Clinical Psychology & Psychotherapy

WILEY

RESEARCH ARTICLE OPEN ACCESS

The Association of Posttraumatic Stress Disorder, Complex Posttraumatic Stress Disorder and Depression: A Network Approach

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Received: 14 April 2025 | **Revised:** 22 June 2025 | **Accepted:** 9 July 2025

Keywords: comorbidity | complex posttraumatic stress disorder | depression | network analysis | posttraumatic stress disorder

ABSTRACT

Background: Complex posttraumatic stress disorder (CPTSD) is a newly recognized condition in the ICD-11, characterized by the core symptoms of PTSD alongside disturbances in self-organization (DSO). Network analysis provides a novel approach to understanding the complex relationships between symptoms. While many studies have identified the comorbidity between PTSD/CPTSD and depression, few have focused on CPTSD using network analysis. This study aims to investigate the bridge symptoms between PTSD, DSO and depression.

Method: A sample of 385 US participants who reported at least one lifetime trauma completed the ICD-11 International Trauma Questionnaire (ITQ) and the Patient Health Questionnaire-9 (PHQ-9).

Results: The obtained network models were stable. The most central symptoms were 'Feeling distant or cut off from people', 'Feeling down, depressed, or hopeless' and 'Feeling like a failure'. The key bridge symptoms in the network were 'Negative self-concept', 'Feeling like a failure', 'When I am upset, it takes me a long time to calm down' and 'Finding it hard to stay emotionally close to people'.

Conclusions: The results indicate that certain symptoms are considerably more influential within the network. Affective, identity and interpersonal DSO symptoms may play a key role in linking PTSD and depression. These symptoms may be important targets for interventions.

1 | Introduction

A majority of people will experience at least one potentially traumatic event during their lifetime (e.g., 89% in Kilpatrick et al. 2013; 81% in De Vries and Olff 2009). Following such events, individuals tend to follow one of four trajectories (Bonanno et al. 2023): More than two-thirds of people show either a resilience trajectory (stable psychological health) or a recovery trajectory (acute symptoms followed by improvement). However, some individuals exhibit chronic (persistently elevated symptoms) or delayed (moderate symptoms that gradually worsen) trajectories. Despite the fact that many people demonstrate resilience or recovery, posttraumatic stress disorder (PTSD) and major depressive disorder (MDD) are also common outcomes (O'Donnell et al. 2004; Shalev et al. 1998; Steel et al. 2009).

Co-occurring depression and PTSD is common (Adams et al. 2019; Nichter et al. 2020). Data from the National Comorbidity Survey Replication showed that 54.7% of people with PTSD were also diagnosed with major depressive disorder (MDD) (Elhai et al. 2008). While estimates vary across the literature, it is thought that approximately 30%–50% of people

Summary

- Network analysis can identify important symptoms among PTSD, CPTSD and depression.
- Central symptoms include emotional detachment, hopelessness and failure.
- Bridge symptoms are affective, identity and interpersonal DSO symptoms.
- Disturbances in self-organization may be important targets for interventions.

with PTSD have depression (Angelakis and Nixon 2015; Flory and Yehuda 2015; Rytwinski et al. 2014). People with both PTSD and MDD have a greater psychological burden than individuals with PTSD alone (Nichter et al. 2019). They tend to have more distress, more suicidal thoughts and poor life quality, as well as worse treatment outcomes and higher drop-out rates (Flory and Yehuda 2015; Nichter et al. 2019; Ramsawh et al. 2014). Therefore, it is important to gain a deeper understanding of this comorbidity.

In addition to PTSD and depression, individuals who experience trauma may also develop complex PTSD (CPTSD) (de Silva et al. 2021; Karatzias et al. 2019), which has recently been codified in the 11th Revision of the International Classification of Diseases (ICD-11) (World Health Organization 2018). There are some differences between the DSM-5-TR and ICD-11 in the diagnosis of PTSD and CPTSD. In ICD-11, PTSD is defined by three symptom clusters: re-experiencing the traumatic event, avoidance of trauma reminders and a sense of current threat. CPTSD includes these core symptoms and adds three additional clusters related to disturbances in self-organization (DSO): affective dysregulation, negative self-concept and disturbances in relationships (WHO 2018). In contrast, the DSM-5-TR includes only the diagnosis of PTSD and does not classify CPTSD as a separate condition (American Psychiatric Association 2022). The ICD-11 symptoms of PTSD are similar to DSM-5-TR criteria B, C and E, while the DSO symptoms of ICD-11 CPTSD correspond to DSM-5-TR criteria D and E (Siddaway 2024). The prevalence of CPTSD ranges from 2.2% to 85.8% in various groups that have experienced trauma (de Silva et al. 2021; Mellor et al. 2021). CPTSD has been found to be more common than PTSD alone in many studies, for example, a Danish sample of psychiatric outpatients (PTSD 8%; CPTSD 36%) (Møller et al. 2020), US adults (PTSD 3.4%; CPTSD 3.8%) (Cloitre et al. 2019), Australian treatment-seeking veterans (PTSD 21.8%; CPTSD 78.2%; Howard et al. 2021) and UK adults exposed to trauma (PTSD 5.3%; CPTSD 12.9%) (Karatzias et al. 2019).

