

A Network Approach to PTSD: Comparing Interview and Self-Report Networks

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A thesis

submitted in partial fulfillment of the

requirements for the degree of

Master of Science

University of Washington

2019

Committee:

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Program Authorized to Offer Degree:

Psychology

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Abstract

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PTSD may be characterized by networks of causal interactions among symptoms, and network analyses can identify central symptoms and processes that may be targeted for precise treatment. In this emerging area, few studies have examined treatment-seeking individuals with PTSD, limiting the clinical utility and generalizability of network analytic findings. In addition, there has been a reliance on self-report, as opposed to interviewer-assessed measures of PTSD symptoms, and a lack of systematic comparisons of the two assessment modalities. This study examined both self-report and interviewer-assessed PTSD network models. Treatment-seeking adults with primary PTSD ($N = 350$) completed interview and self-report measures of PTSD severity (PTSD Symptom Scale – Interview; Posttraumatic Stress Diagnostic Scale). Analyses included regularized partial correlation network estimation, stability analyses, centrality and community detection analyses, and network comparison tests. Centrality profiles were similar

across the networks ($r_s = .71$). Reactivity to trauma cues and interpersonal detachment demonstrating the strongest centrality, suggesting that cue reactivity and interpersonal processes may drive or be driven by other PTSD symptoms. The self-report network featured more and stronger relationships between symptoms compared to the interview network (global strength delta = 4.57, $p = .002$), particularly those with strong content similarities, such as avoidance of internal and external reminders, suggesting that interview assessments may offer superior specificity compared to self-report in assessing PTSD symptom relationships. Future network analytic studies should take into account assessment modality, and both re-experiencing and dysphoric symptoms, particularly interpersonal phenomena, should factor into targeted treatment and prevention approaches. Supplemental materials include Supplemental Method, Supplemental Tables 1 and 2, and Supplemental Figures 1 through 6.

Traditionally, clustering of posttraumatic stress disorder (PTSD) symptoms has been explained via common cause models, wherein latent factors reflecting distinct pathogenic processes produce co-occurring symptoms (Gilbertson, Gurvits, Lasko, Orr, & Pitman, 2001; Yufik & Simms, 2010). More recently, researchers have asserted that PTSD symptoms may co-occur because symptoms mutually reinforce one another (McNally et al., 2015). Instead of attempting to delineate the latent factor structure underlying PTSD symptoms, proponents of these causal systems models of PTSD emphasize identifying functional relationships between symptoms. By modeling these causal relationships as networks of nodes, reflecting symptoms, and edges, reflecting relationships between symptoms, researchers can apply network analytic tools to understand symptom centrality (i.e., influence), network global strength (i.e., overall magnitude network relationships), and communities of symptoms that may reflect independently functioning subgroups (Epskamp, Borsboom, & Fried, 2018). Altogether, these analyses may identify novel etiological processes, symptom relationships, and treatment targets overlooked by latent factor approaches.

Network approaches to PTSD have gained popularity rapidly in recent years. Across studies, PTSD symptoms appear to be highly interrelated. Intrusive memories, reactivity to trauma reminders, and interpersonal detachment have emerged repeatedly as highly central, or connected symptoms, possibly reflecting etiological drivers (Bryant et al., 2016; Fried et al., 2018). Only two studies (Bryant et al., 2016; Moshier et al., 2018) have utilized community detection algorithms to identify communities of PTSD symptoms, typically identifying between three and five symptom communities. Consistently, intrusion symptoms, dysphoric symptoms, and hyperarousal symptoms have clustered within their respective domains, whereas avoidance, sleep and negative belief symptoms have varied in community membership across studies. In

sum, PTSD network analyses have converged on memory intrusions and interpersonal detachment as potential drivers of other PTSD symptoms, with preliminary evidence for stronger relationships among symptoms of the same domain than between symptoms from different domains.

Given the large number of parameters estimated during network modeling and concerns over the replicability of network models (Fried & Cramer, 2017), it is important to investigate potential sources of methodological bias. Nearly all published PTSD network analyses have relied on self-report measures of PTSD severity. Indeed, only two studies (Bryant et al., 2016; Moshier et al., 2018) have utilized an interview measure of PTSD symptoms. Although self-report assessments generally demonstrate good sensitivity and specificity in distinguishing those with PTSD from healthy controls, they can substantially inflate severity scores and rates of PTSD compared to diagnostic interviews and underperform compared to interview assessments in distinguishing PTSD symptoms from other mood and anxiety disorders (e.g., Engelhard, Arntz, & Van den Hout, 2007). Patients may endorse symptoms that are not tied specifically to a traumatic event or that predate the trauma and thus are unlikely to reflect PTSD pathology per se. It is unclear how these issues may bias the symptom associations estimated in network models.

To date, only Moshier et al. (2018) has compared interview and self-report based PTSD networks. The authors combined two samples, trauma-exposed and treatment-seeking U.S. veterans, and found that intrusive memories and interpersonal detachment were the most central symptoms. Further, interview and self-report networks, based on the Clinician Administered PTSD Scale for DSM-5 (CAPS-5) and PTSD Checklist for DSM-5 (PCL-5), respectively, did not differ substantially in terms of overall symptom connectivity and specific symptom relationships. However, the authors did not directly compare centrality indices between the two

measures, and thus it remains unclear the extent to which interview and self-report assessments converge on identifying influential symptoms. Additionally, due to a sample of mostly male veterans that mixed clinical and non-clinical participants, it is unclear whether these findings generalize to treatment-seeking civilians or non-military trauma exposure. Indeed, treatment-seeking individuals are most likely to benefit from network-informed treatment insights that could inform more targeted approaches and may present with more severe symptoms or demonstrate different symptom relationships compared to non-clinical or mixed samples.

