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Repetitive Negative Thinking as a Central Node Between Psychopathological Domains: a Network Analysis

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Abstract

Repetitive negative thinking (RNT) may be defined as a reiterative, passive and uncontrollable thinking process. RNT has been recognized as a transdiagnostic phenomenon associated with the onset and maintenance of several clinical conditions including depression, generalised anxiety, psychosis and insomnia. We aimed to estimate a network model of mutual associations between RNT and the aforementioned indicators whilst controlling for other well-established transdiagnostic factors (i.e. perceived stress, loneliness). A total of 324 participants (M_{age} = 25.26 years, SD = 6.89; 69.3% females) completed a cross-sectional survey of self-report questionnaires. A Gaussian graphical model was estimated using the graphical LASSO in combination with the extended Bayesian information criterion. We found a dense network in which RNT exhibited substantial connections with the majority of the psychopathological domains. The centrality indices confirmed that RNT was one of the most important nodes in the network. Moreover, the estimated network showed satisfactory accuracy and stability. Findings emphasized RNT as a potentially good therapeutic target for psychopathology prevention and treatment protocols.

Keywords Repetitive negative thinking · Perseverative cognition · Anxiety · Depression · Psychosis · Insomnia · Network analysis

Introduction

Repetitive negative thinking (RNT) may be defined as a reiterative, passive and uncontrollable thinking process which is perceived as unproductive (Ehring & Watkins, 2008; Ehring et al., 2011). RNT is generally conceptualised as negatively affect-laden (Harvey, Watkins, Mansell, & Shafran, 2004), and it is commonly

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experienced in individuals with mental disorders. For instance, a recent study comparing patients diagnosed with depression, generalized anxiety and healthy controls on a content-independent measure of RNT found that all clinical groups differed from healthy controls on RNT with moderate to large effect sizes, without differences between clinical conditions (Wahl, Ehring, Kley, Lieb, Meyer, Kordon, et al., 2019). RNT has also been found in individuals with insomnia (e.g. difficulties falling/maintaining sleep, Nota & Coles, 2015) and psychosis (Hartley, Haddock, e Sa, Emsley, & Barrowclough, 2014) compared to healthy controls. Moreover, RNT seems to be associated with higher levels of perceived stress (Segrin & Passalacqua, 2010), as well as with non-clinical conditions including loneliness (Hager et al., 2022). An influential model explaining why individuals with various clinical symptoms share the proneness for RNT is the meta-cognitive model, according to which beliefs about own thoughts and self-regulatory strategies of cognition and emotion determine reactions to environmental stimuli and one's own cognitive processes (Kowalski & Dragan, 2019; Kowalski & Gawęda, 2022; Sellers et al., 2017).

Notably, the co-occurrence of symptoms of depression, anxiety, insomnia and psychosis has been reported both in clinical samples and in population studies (e.g. Reeve et al., 2015; Berger, Li & Amminger, 2020; Na et al., 2019). The high comorbidity between these conditions may be explained by at least two sets of reasons. First, it is possible that one or more of these conditions influence or even cause the others. Previous literature in this field offered plenty of cross-sectional and longitudinal data which explored the directionality of these associations. For instance, individuals with insomnia without other mental health conditions at the baseline are shown to have a higher risk to develop depression, anxiety and psychosis at follow-ups (Hertenstein et al., 2019). Also, individuals with anxiety conditions such as social phobia or agoraphobia may develop secondary depressive and insomnia symptoms (Cosci & Fava, 2021; Shin et al., 2020). Second, all these conditions may be influenced or caused by one or more common variables, such as RNT, which acts as transdiagnostic factors. Consistently, transdiagnostic models of mental health disorders are becoming widely diffused, emphasizing the underlying processes involved in multiple clinical conditions (e.g. Dalgeish et al., 2020). Similar to RNT, loneliness, defined as the discrepancy between the quality and quantity of relationships that individuals have and the ones they desire (Cacioppo & Cacioppo, 2018), has been considered a transdiagnostic clinical phenomenon that may significantly influence mental health and psychological well-being (Heinrich & Gullone, 2006). Moreover, according to the stress-diathesis model, stressful life experiences are considered a risk factor for the onset of several psychiatric disorders (see Zuckerman, 1999).

