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Positive Symptoms of Psychosis and International Classification of Diseases 11th Revision (ICD-11) Complex Post-traumatic Stress Disorder: A Network Analysis in a Canadian Sample from Montreal

Symptômes positifs de psychose et trouble de stress post-traumatique complexe (CIM-11): Une analyse de réseau dans un échantillon canadien de Montréal

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Abstract

Objectives: Traumatic experiences constitute a risk factor for developing different psychopathologies, such as post-traumatic stress disorder (PTSD), complex PTSD (CPTSD), and positive symptoms of psychosis. However, on the symptom level, it is still unclear how CPTSD and positive symptoms of psychosis associate with each other. The present study aimed to shed light on these dynamics by investigating the symptoms network of CPTSD and positive symptoms of psychosis.

Methods: A network analysis was performed on CPTSD and psychosis symptoms among a Canadian community sample with a history of traumatic life events ($n = 747$). Measures included the international trauma questionnaire and the mPRIME screen.

Results: In total, 4.8% of the sample reached the criteria of probable PTSD and 7% fulfilled the criteria of probable CPTSD. PTSD and CPTSD groups had a significantly higher severity of positive symptoms of psychosis compared to the no-disorder group. Network analysis revealed 3 distinct communities of symptoms of PTSD, disturbances in self-organization, and psychosis. Affective dysregulation served as the bridging symptom between the communities. Hearing one's own thoughts aloud was the most central symptom in the network.

Conclusions: Findings show that positive symptoms of psychosis can be considered trauma-related responses. Furthermore, interventions targeting affective dysregulation as well as the experience and distress associated with hearing one's own thoughts aloud may contribute to symptom reduction and improved functioning.

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Understanding the Link Between Trauma and Psychosis: Insights From a Canadian Study
Plain Language Summary
Traumatic experiences can deeply affect mental health, leading to conditions like post-traumatic stress disorder (PTSD) and complex PTSD (CPTSD). CPTSD includes symptoms like difficulty controlling emotions, negative self-perceptions, and relationship challenges, alongside traditional PTSD symptoms such as flashbacks and avoidance of reminders. Interestingly, trauma is also linked to psychosis symptoms, such as delusions and hearing voices. This study explored how CPTSD and psychosis symptoms are connected, using data from 747 adults in Montreal who had experienced trauma. Researchers analysed how different symptoms interacted in a network to identify key symptoms linking the conditions. They found that difficulties in calming down when upset acted as a bridge between trauma-related symptoms and psychosis symptoms. Additionally, hearing one's own thoughts aloud was identified as a central symptom in the network. The study highlights the importance of addressing emotional regulation difficulties and auditory experiences in treating individuals with CPTSD and psychosis-like symptoms. These findings could help clinicians target key symptoms for better mental health outcomes. However, the study's findings may not apply to all populations due to its focus on a specific group from Montreal, and further research is needed to understand the cause-and-effect relationships.

Résumé
Objectifs: Les expériences traumatiques sont un facteur de risque pour l'apparition de différentes psychopathologies, comme le trouble de stress post-traumatique (TSPT), le trouble de stress post-traumatique complexe (TSPT complexe) et les symptômes positifs de psychose. Toutefois, en ce qui concerne les symptômes, l'association entre TSPT complexe et symptômes positifs de la psychose est encore mal définie. La présente étude visait à faire la lumière sur ces dynamiques en examinant le réseau de symptômes du TSPT complexe et les symptômes positifs de la psychose.

Méthodes: Une analyse de réseau a été effectuée sur les symptômes de TSPT complexe et de psychose dans un échantillon communautaire canadien ayant des antécédents d'événements de vie traumatisants (n = 747). Les mesures comprenaient l'International trauma questionnaire (IQT) et le dépistage mPRIME.

Résultats: 4,8 % de l'échantillon ont atteint les critères du TSPT probable; 7 % ont satisfait aux critères du TSPT complexe probable. Les groupes TSPT et TSPT complexe présentaient des symptômes positifs de psychose significativement plus graves que le groupe sans trouble. L'analyse de réseau a révélé trois communautés distinctes de symptômes de TSPT, de troubles de l'auto-organisation et de psychose. La dysrégulation affective a servi de symptôme de rapprochement entre les communautés. Le fait d'entendre ses propres pensées à haute voix était le symptôme le plus central du réseau.