Accordingly, in the present study, treatment-seeking adults with chronic PTSD were administered both an interview and a self-report assessment of PTSD symptoms. Interview and self-report networks were estimated separately and then compared them across several aspects of network estimation and analysis, specifically global strength, edge placement, centrality profiles, community detection, and stability. In line with past PTSD network analyses, we hypothesized that intrusive memories, reactivity to trauma cues, and interpersonal detachment would demonstrate relatively high centrality. Due to the paucity of PTSD network analyses examining symptom communities or comparing interview and self-report networks, there were no additional *a priori* hypotheses.

Method

Participants

Participants were 350 women ($n = 264$, 75%) and men ($n = 86$, 25%) between the ages of 18 and 65 years with a DSM-IV primary diagnosis of PTSD who had enrolled in one of two larger, two-site PTSD treatment outcome studies (NCT00127673; NCT01600456). Both outcome studies were conducted at universities in the U.S., and both studies utilized similar inclusion and exclusion criteria and pre-treatment assessment protocols, which are detailed in the

supplementary materials. Participants' average age was 36.85 years ($SD = 11.68$); average time since trauma was ___ years ($SD = ___$). Participant demographic and psychopathology measures did not differ significantly between the two studies, and participants were collapsed to form a single sample. See Table 1 for additional sample characteristics.

Measures

Self-report and interview versions of the PTSD Symptom Scale (PSS-SR; Foa, Cashman, Jaycox, & Perry, 1997; PSS-I; Foa, Riggs, Dancu, & Rothbaum, 1993) consisting of seventeen items corresponding to the PTSD symptoms in the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; American Psychiatric Association, 1994) were used to assess PTSD symptom presence and severity. Items were rated on a four-point Likert scale according to the frequency and severity of symptoms over the past two weeks, ranging from 0 (*not at all*) to 3 (*5 or more times per week/very much*), yielding a total severity score and diagnosis. Both measures have strong psychometric properties (Foa et al., 1997, 1993). The PSS-I was used to determine PTSD diagnosis. Ten percent of cases were rerated for interrater reliability on the PSS-I; reliability was high for PTSD severity in both studies ($ICC = .95$ and $.89$). The Structured Clinical Interview for DSM-IV (SCID-IV; First, Spitzer, Gibbon, & Williams, 1995) was used to determine primary Axis-I diagnosis. See supplementary materials.

Procedure

Participants provided written informed consent. The PSS-I was completed by independent evaluators who received standardized training, including having to meet an 80% reliability criterion prior to serving as an evaluator. All interviewers were trained mental health professionals ranging from mental health nurses to PhD-level psychologists. After the initial intake, eligible participants completed self-report questionnaires, including the PSS-SR.

Data Analyses

All analyses were conducted in R version 3.5.0 (R Core Team, 2018).

Network estimation. Graphical network models were first generated consisting of nodes, that is, the DSM-IV PTSD symptoms, and edges, or the estimated relationships between pairs of nodes. Self-report and interview networks were estimated separately based on symptom severity ratings from the PSS-I and PSS-SR respectively, via the least absolute shrinkage and selection operator (LASSO) implemented in the R package *qgraph* (Epskamp, Cramer, Waldorp, Schmittmann, & Borsboom, 2012). Graphical LASSO (GLASSO) networks were estimated to reflect regularized partial correlations among all nodes, such that each edge reflected the unique relationship between a pair of nodes after accounting for the variance explained by all other nodes in the network. LASSO regularization mitigated the risk of spurious associations when estimating many pairwise relationships (Epskamp et al., 2018).

Network inference. After estimating interview and self-report network structures, node strength centrality was calculated (Borsboom & Cramer, 2013). Strength centrality consists of the summed absolute weights of all of a node's edges; thus, centrality reflects both the number and magnitude of direct connections to other nodes, with higher values indicating greater connectivity.

Network stability. The R package *bootnet* was used to construct confidence intervals (CIs) for each edge and to determine the stability of node centrality indices. Nonparametric bootstrapping (1,000 repetitions) was used to construct edge CIs; smaller CIs indicate more accurately estimated edge weights. A correlation stability coefficient (CS-coefficient) was calculated to assess centrality stability, with values above .25 indicating adequate stability (Epskamp et al., 2018).

Community Detection. To examine coherence of PTSD symptoms, the modularity-based, community detection algorithm spin glass (Reichardt & Bornholdt, 2006) was applied to the GLASSO networks via the *spinglass.community* function in the R package *igraph* (Csárdi & Nepusz, 2006).

Network Comparison. To assess differences in symptom centrality between the interview and self-report networks, node centrality indices were rank-correlated to obtain a coefficient of similarity for relative symptom centrality between networks. To compare network structures, the two networks' edge weight matrices were correlated, providing a global coefficient of similarity (Rhemtulla et al., 2016). Next, an omnibus, permutation-based Network Comparison Test (NCT; van Borkulo, Epskamp, & Millner, 2016) was used to test whether any edges differed between the interview and self-report networks, and post-hoc tests were used to assess which edges differed. The NCT employs a Holm-Bonferroni correction for multiple comparisons (van Borkulo et al., 2016). The NCT was then used to test whether interview and self-report networks differed in terms of global strength, that is, the sum of a network's absolute edge weights.

See supplementary materials for further details.