The memory and identity (MI) theory of CPTSD suggests that an interaction of trauma exposure and pre-existing individual vulnerability determines the risk of traumatic memories and negative identities (e.g., that one is worthless/inferior, betrayed/abandoned or alienated) that characterize ICD-11 CPTSD (Hyland et al. 2023). The difference between PTSD and CPTSD is thought to result from the predominant type of negative identity. In PTSD, individual identity is mainly concentrated in feelings of powerlessness and a lack of safety, while in CPTSD, there are also identities associated with feelings of worthlessness and betrayal, which contribute to DSO symptoms (Hyland et al. 2023).

Based on the memory and identity theory, CPTSD is more likely to be comorbid with depression, whereas PTSD would occur more often alongside anxiety disorders (Hyland et al. 2023). In the case of CPTSD, when individuals have identities of worthlessness, betrayal or alienation, mood disorders such as major depression tend to coexist frequently (Beck and Bredemeier 2016; Hyland et al. 2023). Consistent with this, Karatzias et al. (2019) found that individuals with CPTSD are more likely than those with PTSD to have MDD symptoms. In another study of people with self-reported depressive symptoms, the prevalence of PTSD was 5.6%, while the prevalence of CPTSD was 57.1% (Fung et al. 2022).

Previous research on comorbidity has largely focused on shared features or similarities between PTSD and depression (Angelakis and Nixon 2015). For example, the quadripartite model of psychopathology suggests that disease has two dimensions: general distress and specificity (Watson 2009). Both PTSD and MDD have high levels of the general distress dimension, leading to high comorbidity (Watson 2009). Besides, some factor analysis studies suggest that PTSD and MDD might be best conceptualized as two-dimensional indicators with some overlap (Grant et al. 2008; Price and van Stolk-Cooke 2015). For example, Gros et al. (2010) established a two-factor model representing symptoms of MDD and PTSD in a sample of veterans and found that some of the symptoms of PTSD were loaded onto the depression factor. Most previous studies have been based on the latent variable model, which views symptoms as representations of disorders. However, this perspective has its limitations (Borsboom 2008), as it ignores the interactions between symptoms of the disorders (Afzali et al. 2017).

An emerging approach to psychopathology and comorbidity is network analysis (Borsboom 2017; Borsboom and Cramer 2013; Jones et al. 2021). The network is defined as a set of nodes (symptoms) and edges (connections between nodes) (Borsboom and Cramer 2013). According to the network model, psychopathology is not an expression of underlying latent variables. Instead, mental disorders are caused by causal interactions between their constituent symptoms (Borsboom and Cramer 2013). Symptoms are not passive indicators of a latent common cause of a disorder but become dynamic components of a causal system (Robinaugh, Hoekstra, et al. 2020). From this perspective, comorbidity is seen as a collection of direct interactions between symptoms of different disorders (Borsboom et al. 2011). In other words, certain symptoms of one disorder may put an individual at risk for other disorders, leading to comorbidity. Those symptoms that increase the risk of transmission to other disorders are referred to as 'bridge symptoms' (Cramer et al. 2010). Bridge symptoms are thought to be particularly suitable targets for interventions, as a reduction in bridge symptoms is thought to benefit the symptoms of both disorders (Jones et al. 2021).