Conclusions: Les résultats montrent que les symptômes positifs de la psychose peuvent être considérés comme des réactions liées au traumatisme. De plus, les interventions ciblant la dysrégulation affective ainsi que l'expérience d'entendre ses propres pensées à haute voix et la détresse associée peuvent contribuer à la réduction des symptômes et à l'amélioration du fonctionnement.

Keywords
complex post-traumatic stress disorder (CPTSD), post-traumatic stress disorder (PTSD), positive symptoms of psychosis, symptoms network analysis

The Association of Positive Symptoms of Psychosis With Complex Post-traumatic Stress Disorder (CPTSD): A Network Analytical Perspective

A solid body of research shows that traumatic experiences are not only associated with a heightened risk for post-traumatic stress disorder (PTSD) but also constitute a risk factor for experiencing psychosis symptoms.[1] The relationship between PTSD symptoms and psychosis symptoms has long been subject to research,[2] and scholars proposed that PTSD and psychosis could be part of a spectrum of reactions to trauma.[3,4] This perspective aligns with studies showing that the Diagnostic and Statistical Manual of Mental Disorders (DSM) PTSD is a key predictor of psychotic symptom severity and is more prevalent among individuals with a psychotic disorder compared to the general population.[5] However, scarce research has examined the association between the International Classification of Diseases 11th Revision (ICD-11) PTSD and complex PTSD (CPTSD) with psychotic symptoms.[6] Specifically, it remains unclear how symptoms of PTSD, CPTSD, and psychosis interact with each other. The present study aimed to investigate the symptoms network of CPTSD and positive psychosis symptoms.

The diagnosis of CPTSD has been introduced in the 11th revision of the International Classification of Diseases.[7] CPTSD includes both "classic" PTSD symptoms (re-experiencing the

trauma, avoidance of traumatic reminders, and a persistent sense of threat [SoT]) as well as disturbances in self-organization (DSO), and thus, represents more severe trauma sequelae.[8] DSO comprises the 3 symptom clusters of affective dysregulation, negative self-concept (NSC), and difficulties in relationships.[7] Evidence suggests that post-traumatic stress reactions occur on a continuum, whereby cumulative trauma exposure seemed to be conducive to a higher risk of developing more severe trauma sequelae, that is, CPTSD.[9] Furthermore, CPTSD often results from complex and chronic interpersonal traumatic experiences from which escape is difficult, such as childhood sexual or physical abuse.[7] Childhood trauma, however, has also been recognized as an important risk factor for psychosis symptoms, for example.[1]

Positive psychosis symptoms comprise delusions, hallucinations, and formal thought disorder. Contrary to traditional beliefs that symptoms such as delusions and hallucinations are outside of the realm of normal experience, psychosis symptoms have recently become understood as a construct on a spectrum of severity.[7] Psychotic-like experiences (i.e., psychosis symptoms that are not deemed clinically relevant) are found in general population samples with prevalence rates of up to 7.2%.[10] Similarly to CPTSD, the risk of developing psychosis symptoms was shown to be linked to traumatic experiences in a dose-response manner in the general population.[11]

However, few published studies explored the associations between psychosis symptoms and ICD-11 PTSD and CPTSD. Frost et al.[3] showed that cumulative childhood adversity was predictive of the occurrence (and co-occurrence) of both psychosis and CPTSD symptoms among a trauma-exposed population sample. Ho et al.[4] further confirmed the significance of this comorbidity, showing a moderate correlation between CPTSD and psychosis symptoms. Likewise, in an adolescent population study, both PTSD and CPTSD correlated with psychotic-like experiences, with CPTSD notably linked to greater distress related to psychosis symptoms.[12] The authors suggested that CPTSD poses a higher risk for transitioning to psychosis than PTSD. Consistent with this, CPTSD prevalence exceeded that of PTSD in a trauma-exposed clinical sample with schizophrenia. Additionally, PTSD and DSO symptoms mediated the link between trauma exposure and positive psychosis symptoms.[13] Finally, Mason et al.[6] showed that CPTSD (but not PTSD) was a significant mediator between childhood trauma and psychosis symptom severity. However, the subtle interactions among PTSD, CPTSD, and psychosis symptoms remain less explored. Moreover, the question arises as to whether varying levels of trauma exposure are associated with the co-occurrence of PTSD, DSO, and psychosis-like symptoms. Network analysis, capable of uncovering these connections, remains underutilized in this context. Symptoms network analysis transcends traditional diagnostic categories visually, representing the intricate relationships between symptoms and emphasizing key central and bridging symptoms essential for comprehending disorders.[14] Central symptoms, with strong associations to others, represent pivotal aspects of the disorder and key treatment targets.[15] Moreover, bridging symptoms link comorbidities and enable targeted interventions for co-occurring disorders.[16] Despite its potential, network analysis has seldom been used to understand posttraumatic and psychosis symptoms. A notable study applied it to DSM-5 PTSD, revealing trauma-related negative self- and world views, self-blame and hypervigilance as key links between PTSD and psychosis symptoms.[17] However, previous network analyses have used small samples of patients diagnosed with psychotic disorders[17] rather than large general population samples with subthreshold symptoms. Investigating the symptom network in large samples of the general population can enhance our understanding of early symptom interactions, aiding in the identification of public health warning signs. Moreover, exploring preclinical stages can reveal relevant information for the prevention of severe psychopathologies. Network analysis could identify key CPTSD symptoms linked to psychosis.