Results

Descriptive Statistics

Demographic characteristics are presented in Table 1, and symptom means and standard deviations are presented in Figure 1. Across the PSS-SR and PSS-I, avoidance of trauma-related thoughts and feelings (i.e., cognitive avoidance), sleep difficulties, and hypervigilance had the highest mean severity. Flashbacks, psychogenic amnesia, and nightmares had the lowest mean severity. Mean symptom severity was higher for the PSS-SR than for the PSS-I, $t(638.1) = 8.23$,

$p < .001$, $d = 0.63$. However, mean symptom profiles for the PSS-SR and the PSS-I were strongly correlated ($r_s = .91$). There was no difference in mean symptom variability between the PSS-SR ($M = 0.90$, $SD = 0.12$) and PSS-I ($M = 0.95$, $SD = 0.11$), $t(31.59) = -1.15$, $p = .26$. PSS-SR symptom means were strongly and negatively correlated with symptom standard deviations ($r_s = -.74$, $p = .001$), suggesting a ceiling effect, whereas PSS-I symptom means and standard deviations were not strongly correlated ($r_s = -.25$, $p = .34$). See Supplemental Tables 1 and 2 for PSS-SR and PSS-I item correlations.

Network Estimation

The self-report and interview networks are visualized in Figure 2. To facilitate visual comparison between networks, each network is plotted according to the average layout across both networks (Fruchterman & Reingold, 1991). Thus, nodes appear in the same spatial location in each figure. Out of 136 possible edges, 68 (50%) were non-zero for the self-report network, whereas 28 (31%) were non-zero for the interview network, reflecting more associations between self-reported PTSD symptoms. In the self-report network, all symptoms shared at least one non-zero edge with another symptom, whereas in the interview network, psychogenic amnesia was unconnected to any other symptom.

Network Inference

Strength centrality plots for both networks are presented in Figure 2. Self-report and interview centrality orders were strongly and positively correlated ($r_s = .71$). In the self-report network, interpersonal detachment ($z = 1.69$) and emotional reactivity to trauma cues ($z = 1.33$) were the most central nodes (standardized centrality estimates > 1); whereas irritability ($z = -1.43$) and amnesia ($z = -2.71$) were the least central. Similarly, in the interview network, physiological reactivity to trauma cues ($z = 2.15$), emotional reactivity to trauma cues ($z = 1.57$),

and interpersonal detachment ($z = 1.18$) emerged as central nodes; whereas irritability ($z = -1.15$), concentration difficulties ($z = -1.19$), and amnesia ($z = -1.77$) demonstrated low centrality. See Supplemental Figures 3 and 4 for additional centrality indices.

Network Stability

Self-report network edges ($M = 0.20$, $SD = 0.04$) were estimated moderately more reliably than were interview network edges ($M = 0.22$, $SD = 0.04$), as evidenced by mean CI lengths of non-zero edges, $t(53.57) = -2.02$, $p = .048$, $d = 0.44$. Strength centrality stability was good for the self-report network (CS -coefficient = .60) and acceptable for the interview network (CS -coefficient = .36), suggesting that centrality order for the interview network should be interpreted with some caution. See Supplemental Materials for centrality stability plots.

Centrality and variability were moderately related ($r = -.67$) for the self-report network, but weakly related for the interview network ($r = -.37$), suggesting that self-report network edges and centrality may be biased by differential variability.

Community Detection

Since the spin glass algorithm requires a fully-connected network (Reichardt & Bornholdt, 2006), networks omitting psychogenic amnesia were estimated. These 16-symptom networks were highly similar to their 17-symptom counterparts.

Five symptom subgroups in the self-report network and six subgroups in the interview network were detected; these subgroups are displayed in Figure 2. In both networks, re-experiencing symptoms were more closely connected with one another than with non-re-experiencing symptoms, though in the interview network these re-experiencing symptoms formed two sub-clusters: (a) intrusive thoughts and flashbacks; and (b) cue reactivity, nightmares, and cognitive avoidance. In both networks, communities of (a) dysphoric symptoms

and (b) exaggerated startle and hypervigilance appeared isolated from one another and from re-experiencing symptoms. The most pronounced differences in clustering between the two networks were that, in the self-report network, avoidance symptoms clustered together, as did sleep-related symptoms; however, in the interview network, cognitive avoidance clustered with re-experiencing while behavioral avoidance clustered with sleep difficulties.

Network Comparison

Self-report and interview edge weights were moderately related ($r_s = .34, p < .001$). Both networks featured strong edges (i.e., in the upper quartile of edge weights) between physiological and emotional reactivity to trauma cues, between startle response and hypervigilance, and among loss of interest in activities, interpersonal detachment and emotional numbing. In addition, the self-report network featured strong edges between sleep difficulties and nightmares, between experiential and behavioral avoidance, and between flashbacks and behavioral avoidance, whereas none of these edges was present in the interview network.

An omnibus network comparison test (NCT) for differences in any of the 136 possible edges between the two networks showed a reliable difference between the overall networks (maximum edge weight difference = .42, $p < .001$). To quantify the extent of edge weight differences between the interview and self-report networks, post-hoc tests for each edge pair were examined. After Holm-Bonferroni correction, eight out of 136 edges (5.9%) differed significantly between the two networks, with the largest differences seen for the edges between hypervigilance and startle reactivity, with edge weights of .68 and .26 in the self-report and interview networks, respectively; nightmares and sleep difficulties, with edge weights of .37 and .01 for self-report and interview networks, respectively; and cognitive and behavioral avoidance, with edge weights of .29 and .00 in self-report and interview networks, respectively. Finally, the

networks differed significantly in global strength, or connectivity, with the self-report network more strongly connected (global strength = 3.37) than the interview network (global strength = 0.14; $\delta = 3.23$, $p = .001$).

