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A cross-cultural comparison of ICD-11 Complex PTSD symptom networks in Austria, Lithuania, and UK

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Abstract

The 11th revision of the World Health Organization's International Classification of

Diseases (ICD-11) may include a new disorder, Complex Posttraumatic Stress Disorder

(CPTSD). The network approach to psychopathology enables investigation of the structure of

disorders at the symptom level, allowing for analysis of direct symptom interactions. The

network structure of ICD-11 CPTSD has not yet been studied and it remains unclear whether

similar networks replicate across different samples. We investigated the network models of four

different trauma samples including a total of 879 participants (age: M = 47.17 years, SD = 11.92;

59.04% women) drawn from Austria, Lithuania, and the UK (Scotland and Wales). The

International Trauma Questionnaire was used to assess symptoms of ICD-11 CPTSD in all

samples. The prevalence of PTSD and CPTSD ranged from 23.7% to 37.3% and from 9.3% to

53.1%, respectively. Regularized partial correlation networks were estimated and the resulting

networks compared. Despite several differences in the symptom presentation and cultural

background, the networks across the four samples were considerably similar with high

correlations between symptom profiles (.48–.87), network structures (.69-.75), and centrality

estimates (.59-.82). These results support the replicability of CPTSD network models across

different samples and provide further evidence about the robust structure of CPTSD. The most

central symptom in all four sample specific networks and the overall network was 'feelings of

worthlessness'. Implications of the network approach in research and practice are discussed.

A cross-cultural comparison of ICD-11 Complex PTSD symptom networks in Austria,

UK, and Lithuania

The 11th revision of the World Health Organization's International Classification of

Diseases (ICD-11) is currently nearing completion (First, Reed, Hyman, & Saxena, 2015). Within

the classification of trauma- and stress-related disorders, the ICD-11 will introduce a new

diagnostic category, Complex Posttraumatic Stress Disorder (CPTSD), as a sibling disorder to

PTSD. CPTSD describes a symptom profile that can arise following any traumatic event but

typically is associated with exposure to multiple or repeated adverse events including child abuse,

torture, and severe domestic violence (Maercker et al., 2013). Persons presenting with CPTSD

suffer from the ICD-11 PTSD symptoms (i.e. re-experiencing, avoidance, and sense of threat)

and three additional clusters of symptoms (i.e. affect dysregulation, negative self-concept, and

difficulties in relationships) described collectively as 'disturbances in self-organization' (DSO).

This newly proposed disorder has been subjected to research and increasing number of studies

support its clinical utility (see Brewin et al., 2017 for an extensive review). In the current study

we use network analysis to investigate the interaction of CPTSD symptoms and the robustness of

the CPTSD network structure in four different samples from four European countries.

The network approach to psychopathology has gained attention in recent years

(Borsboom, 2017). This approach defines mental disorders as sets of causally interacting

symptoms. This definition differs from the typical model of mental disorders, the latent variable

model. In the latent variable model, disorders are defined as a latent entity, which is not directly

observable, and can only be assessed indirectly by the measurement of symptoms. The symptoms

are thus reflective of the disorder (Borsboom, 2008). By comparison, the network approach

assumes that symptoms can initially be triggered by external factors, such as a traumatic event in

the case of PTSD. Once triggered a symptom will likely and directly lead to other symptoms (e.g.

flashbacks may lead to sense of threat which in turn may lead to concentration problems) and

maybe even activate negative symptom loops (Cramer et al., 2016). In this model, the observable

symptoms alone are sufficient to constitute the disorder (Borsboom & Cramer, 2013). Network

analysis is a method that allows visualization of the structure of symptom associations and

identifies symptoms that are particularly central in the network. These symptoms are arguably the

most important symptoms in a disorder.

To our knowledge, no study used a network analytical approach to investigate the ICD-11

formulation of CPTSD. Knefel, Tran, and Lueger-Schuster (2016) used a network approach to

investigate the comorbidity of ICD-11 CPTSD and Borderline Personality Disorder in a sample of

adult survivors of child maltreatment and found that *feelings of worthlessness* was the most central

CPTSD symptom in the resulting network. Two studies evaluating the network properties of

DSM-5 PTSD found that *negative trauma related emotions* and *reactivity to cues* were among the

most central symptoms in both networks (Armour, Fried, Deserno, Tsai, & Pietrzak, 2017; Spiller

et al., 2017). The network approach is still relatively new in the study of psychopathology and it is

not yet clear how robust results from single datasets are and if they will replicate and generalize to

other samples (Epskamp, Borsboom, & Fried, 2017; Fried et al., 2018). For example, while

detachment was among the most central symptoms in one of the aforementioned studies (Armour

et al., 2017), this was not the case in the other study, wherein *self-destructive or reckless behavior*

was instead central (Spiller et al., 2017). Fried et al. (2018) addressed this issue and compared the

network structures of DSM-IV PTSD across four samples. They found good support for the

replicability of network models. We therefore followed this approach and analyzed the network

models of ICD-11 CPTSD in four different samples from four different countries: Austria,

Lithuania, and the UK (Scotland and Wales). Our aims were (1) to investigate the network

structure in four different samples using an estimation procedure that takes similarities between

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samples into account, (2) to find central symptoms within the networks, (3) to test the accuracy of

these estimations, and (4) to compare the networks across the four samples.

Method

Participants and procedure

Participants from four traumatized samples were included in our analysis (total N = 879).

The mean age for the total sample was 47.17 years (SD = 11.92, range = 18–87 years) and the

majority of the sample were women (59.04%). Table 1 depicts the characteristics of each sample.

