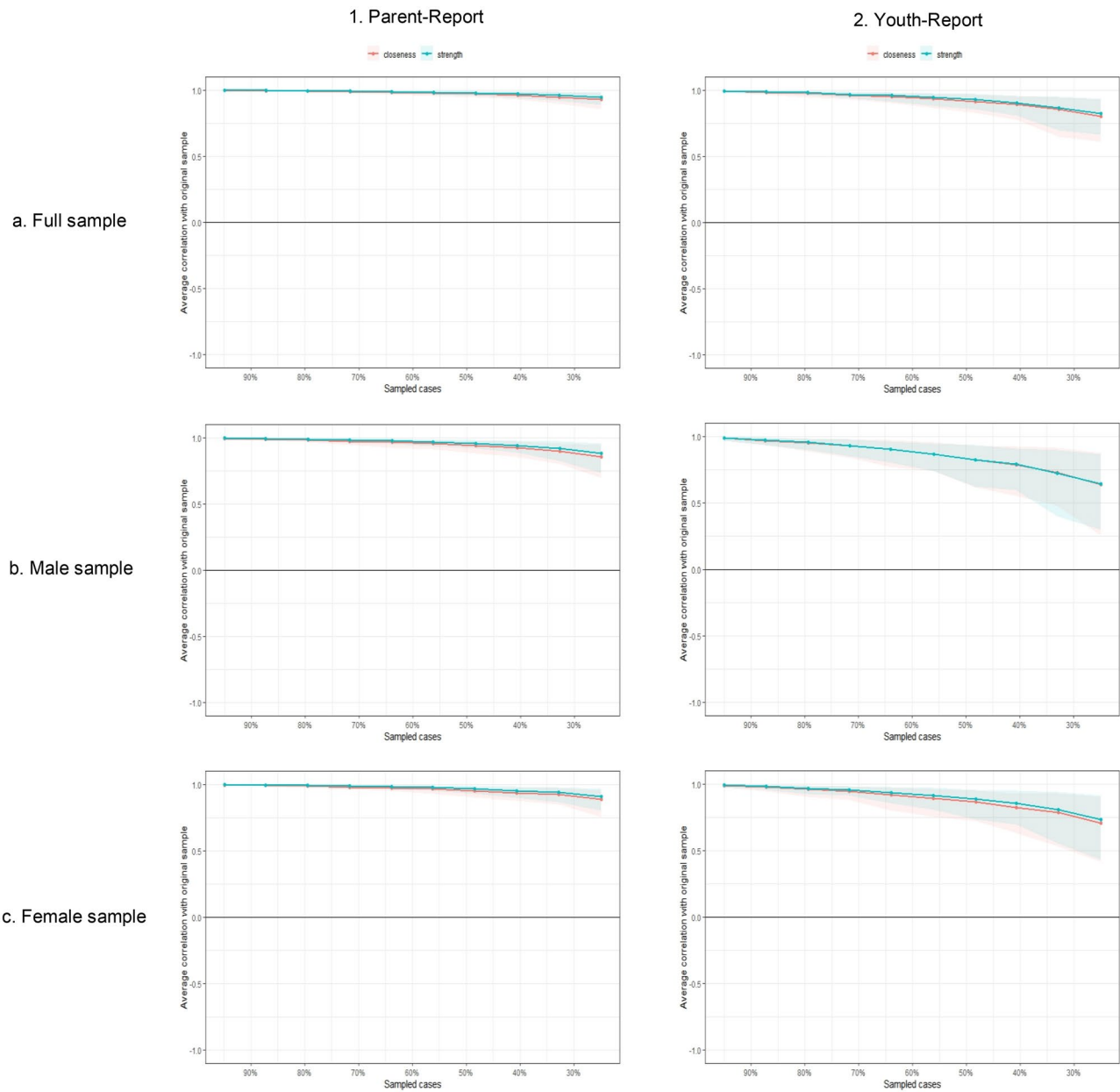
Fig. 5 Stability strength (green) and closeness (red) for (1) parent-report and (2) youth-report CU features and CD symptoms for the (a) full sample, (b) male sample, and (c) female sample. See online article for color version

Parent-Report

Centrality strength and closeness showed adequate stability for parent-report for the full sample (strength = 0.75; closeness = 0.75) and for both genders (male: strength = 0.75; closeness = 0.75; female: strength = 0.75; closeness = 0.75).