Discussion

The current study examined interview and self-report networks of PTSD symptoms in a chronic, treatment-seeking sample. Both interview and self-report networks pointed to reactivity to trauma cues and interpersonal detachment as potential drivers of other symptoms, and re-experiencing and dysphoric symptoms appeared in distinct but connected symptom communities. The interview network was more parsimonious than the self-report network and better differentiated between similar symptoms, such as cognitive and behavioral avoidance, yet both networks suggested that fear and reward processes contribute to PTSD symptomology in distinct but interacting ways. Below, we discuss implications of network inferences for the understanding of PTSD symptom dynamics among treatment-seeking adults.

Reactivity to trauma cues and interpersonal detachment were most strongly connected to other symptoms, particularly within their respective re-experiencing and dysphoric symptom communities. The formation of distinct communities of re-experiencing, hyperarousal, and dysphoric symptoms are consistent with theoretical conceptualizations of PTSD that posit biphasic alternations between periods of re-experiencing and avoidance (e.g., Horowitz, 1986). Consistent with past network analytic studies of PTSD (Bryant et al., 2016; Fried et al., 2018), trauma cue reactivity and interpersonal detachment may drive re-experiencing and withdrawal periods, respectively. Further, self-reported PTSD symptoms were more strongly connected than were interviewer-assessed symptoms, particularly for pairs of symptoms with similar content such as sleep difficulties and nightmares. This may reflect respondent biases inherent to self-

report, suggesting that interview assessments may offer superior specificity when assessing similar pairwise symptom associations.

Both symptom centrality profiles and symptom communities were similar across assessment modalities, suggesting that both re-experiencing and dysphoric symptoms may drive PTSD, and that avoidance and dysphoric symptoms may be driven by distinct but functionally-related motivational systems. Indeed, dysphoric symptoms include both anticipatory and consummatory anhedonia, that is the loss of interest in activities and restricted positive affect. Both avoidance and anhedonia may stem from deficits in fear and reward neural systems, respectively, with heightened avoidance associated with limbic hyperactivity, heightened anhedonia associated with striatal hypoactivity, and deficits in the integration of approach and avoidance associated with orbitofrontal cortex hypoactivity (Aupperle & Paulus, 2010; Nawijn, van Zuiden, et al., 2015). Reward processing deficits in PTSD, particularly for social rewards (Nawijn, van Zuiden, et al., 2015), may explain the distinct community of dysphoric symptoms and the heightened centrality of interpersonal detachment. Further, limited network connectivity between dysphoric and avoidance symptoms suggest that interventions that integrate fear and reward targets may result in more widespread symptom reductions than interventions that target either avoidance or dysphoria alone. Indeed, some authors have advocated reconceptualizing PTSD as characterized by an imbalance of approach and avoidance (Stein & Paulus, 2009).

Although interview and self-report networks point towards similar symptom drivers and communities, they differ markedly with respect to how strongly symptoms are related overall. Interviewer-assessed symptoms demonstrated greater independence than self-reported symptoms, particularly when looking between communities. A number of symptom relationships that appear only in the self-report network include links between symptoms with similar content,

such as between sleep difficulties and nightmares and between cognitive and behavioral avoidance. These links may reflect methodological artifacts of self-report measures such as double counting (e.g., endorsing both avoidance items in relation to a single act of avoidance), a well-established issue with self-report symptom inventories (Engelhard et al., 2007). The lack of specificity in delineating content-related symptoms may manifest in network models as spurious symptom associations, which in turn could inflate centrality estimates for the spuriously associated symptoms and distort community detection analyses. Indeed, past PTSD network studies utilizing self-report have found that both sleep symptoms belong to the same community, as do the both avoidance symptoms (Bryant et al., 2016; Fried et al., 2018), whereas the interview network in the present study placed these content-related symptoms in different communities. The community structure of the interview network suggests that cognitive avoidance is closely tied to re-experiencing symptoms, whereas behavioral avoidance is more closely tied to sleep difficulties. Thus, interview networks may identify relationships between symptoms that are obscured by self-report.

Further supporting superior specificity in interview networks, Moshier and colleagues (2018) observed stronger relationships between content-related symptoms in self-report compared to interview network, though differences between interview and self-report networks were less pronounced in Moshier et al. (2018). Since self-report PTSD measures rely on subjective distress for symptom ratings, higher subjective distress among the treatment-seeking participants in this study compared to the mix of treatment-seeking and trauma-exposed participants in Moshier et al. (2018) may explain the greater discrepancy between interview and self-report networks. Further, increased symptom content overlap in DSM-5 compared to DSM-IV (Brewin, Lanius, Novac, Schnyder, & Galea, 2009; Franklin et al., 2016) may have resulted

in increased network connectivity in Moshier et al.'s (2018) interview network. Indeed, DSM-IV PTSD symptoms may offer greater specificity for network analyses compared to DSM-5, though no studies have directly compared networks using these criteria.