The first sample consisted of 220 Austrian adult survivors of child maltreatment during

foster care placement. Data were collected as part of the Vienna Institutional Abuse Study

(Lueger-Schuster et al., 2017). Child maltreatment was assessed with the Childhood Trauma

Questionnaire (CTQ; Bernstein et al., 2003) and traumatic life events in adulthood with the Life

Events Checklist for DSM-5 (LEC-5; Weathers et al., 2013). All participants lived in institutional

foster care during their childhood and experienced maltreatment during this time. Endorsement

rates for any item (score >1) from the CTQ subscales indicated that any experience of childhood

trauma was very high: emotional neglect 100.0%, physical neglect 99.5%, emotional abuse

99.5%, physical abuse 98.2%, and sexual abuse 70.0%. The mean number of adult traumatic life

event types experienced by this sample was 5.65 (*SD* = 3.09). More than one third (37.3%)

fulfilled the proposed criteria for ICD-11 PTSD and another 17.3% fulfilled the proposed criteria

for ICD-11 Complex PTSD. The study was approved by the [removed for blind review] and all

participants gave full written informed consent.

The second sample consisted of 280 adult primary mental health care patients in Lithuania

(Kazlauskas, Gegieckaite, Hyland, Zelviene, & Cloitre, 2018). Participants were recruited at

primary mental health centers, outpatient mental health clinics and hospitals, private clinical

psychologists' practice, and addiction rehabilitation centers. Lifetime traumatic events were

assessed using the LEC-5 and individuals in this sample reported on average 4.60 ($SD = 2.55$) types of lifetime traumatic experiences. The prevalence of proposed ICD-11 PTSD and Complex PTSD were 27.9% and 9.3% respectively. This study was approved by the [removed for blind review].

The third sample consisted of 193 individuals who were referred for psychological therapy to a National Health Service (NHS) trauma center in Scotland (Karatzias et al., 2016). Cases of childhood, adulthood and both child and adulthood traumatization were referred to the service. Child maltreatment was assessed using the CTQ and adult life events with the LEC-5. Endorsement rates for any item (score >1) from the CTQ subscales indicated that childhood trauma was frequent: emotional abuse 84.6%, physical abuse 63.8%, sexual abuse 53.3%, emotional neglect 79.8%, and physical neglect 68.6%. The mean number of lifetime traumatic experience types was 5.00 ($SD = 2.48$). The prevalence of proposed ICD-11 PTSD and Complex PTSD were 37% and 53.1% respectively. The study was approved by the [removed for blind review].

The fourth sample consisted of 186 adults from Wales who were recruited to the National Centre for Mental Health cohort via primary and secondary mental health services, specialist veterans' services, a specialist civilian trauma service, and via social media (Hyland et al., 2017). Adult life events were assessed using an adapted version of the LEC-5, which included additional items for childhood sexual and physical abuse. Nearly half of the sample (47.9%) reported physical or sexual child abuse and the average number of lifetime traumatic experience types was 6.90 ($SD = 3.83$). In this sample, 23.4% fulfilled criteria for proposed ICD-11 PTSD and 41.5% for Complex PTSD. The study received ethical approval from the [removed for blind review].

Measures

All four studies used the International Trauma Questionnaire (ITQ; Cloitre, Roberts,

Bisson, & Brewin, 2013) to assess the proposed symptoms of ICD-11 PTSD and Complex PTSD.

The ITQ is a self-report measure of the ICD-11 symptoms of PTSD and Complex PTSD (see

Karatzias et al., 2018 for a recent review on the psychometric properties of the ITQ). Six items

measure three PTSD clusters: Re-experiencing in the here and now; deliberate avoidance of

traumatic reminders (internal or external); and a sense of current threat. Sixteen items measure

the three DSO factors: Affective dysregulation (nine items covering both hyperactivation [five

items] and hypoactivation [four items]); negative self-concept (four items); and difficulties in

relationships (three items). Respondents are instructed to respond in relation to how much they

have been bothered by each symptom in the past month, and are instructed to answer the DSO

items in relation to how they typically feel, think about themselves, and relate to others. All items

are answered on a five-point Likert scale anchored by 'Not at all' (0) and 'Extremely'. Diagnostic

criteria for PTSD require a score of ≥ 2 ('Moderately') for at least one of two symptoms from

each of the three PTSD clusters. Complex PTSD diagnosis requires that the PTSD criteria are

met and endorsement of each DSO symptom cluster at a moderate level of severity, defined as

summed score that equals a score of ≥ 2 for each of the items in the cluster: a summed total score

of ≥ 10 for the five items reflecting hyperactivation or a summed total score of ≥ 8 for the four

items reflecting hypoactivation; a summed total score ≥ 8 for the four items reflecting negative

self-concept; and a summed total score ≥ 6 for the three items reflecting difficulties in

relationships. The ICD-11 requires the presence of functional impairment associated with both

sets of symptoms for a diagnosis of PTSD and CPTSD. However, functional impairment was not

assessed in the current study; therefore, diagnostic rates are based on symptom criteria alone. The

ICD-11's taxonomic structure means that an individual can only be diagnosed with PTSD or

Complex PTSD, not both. The studies in English speaking countries used the English version of the ITQ (Cloitre et al., 2013), the Austrian study used the German version (Knefel, Lueger-Schuster, & Maercker, 2013), and the Lithuanian study used the Lithuanian version of the ITQ (Kazlauskas et al., 2018). All versions have proved good psychometric properties in previous research (English Version: Karatzias et al., 2016; German version: Knefel et al., 2016; Lithuanian version: Kazlauskas et al., 2018). Cronbach's alpha of the total scale was good in all samples ranging from α =.91 to α =.94 and in the total sample α = .95.

