Communication

A Network Analysis of Symptoms of Post-Traumatic Stress Disorder and Facets of Mindfulness

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Abstract: Post-traumatic Stress Disorder (PTSD) is a mental health concern impacting a large proportion of the population. There is a growing interest in mindfulness-based treatments for PTSD. However, some individuals with PTSD do not respond to treatment. Identifying factors that may provide a more precise treatment approach has the potential to enhance response. Network analysis is a data-driven methodology that has been used to suggest specific targets for treatment. To date, there has not been a network analysis examining the interrelation between PTSD symptoms and trait mindfulness. The current study is an exploratory analysis of N = 214 adults from a non-clinical sample who endorsed a Criterion A traumatic event and completed the PTSD Checklist for DSM-5 and the Five Facet Mindfulness Questionnaire. Both undirected and directed networks were generated to identify links between PTSD symptom clusters and the facets of mindfulness. Both networks highlighted the connection between the PTSD symptom cluster Alterations in Arousal and Reactivity and the Awareness facet of mindfulness; and the PTSD symptom cluster Negative Alterations in Cognitions and Mood with the Non-judging facet of mindfulness. Taken together, these findings provide further evidence that greater mindfulness is generally associated with lower PTSD symptoms. Importantly, the findings highlight Non-judgement and Awareness as facets that might warrant further investigation in the context of mindfulness-based treatment efforts for PTSD.

Keywords: network analysis; PTSD symptoms; mindfulness

1. Introduction

Post-traumatic Stress Disorder (PTSD) is a psychiatric disorder that can occur in people who have experienced or witnessed a traumatic event such as a natural disaster, a serious accident, a terrorist act, war/combat, rape, or other violent personal assault. PTSD affects millions worldwide, with prevalence rates varying by region and population. Studies have shown that PTSD not only affects the individual's mental health but also has a significant impact on physical health, social relationships, and overall quality of life.

Mindfulness-based interventions (MBIs) have gained popularity and evidence supporting their use in the treatment of a wide range of mental health concerns [1], including PTSD [2]. MBIs focus on promoting present-moment awareness and nonjudgmental acceptance of one's experiences [3]. Research suggests that mechanisms that mindfulness may operate on to address symptoms of PTSD include regulation of interoception and arousal, increasing acceptance of both experiences perceived as good and bad, as well as enhancing attentional flexibility [2]. Despite the efficacy of mindfulness-based treatments, a notable portion of individuals with PTSD do not respond adequately to these interventions [4].

Network analysis has been increasingly leveraged as a promising data-driven methodology to understand the complex interrelations among distinct factors. Extensive work has been conducted to understand the interrelations of PTSD symptoms in network analysis that has highlighted the importance of intrusion symptoms in PTSD [5]. While network analyses have also examined facets of mindfulness alone [6] and in relation to mental health concerns like depression [7], to the best of our knowledge no research has examined PTSD symptoms and the facets of mindfulness in the context of network analysis.

The current study is a secondary network analysis exploring the relationships between PTSD symptom clusters and facets of trait mindfulness. The primary aim is to develop preliminary hypotheses about relationships between mindfulness and PTSD that can be tested in future research to provide more personalized and precise therapeutic strategies given the heterogeneity of PTSD symptom presentations and approaches to mindfulness in treatment.

2. Materials and Methods

2.1. Participants

Participants were undergraduate students who participated in an online survey for research credit as part of an introductory course. The participants provided written, informed consent, and the Institutional Review Board of the University of Texas at Austin approved all procedures. Participants were on average 18.90 years old (SD = 1.06); 71.5% female; 31.8% Hispanic; 45.3% White. Their PTSD symptom scores were low on average (mean = 21.64; SD = 16.61), with 23.8% reporting a score >33 indicating possible PTSD based on symptom severity. The average for the Re-experiencing subscale was 5.24 (SD = 4.35); Avoidance subscale 3.04 (SD = 2.31); Negative Alterations in Cognition and Mood 7.52 (6.77); and Arousal 5.83 (SD = 5.42). The majority of the participants (58.4%) reported directly experiencing more than one traumatic event type (mean = 2.08, SD = 1.65). The most common event type directly experienced was a natural disaster (42.5%), followed by a transportation accident (39.7%). The average total FFMQ score was 45.70 (SD = 7.26), the Observe subscale 8.47 (SD = 2.72); the Describe subscale 9.21 (SD = 2.21); the Awareness subscale 10.03 (SD = 2.64); the Non-judgement subscale 9.92 (SD = 3.13); and the Non-reactivity subscale 8.07 (SD = 2.57).