Network analysis has been used to explore the comorbidity of PTSD and depression. Many studies have found that symptoms

which are common to both PTSD and depression are bridge symptoms, including sleep problems, concentration problems and loss of interest (Afzali et al. 2017; An et al. 2021; Djelantik et al. 2020; Duek et al. 2021; Gilbar 2020; Lazarov et al. 2020; Qi et al. 2021; Shi et al. 2023; Xu et al. 2023). Additionally, feeling sad and trouble experiencing positive feelings are also important bridge symptoms (An et al. 2021; Afzali et al. 2017; Lazarov et al. 2020; Price et al. 2019; Qi et al. 2021). Irritability, psychomotor retardation, experiencing flashbacks and other symptoms have been found to be bridge symptoms in yet other studies (Afzali et al. 2017; Djelantik et al. 2020). Among them, feeling sad, trouble experiencing positive emotions and concentration problems have also been found to be high centrality nodes in the whole network in many studies, such that they have many strong connections with other symptoms (An et al. 2021; Duek et al. 2021; Price et al. 2019; Shi et al. 2023).

However, there are only a few studies focusing on the networks of CPTSD and depression (Gilbar 2020; Haselgruber et al. 2021; Liu et al. 2024). Haselgruber et al. (2021) found that CPTSD is a central element in traumatized children's complex psychopathology. Gilbar (2020) pointed out that in the network of PTSD/CPTSD/depression and anxiety, feelings of worthlessness and avoiding internal reminders were the most central symptoms. In a longitudinal study, negative emotions and negative self-evaluations were most likely to influence other symptoms in the comorbidity network (Liu et al. 2024).

Although these studies provide an initial understanding of which symptoms are important in the comorbidity network, they have several limitations. First, we still do not know which symptoms act as bridges between different symptom clusters (DSO, PTSD, and depression)—only the symptoms that are most central in the overall network. Finding bridge symptoms between different disorders can help us to prevent or treat comorbidity. Second, the samples of previous studies are not sufficiently representative of the wider population, as they consist of university students (Liu et al. 2024), foster children (Haselgruber et al. 2021) and Jewish men receiving treatment for domestic violence (Gilbar 2020), which limits the generalizability of the findings. Since the network structure can be affected by the population (Xu et al. 2023), it is necessary to explore comorbidity in a more representative sample. Finally, in previous studies, most measurements of PTSD have used scales based on the DSM-5 diagnostic criteria, such as the PTSD Checklist-5 (PCL-5; Weathers et al. 2013). This scale includes symptoms such as sleep problems and difficulty concentrating that are listed as PTSD symptoms in the DSM-5-TR but are also common in depression (APA 2022). This symptom overlap may lead to redundancy when examining the comorbidity network of PTSD and depression.

To fill these gaps, our study will investigate a comorbidity network of PTSD/CPTSD symptoms on the one hand and depression on the other in a broadly representative group of participants from the United States who have had at least one traumatic experience. For the present study, we choose to use the International Trauma Questionnaire (ITQ; Cloitre et al. 2018) to measure PTSD and CPTSD. This scale is based on the ICD-11 diagnostic criteria, which focuses only on the unique symptoms of PTSD and CPTSD, making the symptom network more concise and clear. Through this study, we will explore the symptoms with the highest network centrality, as well as bridge symptoms that act as connections between different symptom clusters (DSO, PTSD and depression). Given the mixed findings arising from previous studies, we did not form specific hypotheses regarding the symptoms that would have the greatest centrality or that would serve as bridge items, and our analyses were essentially exploratory.

2 | Method

2.1 | Participants and Procedures

We recruited a sample of 385 participants who reported at least one lifetime trauma from the United States ($M_{age} = 43.74$; SD = 15.97; 49.9% female). Participants were a subset of a larger sample reported in a previous unrelated paper (Berle et al. 2023) and were recruited from the Prolific platform (Palan and Schitter 2018) in September 2021, which is an online participant recruitment source (https://www.prolific.co/). The Prolific platform used a cross-stratifying approach based on age (five groups), ethnicity (five groups) and sex (two groups) to create 50 subgroups from which study participants were drawn to be proportionate to the US population (Prolific 2021). All participants were reimbursed for their time. The study was approved by the university human research ethics committee (UTS Human Research Ethics Committee: ETH20-5427) and conducted in accordance with the Declaration of Helsinki.

As sample size increases, the accuracy of network estimation tends to improve. However, there is currently no clear consensus in the field of psychological networks regarding how many observations are needed to estimate a reasonably stable network (Epskamp et al. 2018). For networks comprising around 20 nodes, a sample size of approximately 400 participants has been considered acceptable in previous work (Epskamp et al. 2018).

2.2 | Measures

Demographic information collected included age, sex, race, employment status and marital status.