The network analysis is a relatively novel and promising approach for modelling complex interactions between psychopathological domains, which accommodates the transdiagnostic framework by conceptualizing mental disorders as networks of related features (see e.g. Boorsbom & Cramer, 2013 and Fonseca-Pedrero, 2017 for an extensive discussion). Instead of assuming a latent construct (e.g., major depression) as the explanation of its observable symptoms (e.g., fatigue, trouble sleeping), the network theory considers mental disorders as a tangled system of interconnected symptoms (i.e. nodes; Van Borkulo et al., 2015) in which transdiagnostic factors may play a central role in their onset and/or maintenance (Jones et al., 2017). Accordingly, network analysis may be employed to address how transdiagnostic constructs interact within a structure of psychopathological nodes (Eadeh et al., 2021). These vulnerability factors may be considered in the network structure as mechanisms able to increase the risk of developing mental health problems (Fritz et al., 2018), as well as to connect several symptomatologic clusters irrespective of traditional nosographic boundaries (Boorsbom, 2017). Under this perspective, network analysis may supply qualitative and quantitative insights about the central role of a specific transdiagnostic factor. Specifically, it allows depicting the direct and indirect associations among nodes on a graph (sometimes called Gaussian graphical model; Højsgaard et al., 2012). Moreover, it provides a series of centrality indices indicating how strongly a transdiagnostic factor is, directly and indirectly, connected to the other symptoms in the network. Notably, a central domain may be considered one of the most influential factors in maintaining the other symptoms included in the network structure due to its substantial and dense connections, thus constituting a preferential clinical target for reducing the interactions in which this specific factor is involved. Although network analysis is mainly conceived as an exploratory approach, it may provide significant insights to maximize the efficacy of treatment protocols (Boorsbom & Cramer, 2013). Accordingly, scientific literature involving network analysis is constantly growing, and its use has been strongly recommended as a novel approach for modelling and simulating psychopathological processes (Fonseca-Pedrero, 2017).

To the best of our knowledge, no previous studies have carried out a network structure in which RNT, loneliness and perceived stress have been simultaneously considered examining their differential relationships with depressive, generalised anxiety, insomnia and psychotic-like symptoms. Since RNT, loneliness and perceived stress have been demonstrated to be significantly associated with each other (e.g. Hager et al., 2022; Segrin & Passalacqua, 2010; Zagaria et al., 2022), disentangling their unique contributions by controlling for the other transdiagnostic factors may provide a significant advancement in the field. To fill these gaps, we aimed to model the structure of mutual dependences among the aforementioned domains by employing a regularized partial correlation network. More specifically, we hypothesized a central position of the RNT in terms of substantial and diffuse connections with the other clinical conditions included in the network structure, thus acting as a transdiagnostic factor. This was consistent with its conception as a content-independent and vulnerability feature associated with the onset and maintenance of a wide range of clinical conditions (Ehring et al., 2011; McLaughlin & Nolen-Hoeksema, 2011).

Methods

Participants and Procedure

A convenience student community sample from the Sapienza University of Rome was recruited by employing a snowball sampling approach. Before completing an online, cross-sectional survey designed through the Qualtrics platform (www.qualtrics.com), participants voluntarily agreed to participate by signing informed consent. The first page of the survey contained a detailed description of the study, and respondents could leave the survey at any point. Anonymity was guaranteed not collecting data that could lead back to the participant's identity. Respondents were eligible to participate in the study if (1) aged over 18 years and (2) signed the informed consent. A total of 324 participants (M_{age} = 25.26 years, SD = 6.89; 69.3% females) completed the survey and were enrolled in the present investigation. The study was conducted following the ethical standard established in the Helsinki Declaration and its later amendments and was reviewed and approved by the Institutional Review Board of the Department of Psychology, Sapienza University of Rome (prot. 0000278).

Measures

The Perseverative Thinking Questionnaire (PTQ; Ehring et al., 2011) was administered to evaluate RNT. PTQ is a self-report and content-independent questionnaire assessing the core features of RNT from a transdiagnostic perspective, including repetitiveness, intrusiveness and difficulties with disengagement. Items are rated on a 4-point Likert scale ranging from 0 ("Never") to 4 ("Almost always"). Examples of items include "Thoughts intrude into my mind" and "My thoughts repeat themselves." The scale was adapted for use in Italy showing satisfactory psychometric properties (Ghezzi et al., in prep). Cronbach's alpha in the present sample was 0.956.