Limitations of this study include the use of cross-sectional data prohibiting the distinction between driving symptoms and those that are driven by other symptoms. In addition, most PTSD network analyses, including this one, have exclusively modeled symptoms from diagnostic manuals, excluding other constructs thought to be etiologically involved in PTSD. Some of the most notable exclusions include intermediate phenotypes which may function as latent sources of symptom covariance or explain causal relationships between symptoms. For example, deficits in extinction learning (e.g., Bowers & Ressler, 2015; Jovanovic et al., 2010; Norrholm et al., 2011) may explain the covariance of re-experiencing symptoms, and avoidance may interfere with extinction learning, thus sustaining re-experiencing. Similarly, dysfunction in reward systems (e.g., Elman et al., 2005; Hopper et al., 2009; Nawijn, Zuiden, et al., 2015) may explain the covariance of dysphoric symptoms. Network structures alone do not indicate whether symptom relationships are explained by direct causal relationships or shared latent variables (Fried & Cramer, 2017; Hallquist, Wright, & Molenaar, 2018). Few studies (e.g., Hallquist et al., 2018) have investigated the impact of unmodeled latent variables on network inferences, yet accounts of both manifest symptoms and underlying pathogenic processes are required for comprehensive theories of PTSD symptom dynamics.

In conclusion, both interview and self-report networks provide evidence that reactivity to trauma cues and interpersonal detachment drive PTSD. Network structures are consistent with theoretical conceptualizations of PTSD that posit phasic alternations between periods of intrusions and withdrawal, the latter composed of two distinct patterns of withdrawal, strategic

avoidance and passive avoidance or dysphoria. A comparison of interview and self-report networks provides evidence that network structure is related to assessment modality, and that networks relying on self-report symptom data may perform poorer than interview-based networks in delineating symptoms. Future research should utilize longitudinal data to investigate functional relationships between re-experiencing and withdrawal processes, as well as intermediate phenotypes such as extinction learning and reward system function, to shed light on the intraindividual symptom dynamics driving PTSD development, maintenance, and amelioration.

Table 1

Sample characteristics.

	Mean (<i>SD</i>) or %
Age (years)	36.85 (11.68)
Gender (Female)	75%
Ethnicity (non-Caucasian)	38.9%
Primary trauma	
Sexual assault	29.4%
Non-sexual assault	23.4%
Childhood sexual assault	17.1%
MVA/general accident	9.4%
Other trauma types	20.7%
Prior psychotherapy	82.9%
Prior psychiatric medication	63.7%
Education (not college educated)	69.7%
Axis I co-occurrence	
Current	73.1%
Lifetime	96.6%
Interview PTSD severity (PSS-I)	30.44 (6.07)
Self-report PTSD severity (PSS-SR)	34.47 (8.01)

Note. PSS-I: PTSD Symptom Scale – Interview; PSS-SR: PTSD Symptom Scale – Self-Report; MVA = motor vehicle accident