Data Analysis

We followed the statistical procedure described by Fried et al. (2018) and conducted four steps of analysis: network estimation, network inference, network stability, and network comparison. We used the R statistical environment (R Core Team, 2016) for all analyses and the package qgraph (Epskamp, Cramer, Waldorp, Schmittmann, & Borsboom, 2012) to visualize all networks. The R-code for our analyses can be found in the Supplementary Materials and the correlations matrices are available upon request.

Missing values. There were only a few ITQ missing values in the four datasets (ranging from 0 to 15 missing values). We retained all participants for the network analysis and used pairwise complete observations to estimate the correlations among the symptoms.

Network estimation. Symptom networks consist of nodes, representing symptoms, and edges, representing the pairwise relations between two nodes. Within the results, symptom nodes are referred to as short codes; please see Table 2 for corresponding full symptom names. We estimated Gaussian Graphical Models (GGM) for pairwise association parameters between all nodes. In the GGM, edges can be understood as conditional dependence relations among symptoms: If two symptoms are connected in the resulting graph, they are dependent after controlling for all other symptoms. Symptoms that are not connected via an edge are

conditionally independent. With 22 symptom nodes, 231 pairwise association parameters are

estimated. The estimation of so many parameters is likely to lead to a number of spurious

connections; we thus controlled for these false positives by using the least absolute shrinkage and

selection operator (LASSO; Friedman, Hastie, & Tibshirani, 2008) which sets very small edges

to zero. This procedure employs a regularization technique that conservatively identifies only the

relevant edges, and accurately discovers the underlying network structure (van Borkulo et al.,

2014). More details on these estimation techniques, including a tutorial, is available elsewhere

(Epskamp & Fried, 2017). Since PTSD symptoms can be considered ordered-categorical, the

estimation of the 22-item networks are based on the polychoric correlation among symptoms.

The aim of our study was to compare the networks of four different samples. Assuming

the networks of the four samples are identical, the best estimation would be a single GGM on the

combined sample. However, as described by Fried et al. (2018), this would neglect that the true

networks might differ between the samples. The complementary approach would be to estimate

each network separately for all four samples. This would allow for a comparison of the networks

across samples, but it would also result in poorer estimates if the networks were in fact identical.

Especially given the relatively small samples in our study, this would be associated with a

relevant loss of power. The joint estimation of different graphical models using a recently

developed network estimation technique, the fused graphical lasso (FGL), addresses these issues

(Costantini et al., 2017). The FGL is a valid method that can lead to a more accurate estimation of

network structures than estimating networks individually (Costantini et al., 2017; Danaher,

Wang, & Witten, 2014).This method comes close to estimating networks independently, if the

true networks are distinct and exploiting similarities would not improve model fit. Thus, true

differences are allowed to emerge. This property makes the FGL a good method for estimating

networks in different groups (Richetin, Preti, Costantini, & Panfilis, 2017) and we therefore used

the FGL in our study. We used the R-package EstimateGroupNetwork (Costantini & Epskamp, 2017) for network estimation employing the k-fold cross-validation for parameter selection as implemented in the package and selected the default value for $k = 10$.

Network inference. We used two parameters to describe the connectedness of each node in the four jointly estimated networks: the centrality index *node strength* and the *predictability* of each node. Strength refers to the sum of all edges connected to a specific node (Opsahl, Agneessens, & Skvoretz, 2010). Other centrality parameters, betweenness and closeness, are reported in the Supplementary Materials to this manuscript, because they could not be estimated reliably in the present manuscript, as also suggested in recent research (Epskamp et al., 2017). Predictability refers to the estimated shared variance of each node with all of its neighbors (Haslbeck & Fried, 2017). We estimated predictability using the R-package mgm (Haslbeck, 2015). Strength and predictability both provide information on the connectedness of each node within the symptom network. While strength can be regarded as a relative metric, predictability is an absolute measure of connectedness. Predictability can be understood as an upper bound for each node to possible influence by its neighboring nodes. Assuming that all connections go toward this node, predictability quantifies how much influence we could have on this node by intervening on all its neighbors.

Network stability. Network stability estimation was only recently introduced (Epskamp et al., 2017). At the moment, there is no method available to test the stability of jointly estimated networks. We thus followed the procedure by Fried et al. (2018) and examined the stability of the individual networks. We used the R-package bootnet (Epskamp, 2015) and bootstrapped 95% confidence intervals around the edge weights, estimated the correlation-stability coefficient for centrality metrics (ranging from 0–1; values above .25 imply moderate stability, above .50 strong

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stability; Epskamp et al., 2017), and computed the edge-weights difference test and the centrality

difference test for each network.

Network comparison. To obtain an index of the degree of similarity across the samples,

we correlated the edges weights across the four networks (Rhemtulla et al., 2016). We then used

the R-package NetworkComparisonTest (NCT; van Borkulo et al., 2017) for several

comparisons: First, we used an overall test to investigate whether all edges in all pairs of

networks were identical. Second, we applied post hoc comparisons using the Holm-Bonferroni

correction for multiple testing to estimate the number of edges that differed between each pair of

networks. Third, we tested whether the sum of all edge weights within each network (global

strength) differed across the networks. In a next step, we averaged the edge weights across the

four networks and visualized the resulting cross-sample network. Finally, we constructed a

network to visualize the differences and similarities of the edges across the samples using the

standard deviation of each edge across the four networks (Rhemtulla et al., 2016).