The main goals of the present study were to: (1) investigate the relationships between CPTSD clusters, positive psychosis symptoms, and total trauma exposure; (2) examine the links between individual positive psychosis symptoms and the presence of PTSD/CPTSD versus no disorder; (3) analyse symptom clusters (communities) in the network to assess if positive psychosis symptoms and PTSD/DSO manifest as distinct entities; (4) explore symptom strength centrality and bridges in the network to identify connections between positive psychosis and CPTSD; (5) determine if the association between CPTSD and positive psychosis symptoms in the network was moderated by trauma exposure level.

Method

Participants

The study utilized data from the Greater Montreal Area Study on mental health and creativity. Data were collected in July 2021 from 1,000 adults via Qualtrics using quota sampling based on sex, age, and geolocation. Participants, aged 18+, completed the study in English. Recruitment was through managed panels via email, SMS, or app notifications, with ethical approval from the first author's University Institutional Review Board (20191030). All participants provided electronic informed consent.

This study included 747 participants who experienced at least 1 traumatic life event and was approximately representative regarding sex, age, and geolocation,[18] with 51.1% males and 48.9% females, aged 18 to 65 ($M = 39.93$; SD = 12.49). Among them, 60.1% were in committed relationships. Educational attainment varied, with 28.5% completing secondary school, 34.7% holding undergraduate degrees, and 35.3% holding postgraduate degrees. In terms of employment, 57.4% were employed full-time, 1.3% part-time,

8.0% unemployed and seeking work, and 16.2% not employed for various reasons.

Measures

Exposure to traumatic life events was measured using the International Trauma Exposure Measure (ITEM). Consistent with the definition of trauma exposure in the ICD-11, the ITEM measures exposure to 21 different traumatic life events (total score ranging from 0 to 21).

PTSD and CPTSD symptoms were measured using the International Trauma Questionnaire (ITQ).[19] The ITQ includes 6 PTSD items and 6 DSO items. The PTSD symptom clusters of re-experiencing, avoidance, and SoT are measured using 2 items each. The DSO symptom clusters of affective dysregulation, NSC, and disturbances in relationships (DiR) are measured by 2 items each. Functional impairment is assessed for both PTSD and DSO. All items were answered using a 5-point adjectival scale ranging from "not at all" (0) to "extremely" (4). Scores $\geq$2 ("moderately") were used to indicate the presence of a symptom. Algorithms for probable PTSD and CPTSD endorsement can be found in Cloitre et al.[19] The internal consistency estimates for the PTSD ($\alpha = .924$) and DSO items ($\alpha = .917$) in this study were excellent.

The mPRIME screen[20] is a short self-administered adaptation of the original PRIME screen questionnaire,[21,22] assessing the risk for developing a psychotic disorder. It is based on the positive symptom items of the Structured Interview for Psychosis-Risk Syndromes.[21] It asks about the occurrence of positive symptoms over the last year with responses measured on a Likert-scale of 0 ("definitely disagree") to 6 ("definitely agree") with a response of "not sure" being represented by a value of 3. Two of the original PRIME screen questionnaires were replaced (items 9 and 12) with modified items (see Table 2 for full mPRIME screen and supplemental materials for further information). It showed a specificity and sensitivity (against Structured Interview for Psychosis Risk Syndromes [SIPS] as a gold standard) of 0.74 and 1.00, and a concordant validity of 0.43.[22] The internal consistency in this study was excellent ($\alpha = .949$).