PTSD and CPTSD were measured using 12 items from the International Trauma Questionnaire (ITQ; Cloitre et al. 2018). Six items represent the three clusters of PTSD: re-experiencing, avoidance and sense of threat. Another six items represent the three DSO clusters of CPTSD: affective dysregulation, negative self-concept and disturbances in relationships. The severity of each symptom over the past month was rated on a Likert scale ranging from 0 (*not at all*) to 4 (*extremely*). The ITQ has been widely used and validated across various countries and populations (Cloitre et al. 2021). The overall Cronbach's α for the ITQ in the present study was 0.93, with 0.90 for PTSD and 0.92 for DSO.

We used the Patient Health Questionnaire-9 (PHQ-9; Kroenke and Spitzer 2002) to measure depression. It has nine items and assesses the nine symptoms of major depression used in the DSM-5 diagnostic criteria for major depressive disorder. Each

item is scored from 0 (*Not at all*) to 3 (*Nearly every day*) based on symptom frequency over the past 2 weeks. The Cronbach's α for this scale in the present study was 0.91.

Several other measures were also administered, but they are not reported here as they are beyond the scope of the present study.

2.3 | Statistical Analysis

2.3.1 | Nodes Selection

In network analysis, careful selection of the included variables is crucial. The inclusion of multiple nodes assessing the same construct can result in inflated centrality of these variables (Levinson et al. 2018). Variable selection should be both data-driven and informed by theory. We used the Goldbricker function in the Networktools package of R (Jones 2018) to calculate the proportion of all possible combinations of correlations in the network which were significantly different. Consistent with other studies (e.g., Berle et al. 2023; Delaquis et al. 2023; Martini et al. 2021), we applied a threshold whereby at least 20% of all possible combinations of correlations needed to be significantly different at $p < 0.01$ for each pair of items. In line with previous literature (Delaquis et al. 2023; Martini et al. 2021), after examining the suggested reductions, if clinically appropriate, these 'redundant pairs' were combined through principal component analysis using the net_reduce function.

The goldbricker test returned 11 'redundant pairs' (see Table S1). Considering the content of the items, we chose three pairs to combine with PCA using the net_reduce function:

- PHQ_4 and PHQ_3: trouble falling or staying asleep, or sleeping too much, and feeling tired or having little energy. Both symptoms are related to disturbances in sleep and overall energy.
- PTSD_4 and PTSD_3: avoiding internal reminders of the experience, and avoiding external reminders of the experience. Both symptoms involve avoiding the experience.
- DSO_4 and DSO_3: I feel like a failure, and I feel worthless. Both symptoms are related to negative self-concept.

2.3.2 | Network Analysis

We conducted the network analysis using the R package Networktools (Jones 2020). Considering that Likert scale data are ordinal, the analysis was based on Spearman correlations and used the GLASSO algorithm (Friedman et al. 2008). The extended Bayesian information criterion (EBIC) was used for model selection. We set the hyperparameter (gamma) to 0.5 to constrain spurious associations between variables to 0, so that a more conservative and concise regularized partial correlation network could be obtained. In the visualized approach, nodes in the network represent symptoms and edges represent associations between symptoms. Red edges signify negative associations and green edges indicate positive associations.

2.3.3 | Centralities Analysis

Network centralities reflect the importance of a node or a symptom. Greater centrality indicates that a node has higher connectivity in a network (Borsboom 2017). The current study focused on expected influence (EI, i.e., the sum of the edge weights connected to a specific node without taking the absolute value), considering that it is a more reliable central index when there are both positive and negative associations in the network (Robinaugh, Millner, et al. 2016).

We also investigated bridge centrality, which is used to investigate the comorbidity across mental disorders (Afzali et al. 2017; Jones et al. 2021). Bridge EI (bEI) was calculated as a measure of bridge centrality to identify 'bridge symptoms' that connect different mental disorders (Jones et al. 2021). The bEI is the sum of the edge weights between the node and all nodes that are not in the same mental disorder as the node (Jones 2020). In this study, following the recommendations of Jones et al. (2021), we selected the top 20% bEI-scored nodes as predicted bridge nodes.

2.3.4 | Robustness Tests

We used the R package bootnet to conduct robustness tests (Epskamp and Fried 2018). Tests of robustness comprised 1000 bootstrapped 95% confidence intervals (CIs) for edge weights and the correlation stability coefficient (CS coefficient) for EI and bridge EI in subset sample dropping bootstrapping tests (Epskamp and Fried 2018). Smaller CIs (narrower grey bands) indicate more accurate edge weights (Cao et al. 2019). As for the CS coefficient, 0.25 is considered to be the minimum accepted value, but values > 0.5 are more favourable (Armour et al. 2012).