Results

Descriptive Statistics

Average symptom distress differed between the four samples (Table 2). Scottish trauma

centre patients reported the highest distress, followed by Welsh primary and secondary mental

health service users, Austrian Survivors of child maltreatment during foster care, and Lithuanian

primary mental health care patients. The symptom profiles were relatively similar across the four

samples: Spearman correlations between the symptom profiles ranged from .48 (Austrian and

Scottish sample) to .87 (Scottish and Welsh sample). The mean symptom profile correlation was

.64. The symptom means ranged from 0.83 (*feelings of failure* in the Austrian sample) to 3.07

(hypervigilance in the Scottish sample). *Emotional vulnerability* was among the most prevalent

symptoms in all samples except for the Scottish one, whereas *reckless behavior* was among the

least prevalent symptoms across all samples.

Network estimation

Figure 1 depicts the results of the four jointly estimated networks. In the Austrian,

Lithuanian, Scottish, and Welsh sample, 108, 113, 107, and 117 of all possible 231 edges (46.8%,

48.9%, 46.3%, and 50.6% respectively) were estimated to be above zero, meaning that the

symptoms had substantial connections to each other. The visual inspection of the four networks

shows many consistent edges, such as strong connections between RE1 and RE2, DR2 and DR3,

AV1 and AV2, NSC1 and NSC2, and AD8 and AD9 (see Table 2 for full symptom names).

Other edges differed between the networks, such as TH1 and TH2 that was strong in three

networks but rather weak in the Austrian network, AD4 and AD5 that was rather strong in all

networks except for the Lithuanian network, or RE1 and TH2 that was relatively strong in the

Scottish network but rather weak in all other networks. The edge between AD3 and AD5 was

negative in the Austrian and the Welsh network while it was fixed to zero by the LASSO in the

other two networks.

Network inference

The standardized strength centrality estimates are presented in Figure 2. These estimates

were very similar across the four networks with Spearman correlations ranging from .59

(Austrian and Welsh sample) to .82 (Scottish and Lithuanian sample). NSC2 had the highest

strength metric across all samples and DR2 had relatively high values in all networks. The

strength of AD4 and AD5 was among the lowest in all samples. The strength metrics of TH1,

TH2, AD6, and AD9 had the highest cross-sample variation. To evaluate a possible bias (Terluin,

de Boer, & de Vet, 2016), we correlated the strength centrality estimates with the variance of

each symptom and found a small average correlation of $r = .14$.

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The average predictability of the nodes is graphically presented in Figure 1 and ranged

from .47 (Austrian and Scottish sample) to .60 (Welsh sample), with a total mean of .52. This

means that on average 47% to 60% of the variation of each symptom could be explained by its

neighboring symptoms. Strength and predictability were closely related (correlations from .80 to

.90), reflecting their conceptual similarity.

Network stability

There are no clear boundaries to interpret the results of the stability analyses. The

confidence intervals around the edge weights were moderately large, indicating a moderate

accuracy of the network estimation. The correlation stability coefficient for the strength centrality

metric was above the suggested .50 threshold for strong stability (Epskamp et al., 2017) for the

Scottish sample (.52) and above the suggested threshold of .25 for moderate stability for the other

three samples (Austrian sample: .44; Lithuanian sample: .44; Welsh sample: .36). The results of

the stability analyses are detailed in the Supplementary Materials.

Network comparison

Spearman correlations of the edge weights between the samples ranged from .69

(Austrian and Scottish sample) to .75 (Austrian and Lithuanian sample), indicating strong

similarities. The NCT is an overall test of network similarity. We compared all six pairs of

networks and found that the network identified for the Austrian sample differed from those

identified in all other samples, while the networks identified among the Welsh and the Lithuanian

participants differed significantly from each other (all $p < .05$). We then used a post hoc test

comparing all edges between the networks and found only one significantly differing edge in the

comparison of the Austrian and the Scottish network (between TH1 and TH2), while no other

edge was found to significantly differ between all networks. The global strength of the networks,

which is a measure of the overall connectivity within a network, was 9.66 for the Austrian, 9.89

for the Lithuanian, 9.41 for the Scottish, and 10.13 for the Welsh network. The NCT showed

significant differences only for the comparison of the overall connectivity between the Scottish

and the Welsh as well as the Scottish and the Lithuanian network. Collectively, these results

therefore suggest a strong similarity between the networks.

As a final step, we therefore estimated a network for the total sample of 879 traumatized

patients. The network graph of this cross-sample network is displayed in Figure 3a. As might be

expected, the structure of this network was similar to the structures of the four jointly estimated

networks: It showed strong connections between RE1 and RE2, NSC1 and NSC2, AV1 and AV2,

TH1 and TH2, as well as AD8 and AD9. NSC2 had the highest strength, followed by DR2,

NSC1, AD2, TH2, and DR1. The least central symptom in this network was AD5 (Figure 3c; see

Table 2 for full symptom names). Figure 3b shows a network visualizing the differences and

similarities of the edges across the samples. In this network, the differences of each edge between

any two symptoms across the four networks is illustrated as edge: Strong edges mean strong

variation of the respective edge across the four samples. The largest variation could be observed

between TH1 and TH2 (0.13), AD1 and AD2 (0.10), and TH1 and AD3 (0.09). For most edges,

the inter-network variation was negligibly small.

Discussion

To our knowledge, this is the first investigation of the ICD-11 CPTSD network structure.