Statistical Analysis

We conducted a multivariate analysis of variance with Bonferroni post hoc tests and age and negative life events as covariates. CPTSD, PTSD, and no-disorder group means were compared for individual items of positive psychosis symptoms.

Network Estimation

The symptom network was estimated for all symptoms of CPTSD (i.e., PTSD and DSO) and positive symptoms of psychosis using the R-package qgraph.[23] The network was weighted and undirected as data were cross-sectional. Questionnaire data were answered at an ordinal scale, thus we estimated a polychoric matrix. We estimated partial pairwise correlation parameters between all nodes (i.e., symptoms), through a Gaussian Graphical Model.[15] Regularized partial polychromic correlations were used as edge estimates, which represent the unique, independent relationships between symptoms. Edge estimates indicate how strongly 2 symptoms are related. This method directly estimates the inverse of the covariance matrix.[24] In Gaussian Graphical Model (GGM), numerous parameters can create redundant edges, which are managed using the least absolute shrinkage and selection operator (LASSO) that utilizes partial correlations (implemented in qgraph[25]). Finally, we used the extended Bayesian Information Criterion,[25] which estimates the inverse of the covariance matrix to choose the optimal model with a tuning parameter of 0.5.

Network Inference

We used indices of centrality to describe the connectedness of each node in the network.

Central symptoms are highly connected to other symptoms and may act as "hubs" within the network. Addressing these symptoms in treatment may have widespread effects on the network. The centrality index node parameters were calculated using the *centrality Plot* and *centralityTable* functions in qgraph.[23] The commonly used strength index of centrality for each network was calculated.[26]

Stability and Accuracy

To assess the accuracy of the edge weight estimates, we conducted the bootnet package[15] using nonparametric bootstrapping based on 2000 samples, including estimating 95% confidence intervals around the edge weights. To assess the accuracy of the centrality estimates, we used the subsetting bootstrap function implemented in the bootnet package using 2000 samples (see supplemental materials for further information).

Community Detection

The *spinglass* algorithm was used to identify communities of items in the network (i.e., symptom clusters that co-occur or reinforce one another) using the *igraph R*-package. Edges should connect nodes of the same community, whereas nodes belonging to different communities should not be connected.[27] We ran the algorithm 1000 times with a different random seed for each run.

Bridge Symptoms

We used the *bridge* function of the *networktools* package[28] to identify bridge symptoms between anxiety and depression in

each network. This provides valuable insights, as it helps identify symptoms that increase the risk of comorbidity and should, therefore, be closely monitored in clinical practice. Bridge strength is defined as the sum of the absolute value of all edges that exist between a node and all nodes that are not in the same cluster.

Group Comparisons

Additionally, we explored the moderating role of exposure level on the associations between CPTSD and psychosis-like symptoms in the network. Network invariance and global strength comparison tests were conducted between groups with high exposure (≥3 events, $n = 705$) versus low exposure (1–2 events, $n = 135$) to traumatic life events. The Network Comparison Test is described in supplemental materials.

Results

Table 1 presents item-level descriptive statistics for the ITQ and mPrime and correlation with total trauma exposure. Table 2 presents the overall frequency of the PTSD and DSO subfactors as well as means and standard deviations of the items of positive symptoms of psychosis across the groups of CPTSD, PTSD, and no-disorder. A total of 4.8% ($n = 40$) of the sample reached the criteria of probable PTSD and an additional 7% ($n = 48$) fulfilled the criteria of probable CPTSD (88.2%; $n = 741$ reported neither probable CPTSD nor PTSD).

The Association Between Specific Positive Psychosis Symptoms and CPTSD/PTSD

A multivariate analysis of variance, controlling for age and traumatic life events, found significant differences between CPTSD, PTSD, and no-disorder groups (all p-values <.0001). Table 2 shows specific comparisons, with uppercase letters denoting distinct or similar group means. Both CPTSD and PTSD groups reported higher psychosis risk symptoms than the no-disorder group, except for "special or supernatural gifts," where no difference was found between PTSD and no-disorder. However, the CPTSD group reported higher means for this symptom compared to both groups. The CPTSD group also showed a higher risk of psychosis symptoms than PTSD for "odd or unusual things," "read minds," "plans to hurt me," and "worsened functioning." Traumatic life events and age were significant predictors for all positive symptoms.

Network Estimation

The symptom network revealed 148 out of 276 possible edges were nonzero (54%), with the average layout shown in Figure 1. A post hoc Monte Carlo power analysis for cross-sectional network models (R package: powerly[29]) indicated a power of 0.87, given a sensitivity of 0.70, the sample size, and the number of nodes/edges.