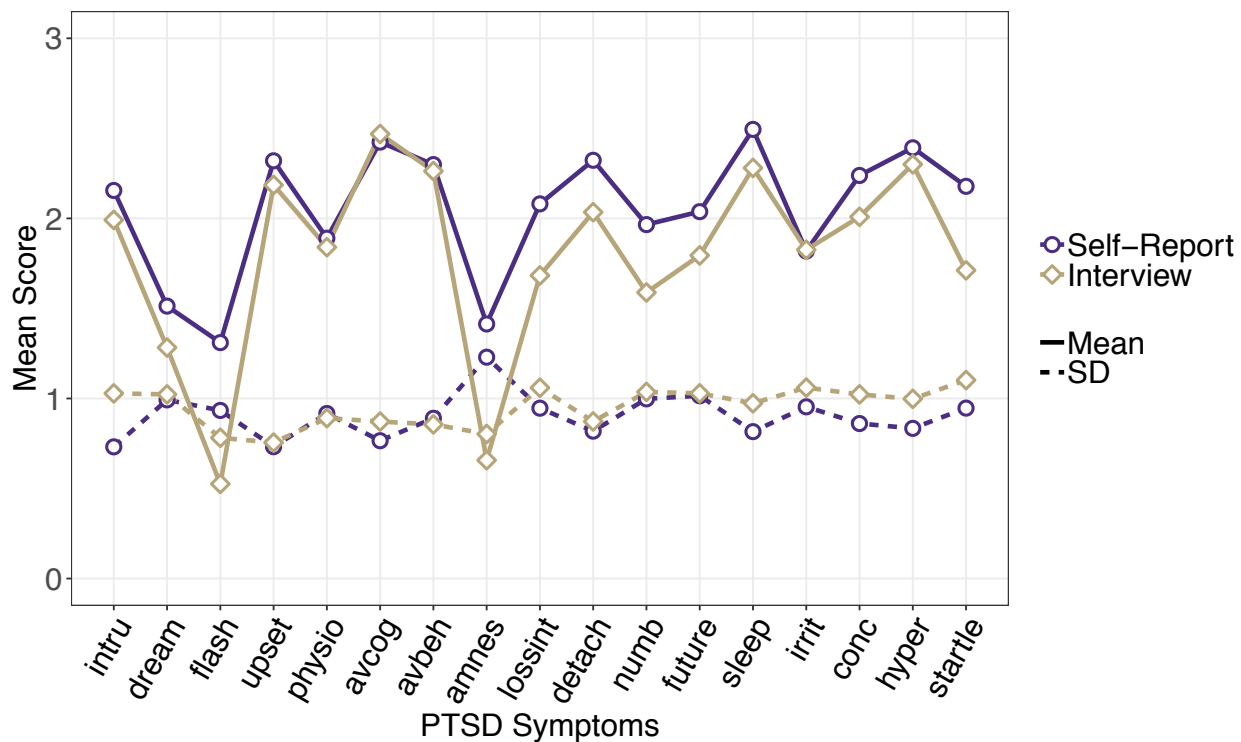
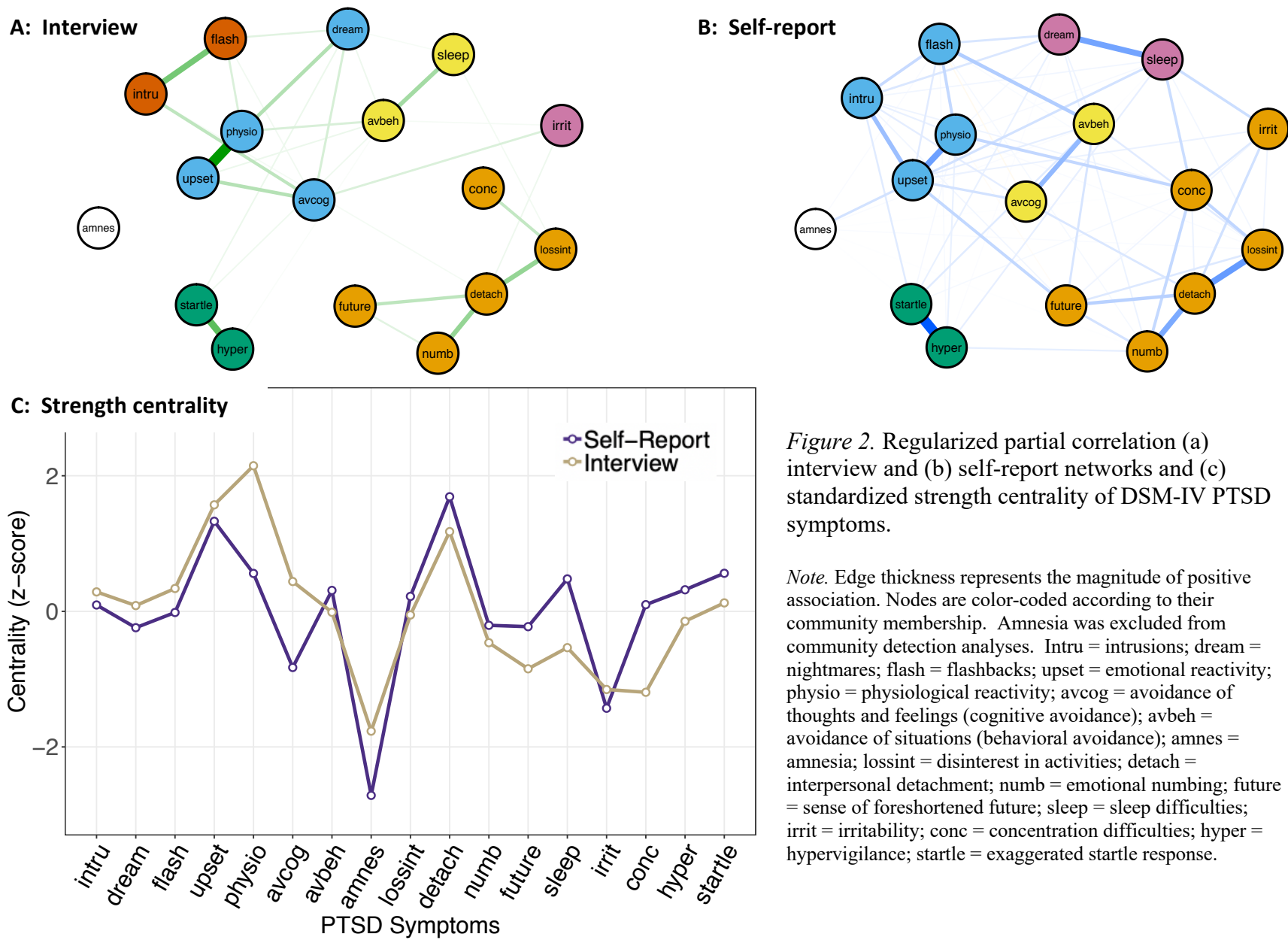


Figure 1. Means and standard deviations of interviewer-assessed and self-reported DSM-IV PTSD symptoms.

Note: Intru = intrusions; dream = nightmares; flash = flashbacks; upset = emotional reactivity; physio = physiological reactivity; avcog = avoidance of thoughts and feelings (cognitive avoidance); avbeh = avoidance of situations (behavioral avoidance); amnes = amnesia; lossint = disinterest in activities; detach = interpersonal detachment; numb = emotional numbing; future = sense of foreshortened future; sleep = sleep difficulties; irrit = irritability; conc = concentration difficulties; hyper = hypervigilance; startle = exaggerated startle response.