3 | Results

3.1 | Sample Characteristics

A proxy diagnosis was derived based on the PTSD and CPTSD diagnostic criteria in the ICD-11, using responses from the participants on the ITQ scale (Cloitre et al. 2018). A total of 19 participants was diagnosed with PTSD only (4.9%), and 47 participants (12.2%) were diagnosed with CPTSD. Additionally, a proxy diagnosis of depression was made using the PHQ-9 scale, with 30 individuals (7.8%) meeting the DSM-5 criteria for depression. The demographic characteristics of the sample are summarized in Table 1. The total scores of PTSD, CPTSD, and depression showed skewness values of 1.01, 0.61, and 0.66, and kurtosis values of 0.05, 0.84, and −0.58, respectively. The data were right-skewed, as this was a non-clinical sample with many participants reporting low symptom scores.

3.2 | Network Analysis

In the network of PTSD, CPTSD and depression symptoms, 88 of 153 possible edges were nonzero (55.6%). Among the 88 edges, 14 were negative associations, and 74 were positive associations.

TABLE 1 | Demographic characteristics of the sample ($N = 385$).

Variable	*M*	SD
Age	43.74	15.97
	n	%
Gender		
Male	188	48.8%
Female	192	49.9%
Other	5	1.3%
Racial/cultural background		
Asian or Pacific Islander	25	6.5%
Black or African American	56	14.5%
Hispanic or Latino	28	7.3%
Native American or Alaskan Native	4	1.0%
White or Caucasian	258	67.0%
Multiracial or biracial	10	2.6%
Other	4	1.0%
Employment		
Not employed full-time	189	49.1%
Employed full-time	196	50.9%
Marital status		
Not in a married or de facto relationship	169	43.9%
Married or de facto/co-habiting relationship	216	56.1%

The thickest edge was PTSD5–PTSD6 (*Being 'super–alert', watchful or on guard—Feeling jumpy or easily startled*; $r = 0.51$), followed by PHQ1–PHQ2 (*Little interest or pleasure in doing things—Feeling down, depressed, or hopeless*; $r = 0.47$) and then DSO34–PHQ6 (*Negative self-concept—Feeling like a failure*; $r = 0.46$). The regularized partial correlation networks are depicted in Figure 1.

3.3 | Centrality Analysis

The mean item scores, EI values and bridge EI values of each item are presented in Table 2 and Figure 2. As for EI, we found that DSO5 'Feeling distant or cut off from people', PHQ2 'Feeling down, depressed, or hopeless' and PHQ6 'Feeling like a failure' had the highest EI, which indicated that these symptoms had strong direct connections to other neighbouring symptoms and thus affected them strongly.

We used a bridge centrality test to assess the bridge symptoms in the network. We found that DSO34 'Negative self-concept', PHQ6 'Feeling like a failure', DSO1 'When I am upset, it takes me a long time to calm down' and DSO6 'Finding it hard to stay emotionally close to people' had the highest bridge EI, indicating these symptoms are important in connecting different mental disorders.

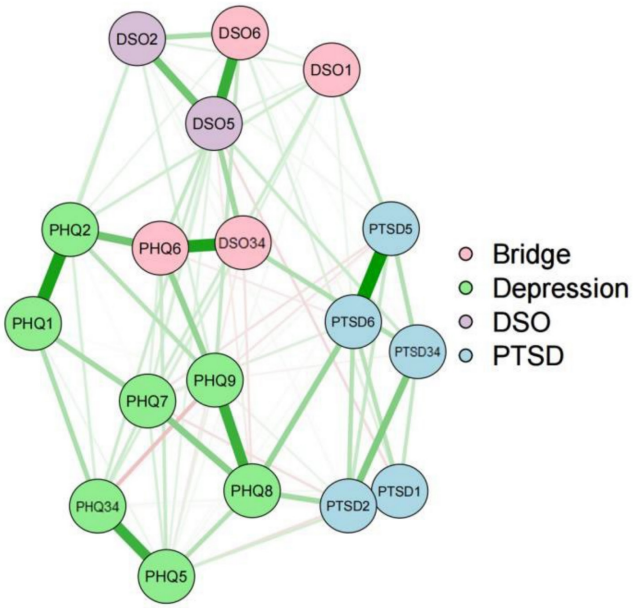

FIGURE 1 | The network structure.