We jointly estimated four networks in four trauma samples that varied in their European cultural

background, demographic characteristics, trauma experiences, and symptom severity. ICD-11

CPTSD symptoms were assessed with the same instrument in all samples, namely the

International Trauma Questionnaire, ruling out possible assessment differences as bias for the

comparison. In summary, we found that even though the severity of symptom distress differed

across samples, the symptom profiles correlated strongly across the samples. In the jointly

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estimated networks, about the half of all possible edges was estimated to be non-zero. The visual

impression that the four networks were highly similar was cautiously supported by the formal

network comparison which revealed only minor differences. The most central symptom in all

four sample specific networks and the overall network was *NSC2-feelings of worthlessness*. The

results were at least moderately robust and accurate as shown by the stability analyses. In all four

sample specific networks, as well as in the overall network, the connections between some

symptoms were very strong: both re-experiencing symptoms (*RE1-distressing dreams* and *RE2-

intrusive recollections*), both avoidance symptoms (*AV1-internal avoidance* and *AV2-external

avoidance*), both dissociative symptoms (*AD8-derealization* and *AD9-depersonalization*), two

symptoms of the DSO domain negative self-concept (*NSC1-feelings of failure* and *NSC2-feelings

of worthlessness*), and two symptoms of the DSO domain difficulties in relationships (*DR2-

difficulties feeling close to others* and *DR3-avoidance of relationships*). The largest variation in

symptom connectivity between the samples was for the connections of the two sense of threat

symptoms (*TH1-hypervigilance* and *TH2-exaggerated startle response*) and two symptoms of the

DSO domain affect dysregulation (*AD1-hightened emotional reactivity* and *AD2-long time

upset*).

This study supports the robustness and replicability of network models, because we found

a relatively stable pattern of associations across four different samples, in contrast to recent

publication that questioned whether these models would generalize and replicate in different

samples (see Borsboom et al., 2017 for an overview). The present study provides evidence that

this type of model replicates and thus supports the findings of Fried et al. (2018). Although Fried

and colleagues (2018) used DSM-IV PTSD symptoms in their analysis, we followed their

analytical strategy and can thus compare our results on a methodological level. In both studies,

the cross-sample networks had high similarity as shown by the intercorrelation of the edge

weights and the strength centrality estimates. The formal network comparison test did not detect large differences between samples, however, the sample size in the current study limits the sensitivity of this test. The four samples in our study differed widely with respect to prevalence rates of ICD-11 PTSD and CPTSD (ranging from 23.7% to 37.3% for PTSD and from 9.3% to 53.1% for CPTSD) and we found similar networks across these samples with different symptom burden. This result gives preliminary evidence for the replicability of CPTSD network models across different populations.

The connections of several symptoms in the networks were considerably stronger than those of other symptoms. We found that any two symptoms that were among those with the strongest connections were from the same symptom domain: re-experiencing, difficulties in relationships, avoidance, negative self-concept, and affect dysregulation (dissociation). This supports the conceptual similarity of these symptoms within their respective domain and the proposed factor structure of ICD-11 CPTSD (Kazlauskas et al., 2018; Shevlin et al., 2017). This result is similar to the findings of factor analytical studies, where symptoms within a factor are strongly related to each other (e.g. Hyland et al., 2017). This is not surprising, because under certain conditions, network models and factor models are mathematically equivalent (Kruis & Maris, 2016) and both are based on the correlation matrix of the data. However, conceptual assumptions underlying these models differ and the network approach emphasizes the mutual interaction between symptoms. Given its similarities to the factor model, the network approach does not introduce a completely new way of modelling associations of symptoms, but it provides novel possibilities to investigate the role of certain symptoms and points towards the dynamic and complex symptom interplay within mental disorders (Bringmann & Eronen, 2018). While the theoretical explanation of statistical covariation of symptoms within a cluster in the factor model is the presence of a latent variable that causes the symptoms, the network approach suggests a

direct interaction on symptom level. Notably, the network approach does not preclude the

existence of a directly not observable variable, such as brain circuits, accounting for observable

covariation on symptom level.

The most central symptom in all networks was *NSC2-feelings of worthlessness*. This

seems similar to prior results on the DSM-5 network structure of PTSD, where *negative trauma*

related emotions showed the highest centrality (Armour et al., 2017). The second most central

symptom, *DR2-difficulties feeling close to others (detachment)*, was also found to be among the

most central symptoms in the analyses of Fried et al. (2018). High centrality means that these

symptoms have strong associations with neighboring symptoms. As our analysis is cross-

sectional, however, we can draw no conclusions regarding the directionality of these associations.

It is possible that considering oneself as worthless is the consequence of many other symptoms,

which seems plausible, because symptom distress is usually associated with functional

impairment (Maercker et al., 2013), which in turn could lead to a negative self-concept which

finds its expression in feelings of worthlessness. However, the opposite seems plausible as well:

to feel worthless could lead to other negative self-concept representations, which in turn could

lead to difficulties in relationships and so on. We conclude that it seems most likely that a central

symptom is bidirectionally related to its neighbors. The important question to this end is, whether

interventions addressing central symptoms are more likely to lead to overall symptom relief than

interventions addressing other symptoms (Fried et al., 2018; Hofmann, Joshua, & McNally,

2016). The answer to this question depends on the actual causal direction which could not be

determined in our study. Nevertheless, it seems advisable to focus on central rather than on

decentral nodes when planning interventions.

Finally, we think it is important to address the relation of cross-sectional between-person

networks and longitudinal within-person networks. It is possible that a cross-sectional network,

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such as the networks presented in this manuscript, significantly differs from an individual

network of a person over several time points. All conclusions drawn from our analyses should be

interpreted in the light of a between-person approach. Applying these results to predict the course

of an individual within-person network cannot be justified and future research should investigate

these issues.