Table 1. Item Level Descriptive Statistics for the ITQ and mPrime and Correlation With Total Trauma (ITEM).

	Mean	SD	Correlation with ITEM
PTSD			
Re1. Having upsetting dreams	1.34	1.26	.34***
Re2. Having powerful images	1.44	1.27	.32***
Av1. Avoiding internal reminders	1.47	1.30	.38***
Av2. Avoiding external reminders	1.45	1.34	.37***
SoT1.Being "super-alert"	1.70	1.40	.33***
SoT2. Feeling jumpy or easily startled?	1.55	1.34	.40***
DSO			
Ad1. Long time to calm down.	1.63	1.20	.25***
Ad2. I feel numb or emotionally shut down.	1.58	1.30	.33***
NSC1. I feel like a failure.	1.46	1.37	.31***
NSC2. I feel worthless.	1.35	1.36	.30***
DiR1. I feel distant or cut off from people.	1.60	1.33	.30***
DiR2. I find it hard to stay emotionally close	1.53	1.31	.30***
Psychosis-risk symptoms			
Odd or unusual things	2.90	1.81	.15***
Predict the future	2.18	1.78	.29***
Controlling thoughts	2.28	1.85	.31***
Superstitions	2.31	1.85	.32***
Real or imagination	2.33	1.83	.32***
Read minds	2.19	1.86	.36***
Plans to hurt me	2.24	1.92	.37***
Special or supernatural gifts	2.18	1.94	.34***
Worsened functioning	2.19	1.90	.37***
Hearing people talking	2.03	1.92	.34***
Hearing own thoughts	2.07	1.92	.35***
Going mad	2.14	1.96	.39***
ITEM total	8.91	5.30	–

Abbreviations: ITQ, international trauma questionnaire; ITEM, International Trauma Exposure Measure; SD, standard deviation; PTSD: post-traumatic stress disorder; DSO, disturbances in self-organization; DiR, disturbances in relationships.

Community Analysis and Bridge Strength

Communities aligned with the ITQ's factor structure, consistently revealing a 3-community solution across all extractions. This suggests that the 2 dimensions of PTSD and DSO cluster separately, while psychosis symptoms form a third cluster. Item AD1 ("difficulties to calm down when upset") exhibited the highest bridge strength (see Figure 2).

Network Inference

Item Hear-Own ("hear own thoughts aloud") had the highest strength centrality in the network (see Figure 2).

Table 2. Frequency of Symptom Endorsement ($N = 747$).

Symptoms		Endorsement (%)
PTSD	Re-experiencing	27.0
	Avoidance	29.5
	Sense of threat	34.9
DSO	Affective dysregulation	33.8
	Negative self-concept	28.9
	Difficulties in relationships	33.1

Psychosis-risk symptoms	No-disorder *M* (SD)	PTSD *M* (SD)	CPTSD *M* (SD)	*F*(4,831)	Effect size
1. Odd or unusual things	2.72 (1.75) [a]	3.78 (1.72) [b]	4.68 (1.53) [c]	33.76***	.09
2. Predict the future	2.01 (1.68) [a]	2.95 (1.95) [b]	3.81 (1.99) [b]	23.05***	.08
3. Controlling thoughts, feelings, action	2.07 (1.75) [a]	3.37 (1.75) [b]	4.17 (1.89) [b]	33.83***	.10
4. Superstitions	2.13 (1.74) [a]	3.63 (1.88) [b]	3.66 (2.22) [b]	21.12***	.08
5. Real or imagination	2.11 (1.72) [a]	3.38 (1.81) [b]	4.34 (1.78) [b]	37.95***	.11
6. Read minds	2.00 (1.76) [a]	2.85 (1.89) [b]	4.07 (1.85) [c]	25.47***	.09
7. Plans to hurt me	2.02 (1.80) [a]	2.95 (1.99) [b]	4.58 (1.59) [c]	40.91***	.12
8. Special or supernatural gifts	2.00 (1.83) [a]	2.73 (2.09) [a]	4.15 (2.09) [c]	24.90***	.09
9. Worsened functioning	1.95 (1.76) [a]	3.10 (1.92) [b]	4.64 (1.61) [c]	51.63***	.14
10. Hearing people talking	1.84 (1.80) [a]	3.10 (2.18) [b]	3.66 (2.23) [b]	21.54***	.08
11. Hearing own thoughts	1.82 (1.77) [a]	3.47 (2.06) [b]	4.24 (1.91) [b]	46.49***	.13
12. Going mad	1.88 (1.81) [a]	3.40 (2.04) [b]	4.53 (1.75) [b]	49.29***	.14

Abbreviations: PTSD: post-traumatic stress disorder; DSO, disturbances in self-organization; CPTSD, complex PTSD; *M*, mean; SD, standard deviation.
Note. Endorsement is the rate of individuals that reached criteria ≥2. All *F* statistics were significant at the level of 0.0001. Different uppercase letters represent significant group differences while similar uppercase letters represent similar (nonsignificant) group differences. ***$p < .0001$.