3.4 | Accuracy and Stability Estimation

Robustness tests were used to assess the stability and accuracy of the networks (see Figures S1–S4). The results showed that the CS coefficients of the EI and bridge EI were 0.67 and 0.60, respectively, representing good stability.

4 | Discussion

This study explored the comorbidity network of PTSD/CPTSD and depression in a US trauma-exposed sample. We found that 'negative self-concept', 'feeling like a failure', 'when I am upset, it takes me a long time to calm down' and 'I find it hard to stay emotionally close to people' were bridge symptoms, highlighting the role of DSO symptoms in connecting PTSD/CPTSD and depression. In addition, 'feeling distant or cut off from people', 'feeling down, depressed, or hopeless' and 'feeling like a failure' were central symptoms in the comorbidity network and had stronger associations with other symptoms across the network.

Negative self-concept is not only a central symptom in the whole network but also a bridge symptom connecting different symptom clusters. The symptom itself overlaps between depression and CPTSD. Traumatic events can lead to a disruption of normal identity development (Harter 1998). According to the MI theory, experiencing single or multiple traumatic events will contradict an individual's positive sense of self and strengthen their negative identity (Hyland et al. 2023). As negative identities are experienced more frequently, they become more powerful (Bjork and Bjork 1992). This negative identity will further affect the development of the entire symptom

TABLE 2 | The network's EI values and bridge EI values.

	Items	EI	Bridge EI
PHQ1	Little interest or pleasure in doing things	0.95	0.09
PHQ2	Feeling down, depressed or hopeless	1.22	0.24
PHQ34	Trouble falling or staying asleep, or sleeping too much; feeling tired or having little energy	0.78	0.18
PHQ5	Poor appetite or overeating	0.90	0.09
PHQ6	Feeling like a failure	1.20	0.53
PHQ7	Trouble concentrating	0.79	0.17
PHQ8	Moving/speaking slowly or fidgety/restless	1.08	0.31
PHQ9	Thoughts that better off dead/suicide	0.79	0.15
PTSD1	Having upsetting dreams	0.82	0.13
PTSD2	Having powerful images or memories	1.06	0.11
PTSD34	Avoiding internal reminders of the experience; avoiding external reminders of the experience	0.78	0.26
PTSD5	Being 'super–alert', watchful or on guard	0.85	0.08
PTSD6	Feeling jumpy or easily startled	1.11	0.31
DSO1	When I am upset, it takes me a long time to calm down	0.63	0.39
DSO2	Feeling numb or emotionally shut down	0.84	0.29
DSO34	Feeling like a failure; feeling worthless	0.88	0.59
DSO5	Feeling distant or cut off from people	1.24	0.31
DSO6	Finding it hard to stay emotionally close to people	1.01	0.37

Note: Table 1 presents the raw EI values and bridge EI values.