Despite the robust methodological design, this study has some limitations that need to be

considered when interpreting the results. First, all studies used the ITQ to assess symptoms of

CPTSD. While it is a strength that symptoms were measured with the same instrument in all

samples, the ITQ is a self-report questionnaire and a clinician administered interview might

provide more valid data on symptom burden. Second, there are likely to be similarities in the

cultural backgrounds of the four samples, even though all samples came from different regions all

over Europe. It is not clear whether our results would generalize to other traumatized populations

such as refugees, veterans or to populations from other areas of the world. Third, the size of the

individual samples limited some of the analyses, especially the overall network comparison test.

It is possible that larger sample sizes with more power would have detected differences that we

missed. Fourth, the ICD-11 requires the presence of functional impairment associated with

symptoms for a diagnosis of CPTSD. However, functional impairment was not assessed in the

current study and it is possible that considering only participants who report functional

impairment would result in different networks. Finally, all data used in this study were cross

sectional, limiting possible causal interpretations.

In conclusion, this study was the first that used network analysis to investigate the

structure of ICD-11 CPTSD with state-of-the-art methods. The similarity of the networks across

the four samples supports the structure of CPTSD which seems to represent a similar disorder

across different cultural groups. Future research should investigate causality and the relation of

between-person and within-person networks as well as the hypothesis that targeting central

symptoms leads to faster recovery than targeting decentral symptoms.

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Table 1

Descriptive Sample Characteristics

Samples	Sample 1	Sample 2	Sample 3	Sample 4
Description	Survivors of child maltreatment during foster care	Primary mental health care patients	Trauma center patients	Primary and secondary mental health service users
Country	Austria	Lithuania	UK (Scotland)	UK (Wales)
Sample size	220	280	193	186
Age *M* (*SD*)	57.90 (9.55)	39.48 (13.35)	40.56 (12.30)	48.40 (12.32)
Women (%)	40.0	77.5	65.1	47.3
ICD-11 PTSD (%)	37.3	27.9	37.0	23.7
ICD-11 Complex PTSD (%)	17.3	9.3	53.1	41.9

Note. PTSD and Complex PTSD rates are based on self-reports.

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Table 2

Means and Standard Deviations of Symptoms

Symptom	Short code	Austria		Lithuania		Scotland		Wales	
		M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Distressing dreams	RE1	1.28	1.56	1.03	1.21	2.66	1.30	2.24	1.44
Intrusive recollections	RE2	1.67	1.55	1.27	1.36	2.48	1.39	2.30	1.41
Internal avoidance	AV1	1.84	1.54	1.54	1.40	2.92	1.06	2.67	1.25
External avoidance	AV2	1.65	1.56	1.52	1.45	3.03	1.08	2.72	1.35
Hypervigilance	TH1	2.45	1.61	1.23	1.28	3.07	1.21	2.69	1.32
Exaggerated startle response	TH2	1.74	1.58	1.62	1.36	2.89	1.25	2.53	1.38
Heightened emotional reactivity	AD1	2.41	1.37	1.86	1.10	2.66	1.16	2.52	1.14
Long time upset	AD2	2.29	1.50	1.95	1.08	2.71	1.06	2.78	1.14
Emotional vulnerability	AD3	2.83	1.33	2.28	1.18	2.69	1.18	2.69	1.23
Anger	AD4	1.48	1.49	1.53	1.25	1.79	1.45	1.69	1.48
Reckless behavior	AD5	0.85	1.26	0.88	1.15	1.20	1.46	1.28	1.38
Emotional numbing	AD6	1.39	1.51	0.92	1.13	2.61	1.25	2.42	1.33
Inability experiencing positive emotions	AD7	1.49	1.55	1.10	1.22	2.24	1.35	2.18	1.43

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Derealization	AD8	1.87	1.62	1.19	1.22	2.83	1.25	2.41	1.35
Depersonalization	AD9	1.59	1.62	1.07	1.22	2.22	1.52	2.01	1.51
Feelings of failure	NSC1	0.83	1.21	1.10	1.27	2.68	1.41	2.28	1.42
Feelings of worthlessness	NSC2	0.89	1.35	1.04	1.3	2.49	1.48	2.14	1.51
Feelings of shame	NSC3	1.10	1.36	1.09	1.24	2.65	1.37	2.35	1.42
Feelings of guilt	NSC4	1.66	1.44	1.91	1.22	2.85	1.26	2.70	1.26
Feeling distant or cut-off from others	DR1	1.23	1.39	1.42	1.25	2.78	1.16	2.55	1.32
Difficulties feeling close to others	DR2	1.68	1.61	1.23	1.22	2.49	1.35	2.23	1.40
Avoidance of relationships	DR3	1.65	1.66	1.13	1.24	2.26	1.55	1.94	1.56
Total Mean[1]		1.63	0.89	1.36	0.78	2.54	0.77	2.29	0.90