The Insomnia Severity Index (ISI; Bastien et al., 2001) is a brief self-report questionnaire designed to evaluate the presence and severity of both night-time and day-time symptoms of insomnia. Items are rated on a 5-point Likert scale, ranging from 0 to 4. An example of an item includes "How satisfied/dissatisfied are you with your current sleep pattern." The scale was adapted for use in Italy showing satisfactory psychometric properties (Castronovo et al., 2016). Cronbach's alpha in the present sample was 0.823.

The Perceived Stress Scale (PSS; Cohen et al., 1994) is a widely used self-report questionnaire for measuring the perception of stress. Items, rated on a five-point Likert scale ranging from 0 (Never) to 4 ("Very often"), assess the degree to which circumstances in own life are appraised as stressful. An example of an item includes "In the last month, how often have you found that you could not cope with all the things that you had to do?" The scale was adapted for use in Italy showing satisfactory psychometric properties (Mondo et al., 2022). Cronbach's alpha in the present sample was 0.860.

The Community Assessment of Psychic Experience (CAPE-15; Capra et al., 2013) was administered to assess the frequency of psychotic-like experiences (PLEs) in terms of persecutory ideation, perceptual abnormalities and bizarre experiences. Items are rated on a 4-point Likert scale ranging from 0 (Never) to 4 (Almost always). Examples of statements include "Heard voices when you are alone" and "Heard your thoughts being echoed back at you." Cronbach's alpha in the present sample was 0.770.

Loneliness, defined as the discrepancy between the quality and quantity of relationships that individuals have and the ones they desire (Cacioppo & Cacioppo, 2018), was assessed through a short version of the Revised UCLA Loneliness Scale (ULS; Hughes et al., 2004). Items are rated on a three-point Likert scale, ranging from 0 ("Hardly ever") to 3 ("Often"). Examples of items include "How often do you feel that you lack companionship" and "How often do you feel isolated from others?" The scale was adapted for use in Italy showing satisfactory psychometric properties (Boffo et al., 2012). Cronbach's alpha in the present sample was 0.821.

Depressive symptoms were measured through a short version of the Patient Health Questionnaire (PHQ; Kroenke et al., 2003). Items are rated on a 4-point Likert scale ranging from 0 ("Not at all") to 3 ("Nearly every day"). For instance, an item investigates the "Little interest or pleasure in doing things." The scale was adapted for use in Italy showing satisfactory psychometric properties (Shevlin et al., 2022; https://www.phqscreeners.com/). Cronbach's alpha in the present sample was 0.749.

Generalised anxiety symptoms were evaluated using a short version of the Generalised Anxiety Disorder (GAD; Kroenke et al., 2007) scale. Items are rated on a 4-step Likert scale ranging from 0 (Not at all) to 3 (Nearly every day). An example of a statement includes "Feeling nervous, anxious, or on edge." The scale was adapted for use in Italy showing satisfactory psychometric properties (Shevlin et al., 2022; https://www.phqscreeners.com/). Cronbach's alpha in the present sample was 0.821.

Data Analysis

Data were analysed through JASP 0.16.1.0 and R version 4.1.3 using the bootnet (Epskamp & Fried, 2015), qgraph (Epskamp et al., 2012) and glasso (Friedman et al., 2014) packages.