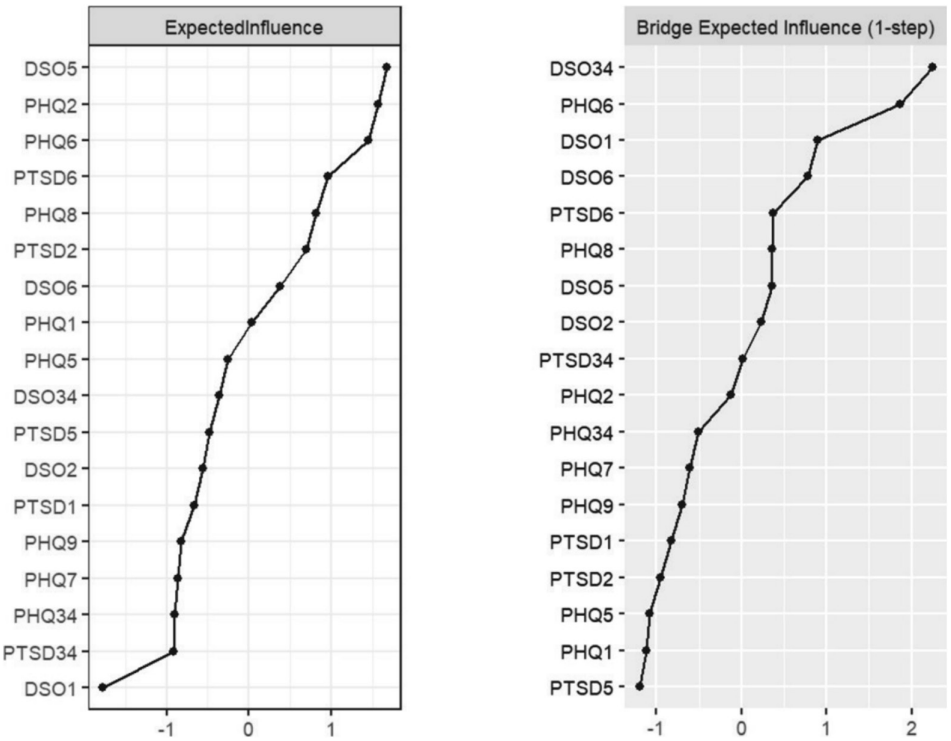

FIGURE 2 | The EI and bridge EI of the network. X-axis are standardized scores (z-scores).

network (Liu et al. 2024). Some previous studies have also found that feeling like a failure and feeling worthless are the central symptoms of the network of PTSD/CPTSD and depression (Gilbar 2020; Liu et al. 2024).

Emotion-related symptoms also deserve attention. From the perspective of CPTSD, many studies have shown that people who experience high-levels of early life stress have less volume in the prefrontal cortex, which is a brain region involved in emotion regulation (Teicher and Samson 2016). In addition, after experiencing early life stress, the connectivity between the amygdala and the prefrontal cortex is disrupted, and the prefrontal cortex's ability to regulate the stress response is impaired (VanTieghem and Tottenham 2018). Our research found that 'feeling down, depressed, or hopeless' is a central symptom in the network. This is consistent with some previous studies. An et al. (2021) found that not only in the depression cluster but also in the entire network of depression and PTSD; most of the important nodes are negative emotional symptoms. In other previous cross-sectional or longitudinal studies, sadness has also been found to have a considerable impact on other symptoms in the network (Liu et al. 2024; Qi et al. 2021). Besides, our study found that although the symptom 'When I am upset, it takes me a long time to calm down' does not have a high EI, it serves as a bridge symptom. Therefore, if this symptom can be effectively managed, potentially by means of therapeutic interventions which focus on emotion regulation skills, it may help reduce the connections between different disorders.

Disturbances in relationships are also important symptoms. A previous network analysis focused on PTSD also found that feeling distant or cut off from others is a core symptom (Duek et al. 2021). In our study, we found that this symptom was the most central node in the entire network of CPTSD/PTSD and depression. Our research also found that 'I find it hard to stay emotionally close to people' was a bridge symptom, which highlights the importance of disturbances in relationships. Previous research has shown that perceived social and emotional support may be a protective factor for individuals who experience trauma (Brinker and Cheruvu 2017), and perceived social support is associated with better mental health outcomes and reduced symptom severity (Ciarleglio et al. 2018; Simon et al. 2019). For individuals with these symptoms, it may be more difficult to perceive social support, further affecting the individual's recovery from traumatic experiences.

These results highlight the potentially important role of DSO. It seems that the affective, identity and interpersonal DSO symptoms largely explain the link between PTSD and depression. Previous research has mainly focused on the full symptom spectrum of CPTSD, that is, PTSD and DSO symptoms, rather than examining these two symptom complexes separately (i.e., PTSD vs. DSO symptoms). Although research focusing on only DSO symptoms is limited, existing studies consistently emphasize the significance of DSO symptoms. Bachem et al. (2021) suggested that post-trauma couple therapy should prioritize alleviating both partners' DSO symptoms rather than PTSD symptoms, as DSO symptoms seem to play a more critical role than PTSD symptoms in the transmission of post-traumatic stress between partners. Additionally, DSO has been found to be associated with physical illnesses. Kuhar et al. (2022) identified a mediating role of DSO in the relationship between Adverse Childhood Experiences and somatic symptoms. Moreover, a study has shown that, compared to CPTSD, isolated DSO symptoms may be more strongly linked to an increased risk of irritable bowel syndrome (Sakuma et al. 2024). In addition, previous research has shown that individuals with CPTSD exhibit reduced bilateral thalamic activation during inhibition tasks compared to those with PTSD and healthy controls, with no significant difference between the PTSD and control groups (Bryant et al. 2022). This may suggest that individuals with CPTSD who have DSO symptoms may experience more pronounced impairments in inhibitory control. This aligns with our network findings, where DSO symptoms emerged as important nodes, suggesting a possible association with inhibitory control difficulties.