2.2. Measures

2.2.1. Five Facet Mindfulness Questionnaire-15 (FFMQ-15)

The FFMQ-15 [8] is a 15-item self-report measure that assesses the five components of mindfulness, including: (1) Observing; (2) Describe; (3) Act with Awareness; (4) Non-judging; and (5) Non-reactivity. Participants rated the truth of each statement on a 5-point scale from "never or very rarely true" to "very often or always true". The total alpha coefficient was 0.76, and the subscale coefficients ranged from 0.45–0.84.

2.2.2. The PTSD Checklist (PCL-5)

The PCL-5 [9] is a self-report measure that has been well validated in the assessment of PTSD symptoms. Individuals are asked to rate how much a symptom bothered them in the past month on a 0–4 scale ("not at all" to "extremely). The PCL-5 includes 4 subscales: Re-experiencing (cluster B), Avoidance (cluster C), Negative Alterations in Cognition and Mood (cluster D) and Arousal (cluster E). The alpha coefficient of the total scale in the current sample was 0.94, and the subscale coefficients ranged from 0.76–0.89.

2.2.3. Life Events Checklist (LEC)

The LEC [10] has been used to reliably measure the occurrence of traumatic events. The measure includes 17 types of potentially traumatic events (such as natural disasters, transportation accidents, physical assault, and military combat) plus an additional "other" category where respondents can specify any other significant event(s) not listed. For each event, individuals indicate whether they have experienced it, witnessed it, learned about it happening to a close family member or friend, are not sure, or prefer not to answer.

2.3. Data Analysis

All analyses were completed using the statistical software package R [11]. Across both network analyses, the mindfulness facets and PTSD symptom clusters were used. This was due both to the relatively small sample size as well as the more approachable interpretations given by associations of these groups of variables. All variables were scaled and centered

prior to analyses. Data and R syntax used for the analyses and to generate the figures are available on OSF: https://osf.io/t9kv7/?view_only=3e2b3c62748949a2b7d9891ce7f0d610.

2.3.1. Undirected Network

The undirected network analysis used Bayesian Gaussian graphical models estimated with the BGGM package [12]. The undirected network is a correlation method that evaluates each individual association while taking into account all the other associations in the network. This analysis used the "explore" function within BGGM which identifies a network with both positive and negative associations. To decide whether an association should be retained, a Bayes Factor threshold of 3 (indicating moderate support) was used. Bayes Factors provide evidence of the strength supporting either the alternative hypothesis or the null hypothesis, and higher or lower values imply stronger or weaker evidence for the alternative or null hypotheses, respectively, with 1 being equal to no evidence either way [13]. In the final step, bridge centrality was assessed with the networktools package [14]. Bridges are variables linked within a specific measure and between different measures, with bridge centrality quantifying the aggregate strength of a variable's associations with variables from another group (essentially, the total of the association strengths that connect different single variables to other variables).

2.3.2. Directed Network

The directed network was fit with bnlearn [15] using the tabu algorithm. The analysis consisted of testing possible structures in the network (e.g., adding, deleting, or reversing directions of associations) and evaluating which network structure fits best. This process was then iteratively repeated to determine how often specific connections are present (their strength) across 10,000 iterations. Coefficient estimates of the associations were extracted from the network along with the strength of the association (how frequently it appeared in the network) and the confidence of association (how frequently the direction was one way or the other).

3. Results

3.1. Undirected Network Findings

Figure 1 provides a graphical representation of the exploratory undirected network analyses, and Table 1 provides the magnitude of the associations. Supplementary Table S1 provides the raw correlation coefficients for the associations. PTSD symptom cluster D (Negative Alterations in Cognitions and Mood) was the only bridge node, with a centrality of 0.507. As expected, there were primarily negative associations between PTSD symptom clusters and facets of mindfulness, and within constructs, associations were primarily positive. However, there was also a weak positive association (0.118) between PTSD symptom cluster B (Intrusions) and the Observing mindfulness facet.

Table 1. Undirected network associations.