Preliminary, descriptive statistics were calculated as means and standard deviations for continuous variables, as well as counts and percentages for categorical variables. Afterwards, to gain exploratory insights into the complex interplay between the psychopathological domains under investigation, a network analysis was employed. The most popular network model for estimating psychological networks is the broad class of statistical models called pairwise Markov random field (PMRF; Costantini et al. 2015a, van Borkulo et al., 2014), in which nodes representing observed variables linked by undirected edges (Epskamp et al., 2018). Each edge indicates the degree of association between two nodes after controlling for all other nodes in the network, with colour and thickness denoting the direction (i.e. positive or negative) and strength of associations. According to Epskamp and colleagues (2018), the analyses involved three steps. First, we estimated a weighted network structure. Second, we explored the importance of individual nodes within the network structure by calculating several centrality indices (see also Haslbeck & Waldorp, 2020). Third, we estimated the accuracy and stability of the network parameters. More specifically, we estimated a Gaussian graphical model using the graphical least absolute shrinkage and selection operator (LASSO; Tibshirani, 1996) in combination with the extended Bayesian information criterion (EBIC; Chen & Chen, 2008) to select the optimal regularization parameter that controls the level of sparsity (hyperparameter gamma = 0.5). The LASSO applies a penalty by limiting the total sum of absolute partial correlations resulting in the shrinkage of many spurious edges to exactly zero. This form of regularization returns a sparse network of partial correlation coefficients in which only a reduced number of edges are selected to uncover the underlying network structure, thus providing a more interpretable and parsimonious model (Epskamp & Fried 2018). As a further step, the most influential nodes were identified by calculating three commonly reported statistics that can be interpreted as indices of the centrality of a given node (Newman, 2010; Opsahl et al., 2010), that is, *strength* (i.e. the absolute sum of edge weights connected to a specific node), *betweenness* (i.e. the number of times in which a node dwells on the shortest path between two other nodes) and *closeness* (i.e. the average distance of the shortest path from one node to every node in the network structure). Afterwards, to strengthen the replicability and generalisability of the findings, we examined the accuracy and stability of the network model following the recommendations of Epskamp and colleagues (2018). Namely, the accuracy of the edge weights was estimated by calculating 95% non-parametric bootstrap confidence intervals (CIs) based on 1000 replications. The stability of the centrality indices was assessed by employing a case-dropping subset bootstrap (1000 replications) examining whether the order of centrality indices remains the same after re-estimating the network structure with fewer cases. To quantify the degree of stability, the correlation stability coefficients (CS-coefficient) were calculated, which represent the maximum proportion of cases that can be dropped to maintain a correlation with the original indices higher than 0.7 (Epskamp et al., 2018). It has been suggested that CS coefficients should be higher than 0.25, and preferably above 0.5, to consistently interpret centrality estimates (Epskamp et al., 2018; Forbes et al., 2021).

Results

Characteristics of the Sample

A total of 324 participants were enrolled and completed the cross-sectional survey. Most of the participants were female (69.3%), with a mean age of 25.26 years (SD = 6.89). With respect to the higher education level, 62.3% had a high-school diploma, 23.8% had a bachelor's degree, 8% had a master's degree, 4% had a middle-school diploma, and 1.9% had a Ph.D. level degree. Regarding marital status, 49.1% of the sample was engaged in a relationship, 43.8% was single, 6.8% was married and 0.3% was widowed. By adopting previously established cut-offs (Castronovo et al., 2016; Kroenke et al., 2003), 28.8% and 8.5% of the sample were considered at risk of developing a major depressive disorder and insomnia, respectively. Descriptive statistics and zero-order correlations for the investigated variables are presented in Supplementary Table 1. As expected, all correlations were significant and positive, ranging from small to large in size (Cohen, 1988).

Accuracy and Stability of the Network

Psychological networks may particularly be sensible to sample variation (Epskamp et al., 2018; Hallquist et al., 2021). Before delving deeper the network parameters, in order to enhance the replicability and generalisability of the emerged findings, we first investigated the accuracy and stability of these parameters (Epskamp et al., 2018). Specifically, the non-parametric bootstrapped CIs of edge weights are plotted in Fig. 1. As depicted, the relatively narrow CIs suggested a trustworthy