References

- Aupperle, R. L., & Paulus, M. P. (2010). Neural systems underlying approach and avoidance in anxiety disorders. *Dialogues in Clinical Neuroscience*, 12(4), 517–531.
- Borsboom, D., & Cramer, A. O. (2013). Network analysis: an integrative approach to the structure of psychopathology. *Annu.Rev.Clin.Psychol.*, 9(1548-5951 (Electronic)), 91–121. <https://doi.org/10.1146/annurev-clinpsy-050212-185608> [doi]
- Bowers, M. E., & Ressler, K. J. (2015). An Overview of Translationally Informed Treatments for Posttraumatic Stress Disorder: Animal Models of Pavlovian Fear Conditioning to Human Clinical Trials. *Biological Psychiatry*, 78(5), E15–E27. <https://doi.org/10.1016/j.biopsych.2015.06.008>
- Brewin, C. R., Lanius, R. A., Novac, A., Schnyder, U., & Galea, S. (2009). Reformulating PTSD for DSM-V : Life after Criterion A. *Journal of Traumatic Stress*, 22(5), 366–373. <https://doi.org/10.1002/jts.20443>
- Bryant, R. A., Creamer, M., O'Donnell, M., Forbes, D., McFarlane, A. C., Silove, D., & Hadzi-Pavlovic, D. (2016). Acute and Chronic Posttraumatic Stress Symptoms in the Emergence of Posttraumatic Stress Disorder. *JAMA Psychiatry*, 2052(2), 1–8. <https://doi.org/10.1001/jamapsychiatry.2016.3470>
- Craske, M. G., Meuret, A. A., Ritz, T., Treanor, M., & Dour, H. J. (2016). Treatment for Anhedonia: A Neuroscience Driven Approach, 33, 927–938. <https://doi.org/10.1002/da.22490>
- Craske, M. G., Meuret, A. E., Ritz, T., Treanor, M., Dour, H., & Rosenfield, D. (2019). Positive affect treatment for depression and anxiety: A randomized clinical trial for a core feature of anhedonia. *Journal of Consulting and Clinical Psychology*, 87(5), 457–471. <https://doi.org/10.1037/ccp0000396>
- Csárdi, G., & Nepusz, T. (2006). The igraph software package for complex network research. *InterJournal, Complex Sy*, 1695.
- Ekers, D., Webster, L., Van Straten, A., Cuijpers, P., Richards, D., & Gilbody, S. (2014). Behavioural Activation for Depression; An Update of Meta-Analysis of Effectiveness and Sub Group Analysis. *PLoS ONE*, 9(6), e100100. <https://doi.org/10.1371/journal.pone.0100100>
- Elman, I., Ariely, D., Mazar, N., Aharon, I., Lasko, N. B., Macklin, M. L., ... Pitman, R. K. (2005). Probing reward function in post-traumatic stress disorder with beautiful facial images. *Psychiatry Research*, 135(3), 179–183. <https://doi.org/10.1016/j.psychres.2005.04.002>
- Engelhard, I. M., Arntz, A., & Van den Hout, M. A. (2007). Low specificity of symptoms on the post-traumatic stress disorder (PTSD) symptom scale: A comparison of individuals with PTSD, individuals with other anxiety disorders and individuals without psychopathology. *British Journal of Clinical Psychology*, 46(4), 449–456. <https://doi.org/10.1348/014466507X206883>
- Epskamp, S., Borsboom, D., & Fried, E. I. (2018). Estimating psychological networks and their accuracy: A tutorial paper. *Behavior Research Methods*, 50(1), 195–212. <https://doi.org/10.3758/s13428-017-0862-1>
- Epskamp, S., Cramer, A. O. J., Waldorp, L. J., Schmittmann, V. D., & Borsboom, D. (2012). qgraph : Network Visualizations of Relationships in Psychometric Data. *Journal of*

- Statistical Software*, 48(4). <https://doi.org/10.18637/jss.v048.i04>
- First, M., Spitzer, R., Gibbon, M., & Williams, J. (1995). *Structured clinical interview for DSM-IV Axis I disorders - Patient edition v.2 (SCID-I/P)*. New York, NY: Biometrics Research Department.
- Foa, E. B., Cashman, L., Jaycox, L., & Perry, K. (1997). The validation of a self-report measure of posttraumatic stress disorder: The Posttraumatic Diagnostic Scale. *Psychological Assessment*, 9(4), 445–451. <https://doi.org/10.1037/1040-3590.9.4.445>
- Foa, E. B., Hembree, E., & Rothbaum, B. (2007). *Prolonged Exposure Therapy for PTSD: Therapist Guide*. Oxford University Press.
<https://doi.org/10.1093/med:psych/9780195308501.001.0001>
- Foa, E. B., Riggs, D. S., Dancu, C. V., & Rothbaum, B. O. (1993). Reliability and validity of a brief instrument for assessing post-traumatic stress disorder. *J Trauma Stress*, 6(4), 459–473. <https://doi.org/10.1002/jts.2490060405>
- Franklin, C. L., Walton, J. L., Cuccurullo, L. A., Raines, A., Ball, J., Vaught, A., ... Maieritsch, K. P. (2016). Examining potential overlap of DSM-5 PTSD criteria D and E. *Psychiatry Research*, 246(September), 250–254. <https://doi.org/10.1016/j.psychres.2016.10.002>
- Fried, E. I., & Cramer, A. O. J. (2017). Moving Forward: Challenges and Directions for Psychopathological Network Theory and Methodology. *Perspectives on Psychological Science*, 12(6), 999–1020. <https://doi.org/10.1177/1745691617705892>
- Fried, E. I., Eidhof, M. B., Palic, S., Costantini, G., Huisman-van Dijk, H. M., Bockting, C. L. H., ... Karstoft, K.-I. (2018). Replicability and Generalizability of Posttraumatic Stress Disorder (PTSD) Networks: A Cross-Cultural Multisite Study of PTSD Symptoms in Four Trauma Patient Samples. *Clinical Psychological Science*, 6(3), 335–351.
<https://doi.org/10.1177/2167702617745092>
- Fruchterman, T. M. J., & Reingold, E. M. (1991). Graph drawing by force-directed placement. *Software: Practice and Experience*, 21(11), 1129–1164.
<https://doi.org/10.1002/spe.4380211102>
- Gilbertson, M. W., Gurvits, T. V., Lasko, N. B., Orr, S. P., & Pitman, R. K. (2001). Multivariate assessment of explicit memory function in combat veterans with posttraumatic stress disorder. *Journal of Traumatic Stress*, 14(2), 413–432.
<https://doi.org/10.1023/A:1011181305501>
- Hallquist, M. N., Wright, A. G. C., & Molenaar, P. C. M. (2018). Problems with centrality measures in psychopathology symptom networks: Why network psychometrics cannot escape psychometric theory. *PsyArXiv*, (January). <https://doi.org/10.31234/osf.io/pg4mf>
- Hopper, J. W., Pitman, R. K., Su, Z., Heyman, G. M., Natasha, B., Macklin, M. L., ... Elman, I. (2009). Expectancy and Satisfaction with Monetary Gains and Losses, 42(10), 802–807.
<https://doi.org/10.1016/j.jpsychires.2007.10.008>
- Horowitz, M. J. (1986). Stress-response syndromes: a review of posttraumatic and adjustment disorders. *Hospital & Community Psychiatry*, 37(3), 241–249.
- Jovanovic, T., Norrholm, S. D., Blanding, N. Q., Davis, M., Duncan, E., Bradley, B., & Ressler, K. J. (2010). Impaired fear inhibition is a biomarker of PTSD but not depression. *Depression and Anxiety*, 27(3), 244–251. <https://doi.org/10.1002/da.20663>
- Markowitz, J. C., Petkova, E., Neria, Y., Van Meter, P. E., Zhao, Y., Hembree, E., ... Marshall, R. D. (2015). Is Exposure Necessary? A Randomized Clinical Trial of Interpersonal Psychotherapy for PTSD. *American Journal of Psychiatry*, 172(5), 430–440.
<https://doi.org/10.1176/appi.ajp.2014.14070908>