The study also identified symptom pairs with high edge weights. Some of these, such as PTSD5–PTSD6 ('Being super-alert, watchful or on guard' and 'Feeling jumpy or easily startled'; $r = 0.51$), may result from semantic overlap, as they assess similar hyperarousal symptoms. Such strong connections should be interpreted with caution (Fried and Cramer 2017). Some symptom pairs showed strong associations despite lower semantic similarity. For example, PHQ1 and PHQ2 ('Little interest or pleasure in doing things'–'Feeling down, depressed, or hopeless'; $r = 0.47$) are both core depressive symptoms, and previous studies have also found a strong association between them (Beard et al. 2016). Other notable links include PHQ34 and PHQ5 ($r = 0.39$), which reflect somatic symptoms like sleep problems, fatigue and appetite changes. Clinically, targeting one symptom in a strongly connected pair may help alleviate related symptoms.

This study has several limitations. First, it was a cross-sectional study, and the comorbidity network was undirected. We cannot infer a causal relationship between these symptoms over time (Fried and Cramer 2017). Second, the sample in this study was from a non-clinical population. The symptoms of clinical samples tend to be more severe, and there may be more complex relationships between symptoms (Angelakis and Nixon 2015), although the range of symptom scores in a clinical sample is also often more restricted than that of a non-clinical sample. Our findings may provide useful insights for understanding symptom networks in clinical populations; however, caution is needed when generalizing these results. Previous research on differences between clinical and non-clinical symptom networks has shown mixed findings, with some studies reporting significant differences (e.g., Lazarov et al. 2020, in PTSD) and others reporting no significant differences in network structure (e.g., Hakulinen et al. 2020, in depression). Therefore, it is necessary to analyse the comorbidity network in clinical samples in the future. Thirdly, our study included CPTSD/PTSD and depression, which are the most common mental disorders in the trauma-exposed population (Fung et al. 2022; Karatzias et al. 2019), but we may have overlooked some other symptoms, such as anxiety and substance abuse (Gilbar 2020; Vazan et al. 2013), as well as non-symptomatic variables that play a role in the comorbidity network, such as coping styles and social support (Badour et al. 2012; Zhou et al. 2019). Future studies should aim to ensure a more complete coverage of symptoms (nodes) in the network. Fourth, all data were obtained through self-report

measures, which are susceptible to biases such as social desirability and recall bias. Finally, although the selection of our sample was guided by a cross-stratifying approach based on age, ethnicity and sex, it is unlikely that our sample was highly representative of the overall US population.

Despite these limitations, this study offers several novel contributions. Unlike prior research relying on DSM-5-based measures, we used ICD-11 criteria to avoid symptom overlap, allowing clearer differentiation between PTSD, DSO and depression. We also focused specifically on bridge symptoms between these clusters, rather than only overall network centrality. Theoretically, our findings, viewed through a network analytic lens, partially align with the transdiagnostic framework, suggesting that DSO symptoms such as emotion dysregulation serve as cross-disorder factors implicated in a range of psychiatric conditions (Beauchaine and Cicchetti 2019). Our findings offer a symptom-level perspective on the comorbidity between PTSD, CPTSD and depression. DSO symptoms were strongly connected to PTSD and depression symptoms, suggesting that mutual activation between these symptoms may drive the risk of comorbidity (Jones et al. 2021). Clinically, identifying such bridge symptoms is important, as targeting interventions at these bridge symptoms is likely to have the greatest impact at reducing the overall constellation of PTSD/CPTSD and depression symptoms (Jones et al. 2021). Specifically, for negative self-concept, therapies that target negative self-evaluations, such as self-compassion related therapy (Wilson et al. 2019), may be particularly effective. For emotion dysregulation, psychoeducation and skills training focused on emotional regulation have shown benefits (Courtois et al. 2009). For interpersonal difficulties, interventions that include an explicit focus on interpersonal and relationship functioning—such as Skills Training in Affective and Interpersonal Regulation (STAIR; Cloitre et al. 2020)—hold promise for the erosion of these difficulties. These findings also support phase-based treatments, which emphasize the importance of preparing individuals for trauma memory processing (Cloitre et al. 2002; de Boer et al. 2021). Working on DSO symptoms in the initial phase of treatment may enhance individuals' overall functioning and readiness to engage with the more intensive aspects of trauma-focused therapy.

Acknowledgements

The authors have nothing to report. Open access publishing facilitated by Australian National University, as part of the Wiley - Australian National University agreement via the Council of Australian University Librarians.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The de-identified data used for the present study are available at www.osf.io/w7ahj.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.