Network Stability

The edges showed satisfactory accuracy (Figure SM1, supplemental materials), and the centrality strength index demonstrated high accuracy (Figure SM2, supplemental materials). The stability coefficient for strength centrality exceeded the 0.5 cut-off for strong stability (16) at 0.75 (95% CI, 0.672 to 1). Similarly, edge accuracy was satisfactory (95% CI, 0.594 to 0.750).

Group Comparisons

Figure SM3 (supplemental materials) presents the networks for high- and low-exposure groups. Global strength testing showed similar networks between the groups ($p = .79$), with comparable centrality indices ("hear own thoughts aloud" and "control"). Strength centrality and bridge graphs are in Figures SM4 and SM5 (Supplemental Material), and stability and accuracy are in Figures SM6 and SM7 (Supplemental Material). The bridge symptom was affective dysregulation ("difficulties to calm down when upset"). Invariance testing revealed group differences, likely due to lower edge and centrality stability in the low-exposure group compared to satisfactory stability in the high-exposure group (see Supplemental Materials).

Discussion

For most positive psychosis symptoms, we identified significant mean differences with small–medium effect sizes between participants who did not screen positive for PTSD/CPTSD and those with probable PTSD and CPTSD. The CPTSD group reported an even higher risk than the PTSD group in several individual domains (i.e., "odd or unusual things," "read minds," "plans to hurt me," and "worsened functioning"). The results of the network analysis suggest 3 distinct communities of PTSD, DSO, and psychosis.

Affective dysregulation ("difficulties to calm down when upset") served as the bridging symptom between the communities. Centrality analysis showed that hearing one's thoughts being said aloud was most central. This was replicated also when comparing groups with high and low trauma exposure. The networks showed high stability of the edges and good centrality accuracy. However, poorer stability was revealed in the low-exposure group, likely due to the weaker relevance of CPTSD and the small sample size.

In line with previous research,[3,12,13] individuals who fulfilled the criteria of probable PTSD or CPTSD had a significantly higher severity of positive symptoms of psychosis compared to the no-disorder group. Notably, however, differences between CPTSD and PTSD only comprised the specific symptoms of "odd or unusual things," "read minds," "plans to hurt me," and "worsened functioning," which were significantly more severe in the CPTSD group relative to the PTSD group. This partially aligns with previous findings that identified differences between PTSD and CPTSD with regard to distress associated with psychosis symptoms severity.[6,12] However, prior to our study, there had been