Youth-Report

Centrality strength and closeness showed adequate stability for youth-report for the full sample (strength = 0.67;

closeness = 0.67) and for the female sample (strength = 0.52; closeness = 0.59). The male sample was the least stable (strength = 0.44; closeness = 0.44).

Bridge Symptoms

Bridge strength (i.e., a node's connectivity with another syndrome) and closeness (i.e., the distance between a node from one syndrome to all nodes of another syndrome) are displayed in Fig. 6. Items are plotted in alphabetical order.
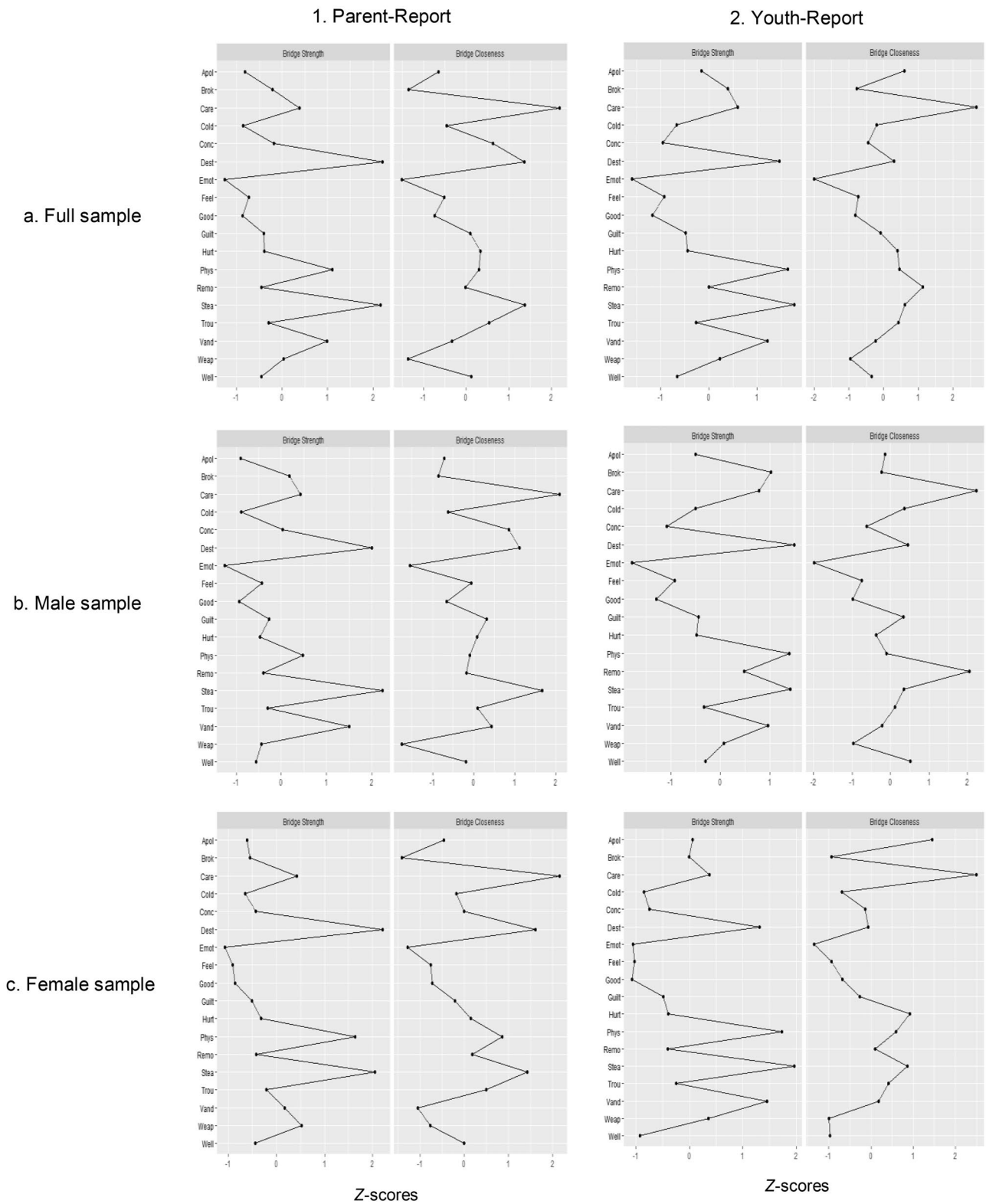
Fig. 6 Bridge strength and closeness as Z-scores for (1) parent-report and (2) youth-report CU features and CD symptoms for the (a) full sample, (b) male sample, and (c) female sample

Parent-Report

With regards to parent-report, the CU feature '*does not* *care who I/they hurt to get what I/they want*' showed the greatest bridge closeness and the two CD symptoms '*destroys things belonging to others*' and '*steals things*

at home' showed the greatest bridge strength for the full sample and both genders.