	Observe	Describe	Aware	Non-Judge	Non-React	Re-Exp	Avoid	Neg-Cog	Arousal
observe		0.377	−0.172	−0.181	0.194	0.118	0	−0.208	0
describe	0.377		0.150	0.198	0.316	0	0	0	0
aware	−0.172	0.150		0.139	0	0	0	0	−0.239
non-judge	−0.181	0.198	0.139		0	0	0	−0.299	0
non-react	0.194	0.316	0	0		−0.155	0	0	0
re-exp	0.118	0	0	0	−0.155		0.458	0.143	0.336
avoid	0	0	0	0	0	0.458		0.282	0
neg-cog	−0.208	0	0	−0.299	0	0.143	0.282		0.472
arousal	0	0	−0.239	0	0	0.336	0	0.472	

Observe, Describe, Aware(ness), Non-judg(ment), and Non-react(ivity) represent the facets of the Five Facet Mindfulness Questionnaire (FFMQ). Re-exp = Re-experiencing symptoms (cluster B of Post-traumatic Stress Disorder; PTSD). Avoid = Avoidance symptoms (cluster C of PTSD). Neg-cog = Negative Alterations in Cognition and Mood (cluster D of PTSD). Arousal = symptoms related to increased arousal and reactivity (cluster E of PTSD).
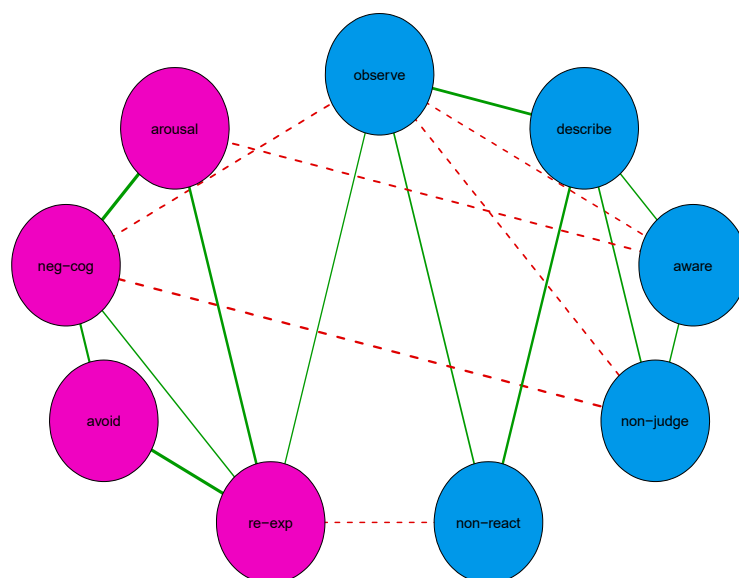
Figure 1. The undirected network. The green lines are positive associations; the red lines are negative associations. The thickness of the line is related to the strength of the association. Purple nodes (the circles) are PTSD symptom clusters; blue nodes are facets of mindfulness.

3.2. Directed Network Findings

Figure 2 provides a graphical representation of the directed acyclic graph, and Table 2 provides the strength of each association (how often it appeared in the network), the direction (how often that specific direction appeared compared to the revers), and the regression coefficient for that association. Between PTSD and mindfulness, there were two predictions: First, greater scores in the Awareness facet of mindfulness predicted less PTSD symptom cluster E (Alterations in Arousal and Reactivity) $b = -0.37$ (strength = 0.93, confidence = 0.501). Second, greater PTSD symptom cluster D (Negative Alterations in Mood and Cognitions) predicted lower scores in the Non-judging mindfulness facet $b = -0.54$ (strength = 0.98, confidence = 0.79).
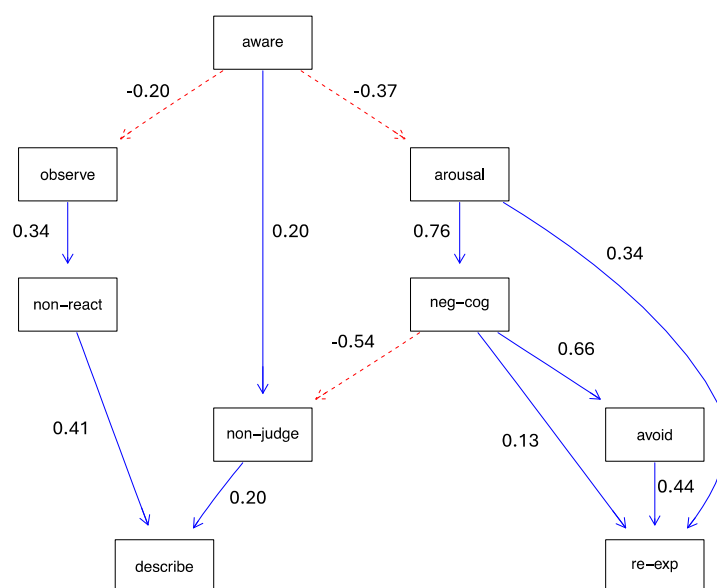