Note. Symptoms assessed with the International Trauma Questionnaire. [1] T-tests comparing total

means: Lithuania < Austria < Wales < Scotland, all t-values > 2.74, all p-values < .007.
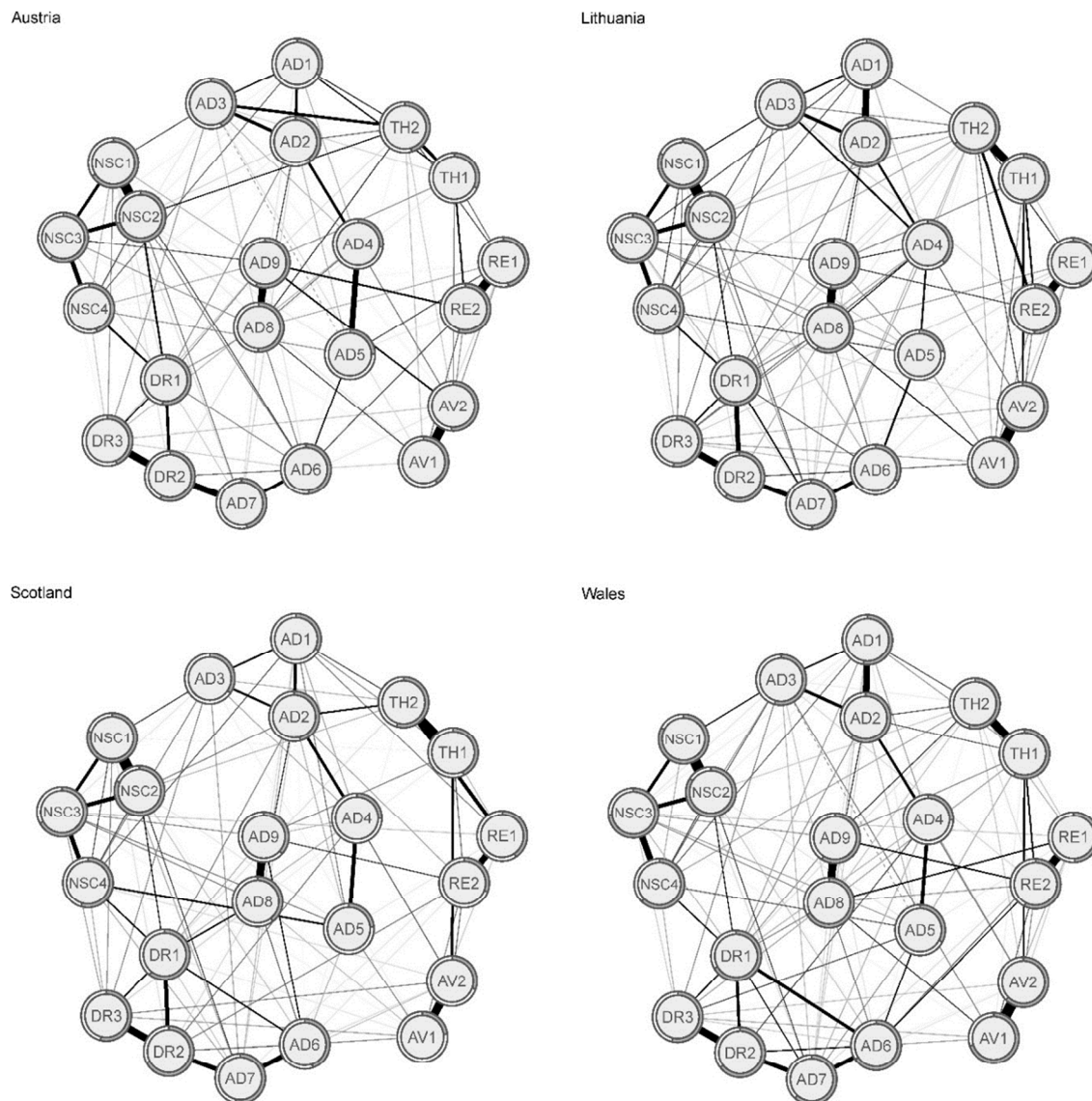
Figure 1. Regularized partial correlation networks across four data sets of traumatized individuals. Edge thickness represents the degree of association, green edges (solid) indicate positive relations, and red edges (dashed) indicate negative relationships. The gray area in the rings around the nodes depicts predictability (the variance of a given node explained by all its neighbors). RE1=Distressing dreams, RE2=Intrusive recollections, AV1=Internal avoidance, AV2=External avoidance, TH1=Hypervigilance, TH2=Exaggerated startle response, AD1=Heightened emotional reactivity, AD2=Long time upset, AD3=Emotional vulnerability, AD4=Anger, AD5=Reckless behavior, AD6=Emotional numbing, AD7=Inability experiencing positive emotions, AD8=Derealization, AD9=Depersonalization, NSC1=Feelings