Youth-Report

With regards to youth-report, the CU feature '*does not care who I/they hurt to get what I/they want*' showed the greatest bridge closeness for the full sample and both genders, followed closely by '*shows no remorse when I/they have done something wrong*' for the male sample. The CD symptoms '*destroys things belonging to others*', '*physically attacks people*' and '*steals things at home*' showed the greatest bridge strength for the full sample and the male sample. For the female sample, '*physically attacks people*' and '*steals things at home*' showed the greatest bridge strength.

Discussion

The purpose of the present study was to inform current understanding of the connectivity between CU features and CD symptoms in a sample of high-risk youth. We achieved this through the use of a network analytic approach; these analyses have only recently been applied in the field of psychopathology to provide a more nuanced understanding of the inter-item relations between psychopathological symptoms. Our study adds several important findings to current literature, which we outline in detail below; however, here we note four overarching themes. First, examining CU features and CD symptoms from both the perspective of the parent and child, we found densely connected network structures for CU features and lower density for CD symptoms across both informants. Overall, youth-reported CU features and CD symptoms were less densely connected than parent-reported CU features and CD symptoms. Second, whereas network connectivity plots demonstrated the importance of items commonly comprising the uncaring subscale for conceptualizing CU features, statistics of centrality supported items of callousness as important. Third, our findings showed lower indices of centrality and lower within-sample stability for CU features and CD symptoms among male youth, and these differences were particularly apparent in youth self-report information. Fourth, items commonly comprising the callousness dimension linked the two constructs (i.e., CU and CD) together.

Network Structure of CU Features and CD Symptoms

The network structure of CU features and CD symptoms as reported by parents demonstrated that CU features were strongly associated with each other as indicated by densely connected nodes and high weight loadings of the edges. This was particularly salient among items that commonly comprise the uncaring dimension. In contrast, the connectivity between parent-reported CD symptoms was less dense than CU features and showed lower edge weights. A similar general network pattern was also observed among youth reports. Specifically, the items comprising the uncaring dimension were most densely connected with the greatest edge weights, and the connectivity between CD symptoms was less dense with lower edge weights. These findings highlight the overall connectivity of CU features and CD symptoms from the parent and youth perspectives; however, when comparing across informants our findings demonstrated some important and nuanced differences, which we explain in turn below.

Network plots indicated greater connectivity of parent-reported than youth-reported CU features and CD symptoms. The greater network density and edge weights between CU features and CD symptoms of parent-report, over youth self-report, supports and extends past research finding higher correlations between CU features and external criterion of antisocial behavior for 'other' reports (Ray & Frick, 2018). Past research using factor analytic approaches has also found higher correlations between parent-reports of CU features and CD symptoms compared to child-reports (parent, $r = 0.36$, $p < 0.001$; child, $r = 0.08$, $p = n.s$) (Gao & Zhang, 2016). Our findings add to this literature by demonstrating greater associations among parent-report relative to youth self-report may be also observed at the item level through a network approach. This suggests that it is not only factors, underpinned by a number of symptoms, that are related; but also at the inter-item level do these associations exist. The greater network connectivity of parent- versus youth self-report may be related to issues of conceptual understanding and introspective insight for children and adolescents. These issues may be particularly problematic for younger children reporting on CU features and levels of emotionality. For example, the ICU has items related to emotions of guilt (i.e., '*feels bad or guilty when I/they have done something wrong*'; uncaring item) and remorse (i.e., '*shows no remorse when I/they have done something wrong*'; callousness item), which require the individual to understand these constructs conceptually and have enough insight to determine whether they identify with such complex emotions. Although, it is important to note that the youth self-report ICU was developed to be age appropriate (Frick et al., 2000; Kimonis et al., 2008), and our findings with a majority adolescent sample (*M* age = 13.98) support past factor analytic research with a younger child sample (*M* age = 9.06; Gao & Zhang, 2016). It would be important for future research to examine the network structure between CU features and CD symptoms at various ages for a developmentally informed understanding of this connectivity.