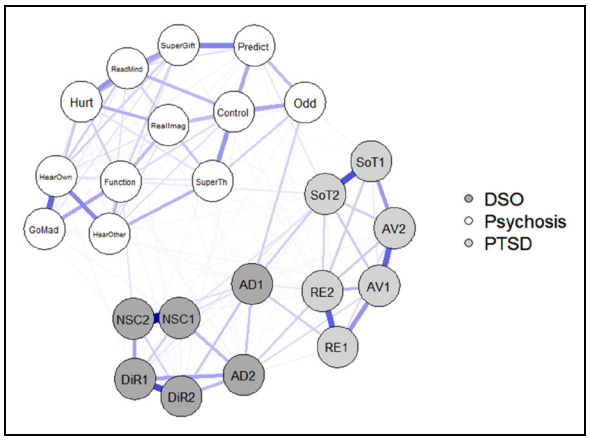

Figure 1. Network of CPTSD and psychotic symptoms using average spring layout. The 3 communities are coloured (PTSD, DSO, and psychosis) nodes representing items, and edges regularized partial correlations with LASSO penalty. Distances among nodes and thickness of edges relate to the size of their partial correlations. Blue edges indicate positive relations and red edges indicate negative relationships. **Odd**: I think that I have felt that there are odd or unusual things going on that I can't explain; **Predict**: I think that I might be able to predict the future; **Control**: I may have felt that there could possibly be something interrupting or controlling my thoughts, feelings, or actions; **Superstitious**: I have had the experience of doing something differently because of my superstitions; **RealImag:** I think that I may get confused at times whether something I experience, sense or see may be real or maybe just part of my imagination or dreams; **ReasMind:** I have thought that it might be possible that other people can read my mind, or that I can read other's minds; **Hurt**: I wonder if people may be planning to hurt me or even may be about to hurt me. **SuperGift**: I believe that I have special natural or supernatural gifts beyond my talents and natural strengths; **Function**: I feel that my ability to properly think or mentally function has seriously worsened in the last month; **HearOther**: I have had the experience of hearing faint or clear sounds of people or a person mumbling or talking when there is no one near me; **HearOwn**: I think that I may hear my own thoughts being said out loud; **GoMad**: I have been concerned that I might be "going mad." Abbreviations: PTSD, post-traumatic stress disorder; CPTSD, complex PTSD; LASSO, least absolute shrinkage and selection operator.

limited exploration into the specific associations between individual CPTSD symptoms and individual psychosis symptoms. The present results suggest that specific psychosis symptoms may represent correlates of severe trauma sequelae (i.e., CPTSD). These symptom-specific associations highlight substantial qualitative differences between CPTSD and PTSD in how they relate to psychosis symptoms. Additionally, while this evidence lends partial support to the idea of a continuum extending from post-traumatic stress severity, incorporating (C)PTSD and including psychosis symptoms (e.g., worsened functioning),[3] it also underscores the importance of addressing specific psychosis-related symptoms that stand out (e.g., "read minds" and "plans to hurt me").

DSO symptoms, core to CPTSD, may have contributed to the study's findings. For instance, DSO's interpersonal trust challenges could relate to psychosis-like symptoms such as "read minds," "odd or unusual things," or "plans to hurt me." Similarly, beliefs of thought-reading or imminent harm align with DSO's heightened emotional responses and trust issues, which are characteristic features of DSO. Additionally, "worsened functioning," indicating daily impairments, is often more severe in CPTSD than PTSD.[30]

Interestingly, belief in "special or supernatural gifts" only differed between individuals with probable PTSD and those with probable CPTSD. This belief may reflect changes in self-concept beyond the scope of PTSD diagnosis. Individuals with probable CPTSD, who experienced altered self-concepts, affirmed these beliefs, supporting this speculation. However, the existing literature suggests that such changes are typically negative, such as feeling diminished or worthless.[7,31] Beliefs in special or supernatural gifts, however, suggest positive aspects of the self-concept or, possibly, posttraumatic growth experiences.[32] Although there is a paucity of research linking CPTSD to posttraumatic growth, it could be speculated that based on the more fundamental posttraumatic changes in self-organization, posttraumatic growth may be more likely.[32] However, more research is needed to better understand the potential relationship between CPTSD, posttraumatic growth, and psychotic-like experiences.

Three symptom communities were identified in the network, reflecting PTSD, DSO, and positive psychosis-like symptoms. This finding is in line with a previous study in which psychotic experiences and PTSD symptoms also formed separate clusters in their overall network.[33] In the network analysis, "difficulties to calm down when upset" (affective hyperactivation) showed the highest bridge strength, and also in both low and high exposure groups, underscoring its pivotal role in connecting symptom clusters. This indicates that in CPTSD, heightened emotional reactivity is a significant contributor to the co-occurrence of CPTSD and positive psychosis symptoms, aligning with research that links affective dysregulation to trauma exposure and psychosis[6,13] and that it is an important risk factor for the development of psychosis.[34] For instance, dysfunctional affective regulation strategies were partly responsible for a stronger increase in paranoid beliefs following social stressor exposure in individuals at high risk of psychosis, compared to healthy controls and those with anxiety disorders.[35] Affective dysregulation was linked to a stronger stress response in individuals with psychosis, recognized as a key risk factor in psychosis etiology.[36,37] These findings indicate that affective dysregulation may account for the high co-occurrence of CPTSD and positive psychosis-like symptoms, highlighting the need for interventions targeting affective hyperactivation in managing CPTSD and psychosis. However, further longitudinal research is required to understand the causal and temporal dynamics of this relationship.