of failure, NSC2=Feelings of worthlessness, NSC3=Feelings of shame, NSC4=Feelings of guilt, DR1=Feeling distant or cut-off from others, DR2=Difficulties feeling close to others, DR3=Avoidance of relationships.
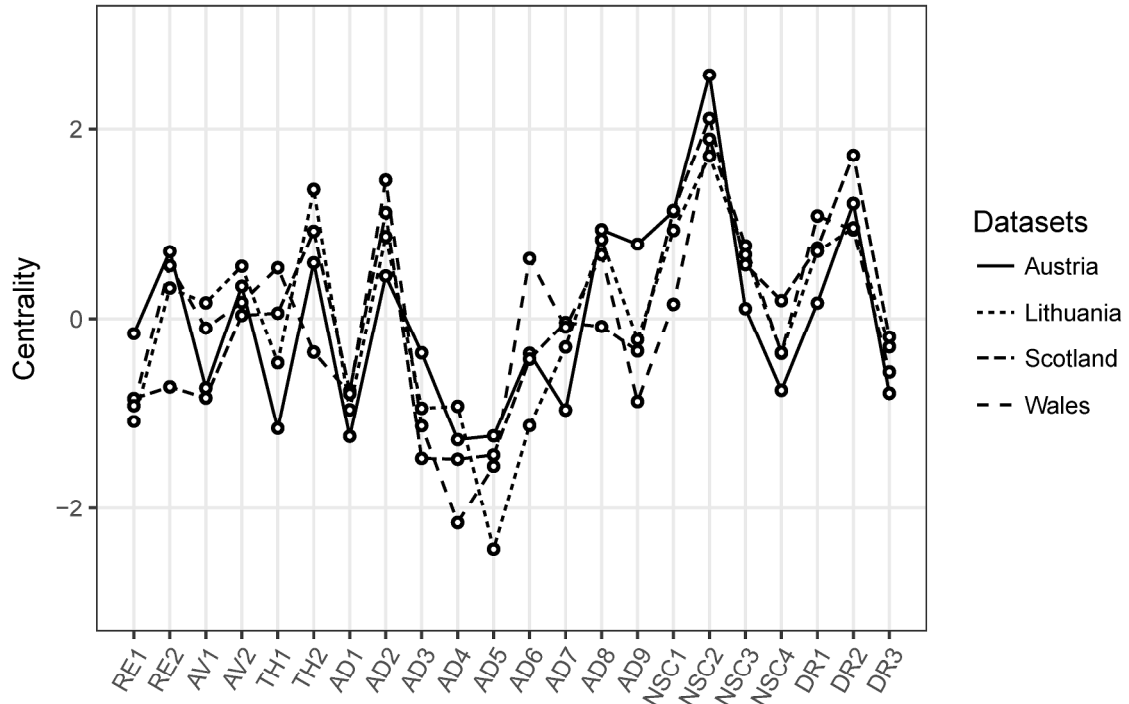
Figure 2. Standardized node strength centrality of the 22 Complex Posttraumatic Stress Disorder symptoms across four clinical data sets of traumatized patients receiving treatment. See Table 2 for full symptom names.
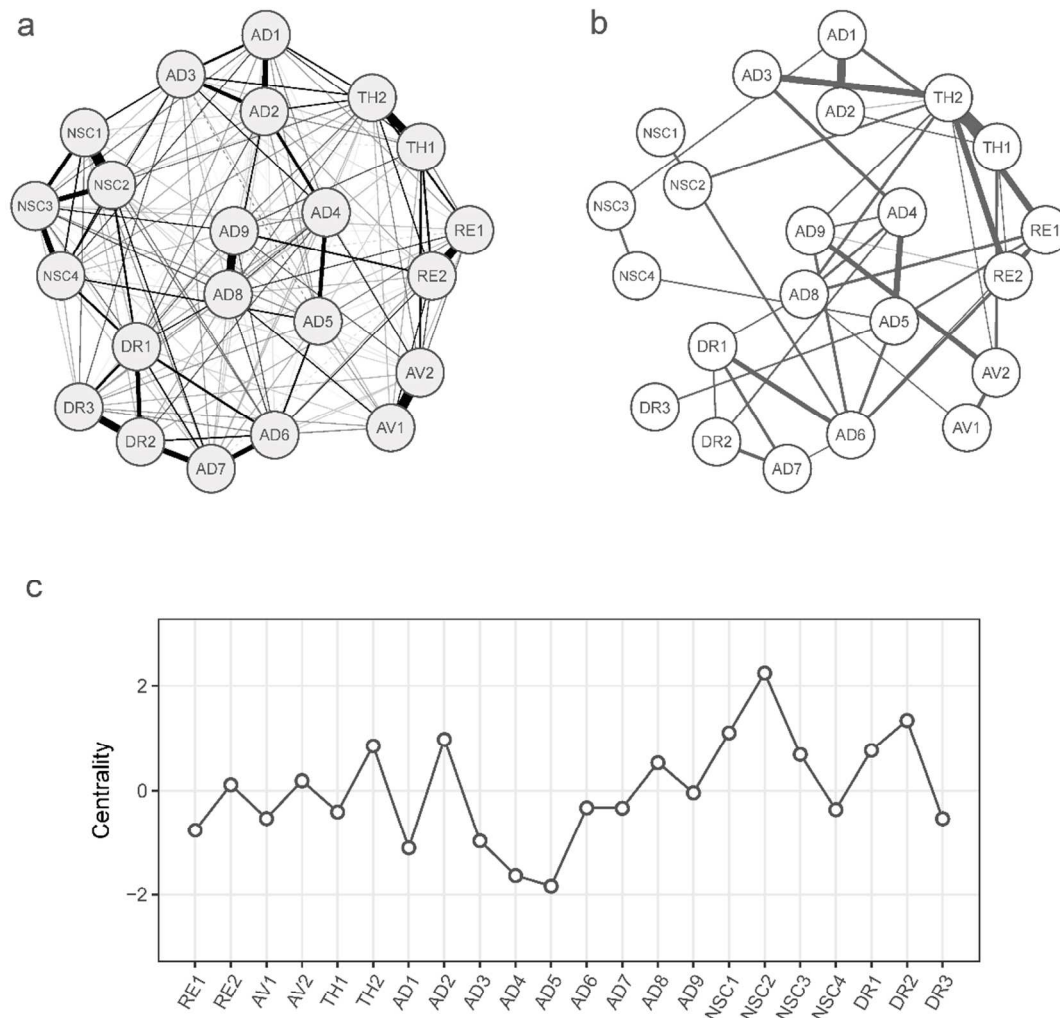
Figure 3. Network analysis in the combined data set. (a) Cross-sample network (n = 879) depicts

the average of the four individual networks; green (solid) edges indicate positive relations, and

red (dashed) edges indicate negative relationships. In the (b) cross-sample variability network,

each edge depicts the standard deviation of this edge across the four networks. (c) Standardized

node strength centrality for the cross-sample network is shown. See Table 2 for full symptom

names.