While we found greater network connectivity of parent-report relative to youth self-report overall, it was CU features rather than CD symptoms that demonstrated the greatest node density and edge weights. This finding was replicated across informants and genders. For parent-report, although CD symptoms are observable behaviors and CU features are less readily observable, it may be the case that the behaviors comprising the BCFPI CD scale are less likely to occur in sight of parents given the level of severity of these behaviors. For example, '*broken into house, building, or car*' and '*uses weapons when fighting*' might be particularly unlikely to occur in view of parents. Whereas CU features, such as '*does not care who I/they hurt to get what I/they want*', could be demonstrated through more common daily activities and within the context of the home. For youth-report, given the severity of the CD behaviors, youth may not have engaged in these behaviors or they could be hesitant to accurately report for fear of negative consequences. An alternative explanation of these findings may be related to the inferences parents make about the underlying personality features in their children. For example, behaviors such as '*broken into house, building, or car*' may activate a cascading network of assumed associated personality features. When observed behaviors occur at a low rate but are provocative, such personality inferences may be more likely to occur and these could be specifically related to CU-type features.

Across both informants and genders, the items comprising the commonly identified uncaring subscale of the ICU showed the greatest edge weightings. Factor analytic research has argued that the identification of ICU subscales and item endorsement may be due, in part, to shared method variance (Ray & Frick, 2018). Such that, the items comprising the uncaring subscale are all worded in the negative direction (i.e., items with lower ratings indicate greater CU features; e.g., '*concerned about the feelings of others*') and the items comprising the callousness subscale are all worded in the positive direction (i.e., items with higher ratings indicate greater CU features; e.g., '*does not care who I/they hurt to get what I/they want*'). Through an item response theory (IRT) analysis, Ray et al. (2016) found that relative to negatively worded items, positively worded items were more likely to be rated in the lower response categories. In addition, positively worded items also showed higher difficulty levels; that is, these items discriminate CU features best at higher levels of CU features. These findings suggest that methodological characteristics may contribute to factor discrimination, and we have demonstrated this possible discrimination at the inter-item level too.

Network Centrality of CU Features and CD Symptoms

While CU symptoms indicative of uncaring were more prominent in network connectivity, items commonly operationalized as callousness scored higher on indices of centrality. Specifically, across parent- and youth self-reports and genders, '*does not care who I/they hurt to get what I/they want*' and '*concerned about the feelings of others*' tended to score the highest in centrality strength and closeness. Whereas the uncaring subscale reflects an uncaring attitude towards others' feelings, the callousness dimension is marked particularly by an absence of remorse. These findings support the research by Bansal and colleagues (2020) pointing to the importance of callousness in conceptualizations of CU features, and we extend their findings to high-risk youth from both the perspective of the parent and child.

The '*does not show emotions*' item was the least central CU feature for youth-reports across the full sample and the gender subsamples. In the present study, we used the 12-item measure of the ICU, which has been validated in other youth samples (Colins et al., 2016; Hawes et al., 2014). However, in the original 24-item ICU, this item (i.e., '*does not show emotions*') loaded onto an unemotional scale (and not the callousness scale, as per the 12-item measure). This item was also the only unemotional item retained from the 24-item version to the brief 12-item version. Our findings showing the lowest centrality of this unemotionality item among youth-reports suggests that low emotional expression may be less relevant for operationalizing CU features particularly from the youth perspective. It is also important to note that statistics of centrality showed very few significant effects for male self-report overall.

Within-Sample Stability of CU Features and CD Symptoms

In addition to few significant centrality effects, male self-reports also showed the lowest within-sample stability for both centrality strength and closeness. Within-sample stability refers to the extent to which the network structure remains stable while removing a number of participants from the analyses (Epskamp et al., 2018). Parent-reports of the full sample and both genders and youth-reports of the full sample and the female sample all reached the recommended CS coefficient cutoff (0.50). However, male self-reports fell below this cutoff limiting interpretability of these findings. It should be noted that the authors suggest that these cutoffs should only be taken as guidelines (Epskamp et al., 2018). Taken together (i.e., few significant centrality effects and low within-sample stability), these findings suggest that the male self-reports represent the greatest heterogeneity in presentations of CU features and CD symptoms. Alternatively, the items used in this study may not have sufficiently assessed the scope of their specific CU features and CD symptoms.