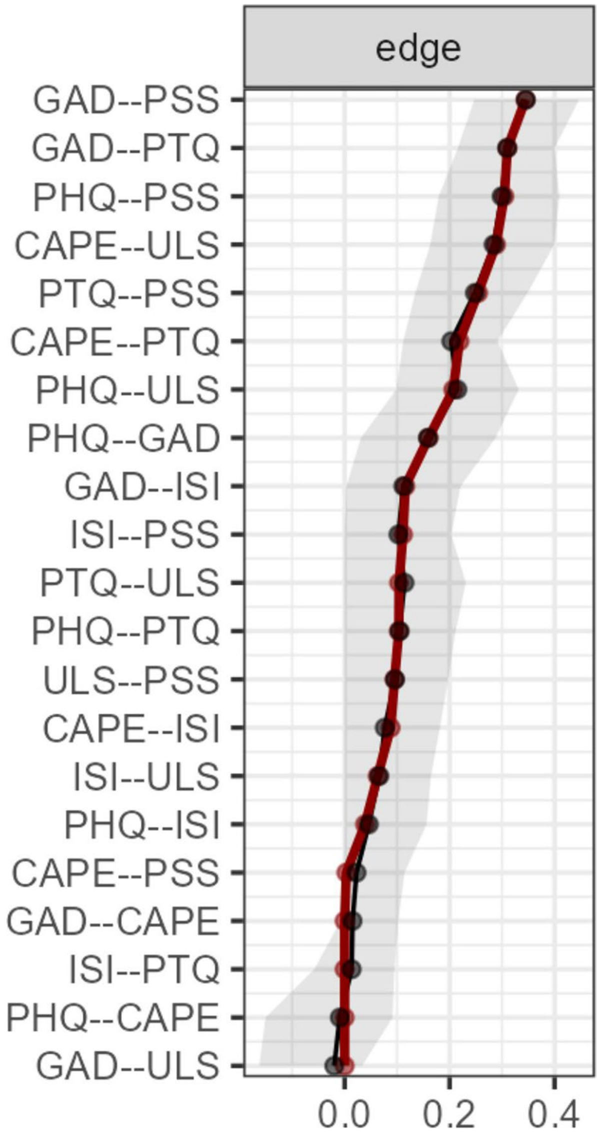

Fig. 1 The nonparametric bootstrapped confidence intervals of edge weights. The red dots indicate the sample values, the black dots indicate the bootstrap means, and the grey area indicates the 95% bootstrapped CIs. The wider the grey area, the lower the accuracy. Each horizontal line represents one edge, ordered from the highest weight to the lowest weight. CAPE, Community Assessment of Psychic Experience; GAD, Generalised Anxiety Disorder Scale; ISI, Insomnia Severity Index; PHQ, Patient Health Questionnaire; PSS, Perceived Stress Scale; PTQ, perseverative thinking questionnaire; ULS, UCLA Loneliness Scale

network (i.e. the variability in the estimation of the edge weights is not substantial). Note that clear recommendations to interpret the CIs are currently missing in the literature. Moreover, the stability analysis for the centrality indices through the case-dropping subset bootstrap is plotted in Fig. 2. In contrast to the average correlation of betweenness which dropped steeply, the stability of strength and closeness was graphically satisfactory. To quantify the degree of stability, CS coefficients were estimated, each representing the maximum proportion of cases that can be dropped to maintain the correlation between original and subset networks at 0.7 with a 95% probability. While betweenness was not stable under subsetting cases (CS(cor = 0.7) < 0.25), both strength (CS(cor = 0.7) = 0.672) and closeness (CS(cor = 0.7) = 0.516) were higher than the recommended cut-off of 0.5 (Epskamp et al., 2018), thereby assuring stable and interpretable results. Consistently, for the remainder of the investigation, we focused on and emphasized findings concerning strength and closeness indices.

Network Description and Centrality Indices

The estimated network structure is graphically depicted in Fig. 3. The layout is based on the Fruchterman and Reingold (1991) algorithm which sets connected nodes close to each other, as well as nodes with higher centrality indices closer to the centre of the graph (Epskamp et al., 2018). More deeply, the network was made up of seven nodes with a mean edge weight of 0.133. The number of non-zero edges was 17 out of 21 possible edges. For the sake of comprehensiveness, the edge weights matrix

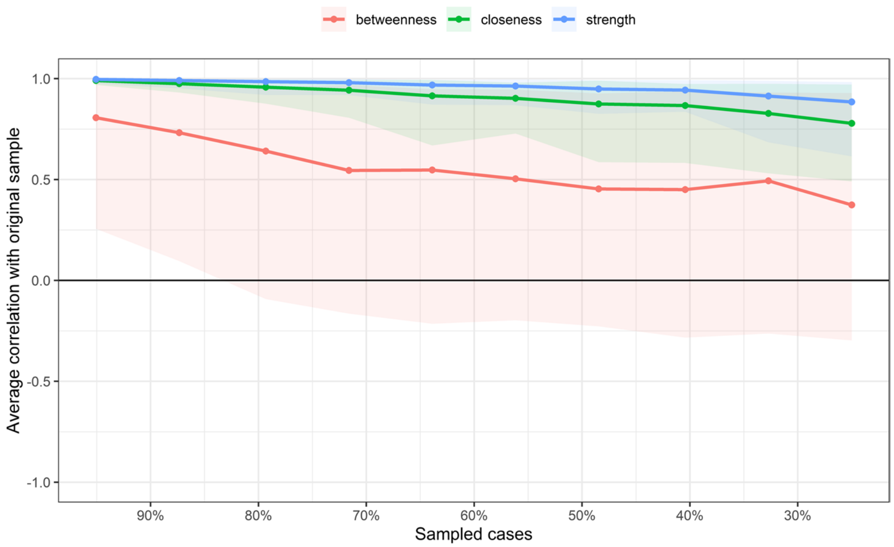

Fig. 2 Stability of centrality indices through case-dropping subset bootstrap. The *x*-axis depicts the percentage of cases at each step. The *y*-axis depicts the average correlations between centrality indices of networks with the original sample and those re-estimated with an increasingly higher percentage of dropped-out cases