- McNally, R. J., Robinaugh, D. J., Wu, G. W. Y., Wang, L., Deserno, M., & Borsboom, D. (2015). Mental Disorders as Causal Systems: A Network Approach to Posttraumatic Stress Disorder. *Clinical Psychological Science*, 1–14. <https://doi.org/10.1177/2167702614553230>
- Moshier, S. J., Bovin, M. J., Gay, N. G., Wisco, B. E., Mitchell, K. S., Lee, D. J., ... Marx, B. P. (2018). Examination of posttraumatic stress disorder symptom networks using clinician-rated and patient-rated data. *Journal of Abnormal Psychology*, 127(6), 541–547. <https://doi.org/10.1037/abn0000368>
- Nawijn, L., van Zuiden, M., Frijling, J. L., Koch, S. B. J., Veltman, D. J., & Olf, M. (2015). Reward functioning in PTSD: A systematic review exploring the mechanisms underlying anhedonia. *Neuroscience and Biobehavioral Reviews*, 51, 189–204. <https://doi.org/10.1016/j.neubiorev.2015.01.019>
- Nawijn, L., Zuiden, M. Van, Frijling, J. L., Koch, S. B. J., Veltman, D. J., & Olf, M. (2015). Neuroscience and Biobehavioral Reviews Reward functioning in PTSD : A systematic review exploring the mechanisms underlying anhedonia. *Neuroscience and Biobehavioral Reviews*, 51, 189–204. <https://doi.org/10.1016/j.neubiorev.2015.01.019>
- Norrholm, S. D., Jovanovic, T., Olin, I. W., Sands, L. A., Karapanou, I., Bradley, B., & Ressler, K. J. (2011). Fear Extinction in Traumatized Civilians with Posttraumatic Stress Disorder: Relation to Symptom Severity. *Biological Psychiatry*, 69(6), 556–563. <https://doi.org/10.1016/j.biopsych.2010.09.013>
- Powers, M. B., Halpern, J. M., Ferenschak, M. P., Gillihan, S. J., & Foa, E. B. (2010). A meta-analytic review of prolonged exposure for posttraumatic stress disorder. *Clinical Psychology Review*, 30(6), 635–641. <https://doi.org/10.1016/j.cpr.2010.04.007>
- Reichardt, J., & Bornholdt, S. (2006). Statistical mechanics of community detection. *Physical Review E*, 74(1), 016110. <https://doi.org/10.1103/PhysRevE.74.016110>
- Rhemtulla, M., Fried, E. I., Aggen, S. H., Tuerlinckx, F., Kendler, K. S., & Borsboom, D. (2016). Network analysis of substance abuse and dependence symptoms. *Drug and Alcohol Dependence*, 161(2016), 230–237. <https://doi.org/10.1016/j.drugalcdep.2016.02.005>
- Roy-Byrne, P. (2015). Improving Relationships in Trauma Victims: The Case for Interpersonal Psychotherapy and PTSD. *American Journal of Psychiatry*, 172(5), 403–405. <https://doi.org/10.1176/appi.ajp.2015.15010099>
- Stein, M. B., & Paulus, M. P. (2009). Imbalance of Approach and Avoidance: The Yin and Yang of Anxiety Disorders. *Biological Psychiatry*, 66(12), 1072–1074. <https://doi.org/10.1016/j.biopsych.2009.09.023>
- van Borkulo, C. D., Epskamp, S., & Millner, A. J. (2016). Network comparison test: Statistical comparison of two networks based on three invariance measures.
- Yufik, T., & Simms, L. J. (2010). A meta-analytic investigation of the structure of posttraumatic stress disorder symptoms. *Journal of Abnormal Psychology*, 119(4), 764–776. <https://doi.org/10.1037/a0020981>