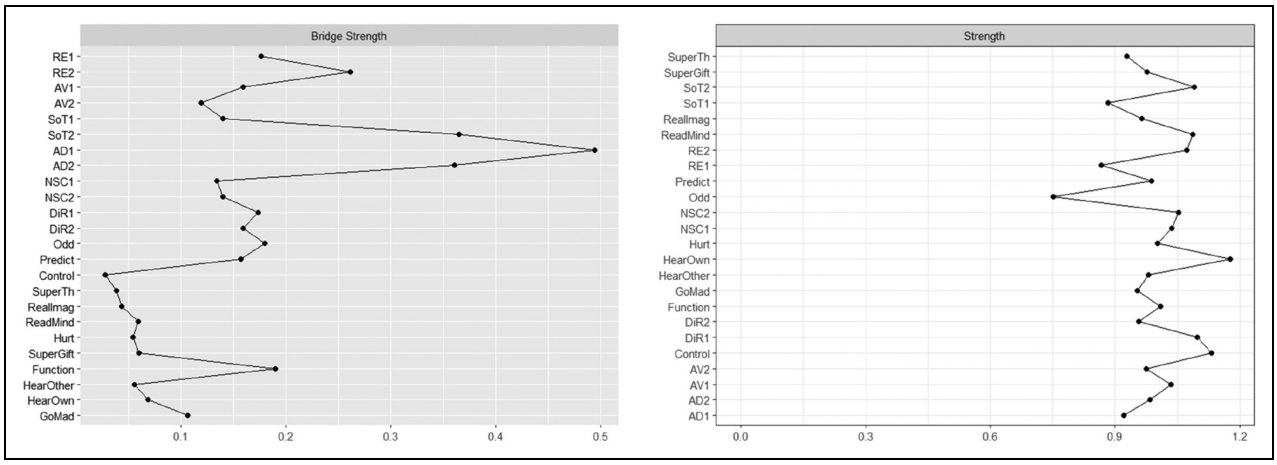

Figure 2. Strength bridge (left figure) and strength centrality (right figure).

Interestingly, network centrality did not coincide with bridge strength; centrality analysis showed that hearing one's thoughts being said out loud ("hear own thoughts aloud") was the most central symptom in the network and thus the node with the strongest interconnectivity with all symptoms in the network. Hearing own thoughts aloud has been recognized as an associated feature of PTSD,[31] which is supported by a strong body of evidence that found an association between voice hearing and traumatic memories.[38] Pertinent to this connection, research also revealed relatively high rates of auditory hallucinations among people affected by PTSD.[39] Moreover, some theorists contend that voice hearing reflects the essentially dissociative nature of a "normal" personality.[40] That is, voice hearing may not be the exclusive consequence of trauma exposure but an exaggeration of the universal experience of (negative) self-talk, potentially present in everyone and exacerbated following stress exposure.[40] Nonetheless, evidence from a community sample showed that among the most frequently endorsed psychosis symptoms, hearing own thoughts aloud was one of the most distressing experiences.[41] Therefore, hearing one's thoughts aloud can be burdensome and clinicians should monitor this symptom, which has a significant impact on managing these conditions.[40] Interventions targeting voice-hearing could be beneficial both among trauma and psychosis patients as well as at the subclinical level where it might be a preventive impact.

Several limitations should be acknowledged. Our study focused on positive rather than negative symptoms, potentially limiting the depth of understanding of the trauma-psychosis symptom relationship. Second, the use of self-report measures instead of clinician-administered interviews may introduce bias. Third, the cross-sectional study design does not allow temporal or causal inferences.[42] The exact role of affect dysregulation (highest bridge strength) and hearing own thoughts (highest network centrality) in the network remains to be explored in future research. Finally, while the data approximately represent the Greater Montreal Area in terms of sex, age, and geolocation, it is not fully representative, which limits the generalizability of the study's findings.

Despite its limitations, this study has important clinical implications. Findings show that positive symptoms of psychosis can be considered trauma-related responses in the case of both low and high trauma exposure. Furthermore, the findings accentuate the clinical importance of addressing both affective hyperactivation and auditory hallucinations in treating CPTSD with positive psychosis symptoms. Such focused interventions should abate these symptoms and thus prevent the development of future psychosis. These insights call for further research into the mechanisms of affective dysregulation and auditory symptoms in CPTSD and psychosis, to enhance clinical understanding and guide future research directions.

Data Access

Available upon request and consideration.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethics Statement

This study was performed following the Declaration of Helsinki. This human study was approved by Ariel University (Approval No. 20191030). All adult participants provided written informed consent to participate in this study.

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Supplemental Material

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