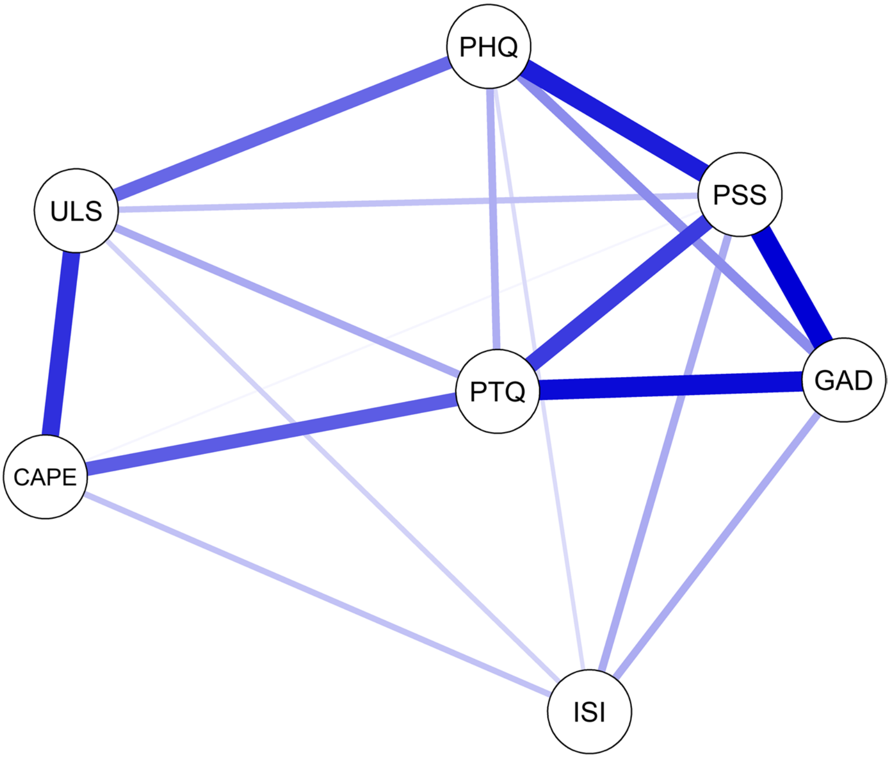

Fig. 3 Estimated network structure. Stronger correlations and weaker correlations were represented by thicker edges and thinner edges, respectively. Blue lines indicate positive edges. CAPE, Community Assessment of Psychic Experience; GAD, Generalised Anxiety Disorder Scale; ISI, Insomnia Severity Index; PHQ, Patient Health Questionnaire; PSS, Perceived Stress Scale; PTQ, perseverative thinking questionnaire; ULS, UCLA Loneliness Scale

is reported in Table 1. As expected, we found all positive edges among the nodes under investigation. The strongest positive associations emerged between PSS and GAD ($r_{partial}$=0.337), between PTQ and GAD ($r_{partial}$=0.324), between PSS and PHQ ($r_{partial}$=0.299) and between PTQ and PSS ($r_{partial}$=0.258). Some associations were absent, for instance between ULS and GAD and between CAPE and GAD, suggesting that these domains were statistically independent after conditioning on all

Table 1 Edge weights matrix. *CAPE* Community Assessment of Psychic Experience, *GAD* Generalised Anxiety Disorder Scale, *ISI* Insomnia Severity Index, *PHQ* Patient Health Questionnaire, *PSS* Perceived Stress Scale, *PTQ* perseverative thinking questionnaire, *SD* standard deviation, *ULS* UCLA Loneliness Scale

Node	PHQ	GAD	CAPE	ISI	PTQ	ULS	PSS
PHQ							
GAD	0.152						
CAPE	0	0					
ISI	0.047	0.109	0.081				
PTQ	0.107	0.324	0.215	0			
ULS	0.201	0	0.275	0.061	0.113		
PSS	0.299	0.337	0.011	0.110	0.258	0.082	

other nodes. Considering a cut-off of 0.1 as separating negligible from non-negligible effects (Cohen et al., 1988), PTQ was the node showing the most considerable direct edges with the other mental health domains (i.e. 5/6), followed by PSS (i.e. 4/6).