Bridge Centrality of CU Features and CD Symptoms

With regards to the connectivity between these two constructs, one item reflecting callousness, '*does not care who I/they hurt to get what I/they want*', showed the greatest bridge closeness (i.e., the distance between a node from one syndrome to all nodes of another syndrome) for parent- and youth self-reports. Whereas, CD symptoms '*destroys things belonging to others*', '*physically attacks people*' and '*steals things at home*' showed the greatest bridge strength (i.e., a node's connectivity with another syndrome) for parent- and youth self-reports. These findings suggest that symptoms of callousness may underpin serious and aggressive antisocial behavior than symptoms of uncaring that may be more related to nonaggressive delinquency—a finding that supports past factor analytic research (Cardinale & Marsh, 2017; Kimonis et al., 2013; Kimonis et al., 2016a, b).

Strengths and Limitations

Methodological strengths of the present study include our network analytic approach to identify connectivity among CU features and CD symptoms in large samples of parents and high-risk youth. In addition, our inclusion of multi-informant (i.e., parent and child) report and gender differences helped to clarify core characteristics of these constructs from both the perspective of the parent and child and across genders. However, interpretation of our findings must be considered within the context of some methodological limitations. First, while our findings point to the importance of considering how parent versus youth-reports may differentially contribute to diagnostic conclusions, shared method variance cannot be ruled out as a source of the associations between constructs. Future research might consider combining parent- and youth self-report information and including other informants (e.g., teacher-report) or objective indicators. Second, while recent studies have supported a brief version of the ICU (Colins et al., 2016; Hawes et al., 2014), Ray and Frick (2018) emphasized the importance of the unemotional scale for understanding the broader CU construct. Thus, future research should examine the network structure of the 24-item ICU. Similarly, our measure of CD symptoms contained only six items related to serious antisocial behavior, and it would also be important for research to examine the network connectivity of CU features and CD symptoms using other measures of these constructs and a broader scope of CD symptoms. Finally, some researchers in the field have suggested that network analyses may contribute to limited replicability or stability (Forbes et al., 2017a, b). These researchers note that while network theory has a place in explaining how psychopathology emerges, current network methodology may still need refining.

Implications and Conclusion

Examining the network structure of psychopathological constructs can provide critical information with regards to core characteristics. Our findings showed greater overall connectivity and weightings of CU features relative to CD symptoms, and parent-report versus youth-report. The present findings also demonstrated important differences in CU connectivity versus centrality, and particularly as they related to distinct items of uncaring and callousness, respectively. In discussion of our findings, we indicated which dimension items commonly loaded onto for ease of interpretation; however, in line with perspectives of network psychometric approaches, we echo that while a latent factor may exist, the a priori assumption that one will be identified may not always be theoretically and empirically supported (Borsboom & Cramer, 2013). Indeed, Ray and Frick (2020) noted that dimensions of CU features do not have a strong theoretical model for their distinction, supporting the examination of CU features through network analytics.

Our findings may also have clinical implications for intervention efforts. We identified features that proved most central in our network models, particularly with regards to items of callousness. With further research and replication, these approaches may help to establish specific symptoms (rather than latent factors) as therapeutic targets (Borsboom & Cramer, 2013). There is strong clinical validity for the distinction of CU features given their traditionally poorer response to treatment, and we showed that CU features (over CD symptoms) were significantly more central across informant and gender. It is important to note, across the parent-report full sample and separate gender samples, and youth-report full sample and female sample, the callousness CU feature '*does not care who I/they hurt to get what I/they want*' was the node that provided the greatest 'bridge' to CD symptoms. Although we state with caution and emphasize the importance of future prospective longitudinal designs and methodology development, interventions targeting CU features, and callousness specifically, may in turn affect other symptoms in the CU and CD network system.

Compliance with Ethical Standards

Ethics Approval This study was approved by the University Office of Research Ethics at Simon Fraser University.

Consent to Participate and Publication Parents provided informed consent and youth assent to participate in the program and for research publication before data collection.

Conflicts of Interest The authors report no conflicts of interest.

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