Figure 2. The directed network. Each line with a single-headed arrow represents a directional association, meaning that the model fits better with that association. Across 10,000 iterations, the direction appearing the most often is indicated by the direction of the arrow. Red, dashed lines are negative associations, and blue lines are positive associations.

Table 2. Directed network edge confidence, strength, and associations.

From	To	Strength	Direction	Coefficient
observe	non-react	0.69	0.56	0.34
aware	observe	0.60	0.79	−0.20
aware	non-judge	0.68	0.67	0.20
aware	arousal	0.93	0.50	−0.37
non-judge	describe	0.68	0.75	0.20
non-react	describe	0.99	0.52	0.41
avoid	re-exp	1.00	0.52	0.44
neg-cog	non-judge	0.98	0.79	−0.54
neg-cog	re-exp	0.52	0.57	0.13
neg-cog	avoid	0.99	0.56	0.66
arousal	re-exp	1.00	0.56	0.34
arousal	neg-cog	1.00	0.50	0.76

Strength refers to the proportion of times out of the 10,000 bootstraps that the edge was present in the network; direction refers to the proportion of times the direction of the edge was in that direction; coefficient represents the regression coefficient of the edge.

4. Discussion

This exploratory analysis examined relationships between PTSD symptom clusters and facets of mindfulness using a data-driven approach. Across both networks, the results suggested that the PTSD symptom cluster Alterations in Arousal and Reactivity was associated with the Awareness facet of mindfulness and that the PTSD symptom cluster Negative Alterations in Cognitions and Mood was associated with the Non-judging facet of mindfulness. The undirected network provided some insights into the associations within and across constructs, including a potential risk factor from the Observing mindfulness facet which was associated with greater Re-experiencing. However, there were also negative associations between Observing and other facets. Some research has suggested that the Observing facet does not include internal emotional/cognitive elements, rather focusing on external stimuli which may make it distinct from the other facets [16,17] and may also explain the negative associations between Observing and the other facets in the FFMQ. It makes sense that individuals who tend to observe the environment may notice more reminders that could lead to intrusive memories. Similarly, the weak negative association between Non-reactivity and Intrusions reasonably suggest that individuals who are less reactive are less likely to experience intrusions.

The directed network had fewer associations overall but captured the two strongest associations also present in the undirected network. The directed network also suggested that the mindfulness facet of Awareness might take precedence when considering specific mindfulness practices to implement for individuals with PTSD. However, the direction of the Awareness association with Arousal was quite weak, suggesting that it is unlikely the direction should be interpreted with confidence. Within the mindfulness facets, Awareness also predicted Non-judgement. This aligns with some conceptualizations of mindful practices related to Awareness as foundational to effectively and fully engaging in Non-judgement [18]. The idea that individuals with elevations in symptoms related to Alterations in Arousal and Reactivity might benefit from Awareness-focused practices is not new [19]. Similarly, findings related to Non-judging as being salient to Negative Alterations in Cognitions and Mood is also well established [18]. That the direction included from PTSD symptoms to facets of mindfulness may be related to the non-clinical nature of this sample and is a limitation. These findings are also limited by the relatively small sample size and narrow age-range of the sample (due to the fact that they were undergraduate students). Additionally, mindfulness practice was not assessed which may play a role in how associations between trait mindfulness and PTSD symptoms unfold. It is important to use caution when interpreting the directed edges as causal especially given the relatively low confidence of some of the edges, but the analyses provide further support for the importance of the Awareness facet of mindfulness, specifically. Overall, the findings offer additional evidence

in support of linkages between mindfulness (as primarily protective) and PTSD, suggesting potential avenues for future investigation.

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