The central role of the PTQ in the network structure was sustained by the analysis of the standardized estimates of the centrality indices (see Fig. 4). With respect to strength, an index reflecting which nodes have the overall stronger direct associations (Epskamp et al., 2018), PTQ and PSS exhibited the highest values. Concerning closeness, which reflects how close a node is to all other nodes in the network structure (Golbeck et al., 2013), PSS and PTQ analogously showed the highest estimates.

Discussion

RNT has been recognized as a transdiagnostic phenomenon associated with the onset and maintenance of multiple forms of psychopathology (McLaughlin & Nolen-Hoeksema, 2011; Wahl et al., 2019). However, little is known about its differential impact on and its specific complex interactions with distinct psychopathological symptoms. Therefore, the present research aims to estimate the structure of associations between patterns of psychopathology and RNT among a sample of non-clinical adults. To this aim, a network analysis was performed hypothesising a

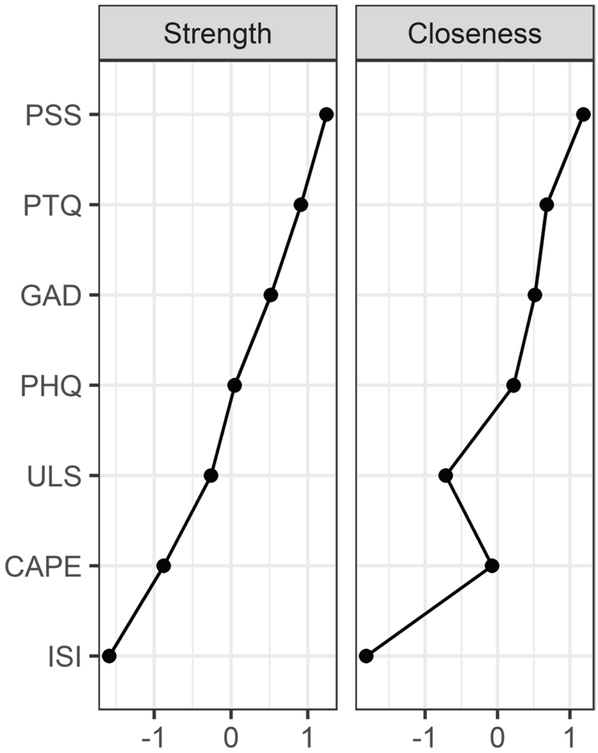

Fig. 4 Standardized estimates of the centrality indices for strength and closeness. Nodes with higher centrality are positioned to the right from the vertical axis. CAPE, Community Assessment of Psychic Experience; GAD, Generalised Anxiety Disorder Scale; ISI, Insomnia Severity Index; PHQ, Patient Health Questionnaire; PSS, Perceived Stress Scale; PTQ, perseverative thinking questionnaire; ULS, UCLA Loneliness Scale

central position of RNT to obtain a comprehensive and data-driven perspective on the interplay between these outcomes.

Overall, results showed robust stability of the network — as indicated by edges' 95% bootstrap confidence intervals — and partially confirmed the hypothesized centrality of RNT for psychopathology, with this construct consistently emerging as a central node sharing non-negligible unique connections with all the psychopathological symptoms assessed, except for insomnia.

First, centrality indices indicated highly stable and interpretable results in terms of strength and closeness. More specifically, the nodes most directly connected to the others in the network were perceived stress (PSS), followed by RNT (PTQ), possibly suggesting that these domains may be conceptualized as risk factors for developing and/or maintaining other connected cluster of symptoms. However, the high-strength centrality of these nodes may be a plausible effect of strong connections with other symptoms, as previous authors argued (Forbes, Wright, Markon, Krueger, 2019). In these regards, the highest estimated edges were the following: perceived stress with generalised anxiety (PSS-GAD), perceived stress with depressive symptoms (PSS-PHQ), RNT with generalised anxiety (PTQ-GAD) and RNT with perceived stress (PTQ-PSS). There is a considerable amount of literature supporting perceived stress consistently demonstrating significant correlations with anxiety and depression (Lee, 2012; Pidgeon, Coast, Coast, & Coast, 2014). Moreover, these connections substantiated previous findings on the role of RNT in predicting both anxiety (Spinhoven et al., 2018) and psychological distress (Macedo et al., 2015) among the general population. Individuals who engage in high levels of RNT are at great risk of developing and maintaining high anxiety and mental distress (Mills et al., 2014), with some authors suggesting possible mechanisms underlying this process may be the prolonged negative affect (Stanton & Watson, 2014) as well as stress generation (Hosseinichimeh, Wittenborn, Rick, Jalali, & Rahmandad, 2018) associated with RNT. This construct emerged as a central node in the context of the estimated psychopathological domains, as evidenced by its numerous connections (5/6) with other nodes and its high strength centrality. These results indicated that individual differences in the use of RNT may be associated with variation in the clinical presentation of the other symptoms, consistent with previous observations (Everaert & Joormann, 2019). Such findings corroborated our initial hypothesis suggesting RNT captures important transdiagnostic variance across a wide range of mental distress indicators (e.g. Gustavson, du Pont, Whisman, & Miyake, 2018). RNT showed particularly strong links to perceived stress (PSS) and generalised anxiety (GAD) as mentioned above, but also to psychotic-like experiences (CAPE), depressive symptoms (PHQ) and loneliness (ULS). This latter result is especially relevant as, although a growing body of literature has examined the role of RNT in negative emotions (e.g. sadness; Nolen-Hoeksema et al., 2008; Watkins, 2008), its association with loneliness is substantially an emerging topic of interest. Consistently with the present results, some authors evidenced a bivariate correlation between RNT and both cross-sectional and prospective loneliness (Raes et al., 2020). It is possible that chronic engagement in RNT may result in increased feelings of loneliness over time, consistent with past evidence that increased rumination (i.e. a component of RNT) was related to higher loneliness (Gan et al., 2015). On the other hand, it is also plausible that feeling lonely is likely to evoke repetitive and unpleasant thoughts (e.g. McComb et al., 2020; Vanhalst, Luyckx, Raes, & Goossens, 2013). Recently, RNT has emerged as a significant mediator of the association between loneliness and depression, suggesting it may be a potential underlying mechanism explaining this relation (Hager, Judah, & Milam, 2022). Further longitudinal evidence is needed to shed new light on the direction of these pathways. The association between RNT and depression was also suggested by the present results, in complete agreement with past research (Nolen-Hoeksema et al., 2008). Persistent and uncontrollable worrisome thoughts have emerged as a key characteristic and even a causal factor of depressive symptoms (Topper et al., 2010). Although the above association is well-established in the literature, from both cross-sectional and longitudinal perspectives, the present findings add substantially to our understanding of the RNT-depression link after partialising for all the associated clinical conditions which can be involved in this relationship (e.g., loneliness; Hager et al., 2022).

The positive connection with psychotic-like experiences (CAPE) reflected the well-documented correlations between some forms of RNT (e.g. catastrophic worry) and psychotic symptoms such as paranoia (Martinelli et al., 2013; Simpson et al., 2012) and bizarre experiences (Hartley, Haddock, Sa, Emsley, & Barrowclough, 2014; Ballesio et al., 2023). Repetitive thinking has also been recognized as a crucial cognitive process contributing to hallucinatory experiences (Gracie et al., 2007). Scholars suggested that some aspects of RNT, such as worry, can bring persecutory delusions to mind and "keeps them there" (Freeman et al., 2012; p.2). Systematic evidence on the association between negative perseveration (e.g., worry, rumination) and psychosis highlighted that perseverative thinking patterns are consistent across different diagnoses, thus suggesting its non-specific role in the development and maintenance of psychotic symptoms (Sellers et al., 2018). However, the authors encouraged further investigation to identify the specific underlying mechanisms or potential pathways through which negative perseveration is associated with psychotic experiences. Interestingly, the present network structure revealed that RNT played a role in connecting the tendency of reporting psychotic symptoms with the experience of generalized anxiety as well as perceived stress. These results concur well with recent findings indicating psychotic-like experiences (e.g. paranoia thoughts) may serve as a trigger for activation of cognitive-attentional syndrome strategies (e.g. RNT), which, in turn, contributed to high levels of psychopathological symptoms (Kowalski & Gawęda, 2022). These findings are encouraging and should be validated by further perspective research.

Contrary to our expectations, there was no robust pathway involving RNT and symptoms of insomnia. These results are incongruent with past research emphasizing the role of RNT in explaining insomnia-related symptoms such as delayed sleep onset (Stewart, Gibb, Strauss, 2020) and poor sleep quality (Carney et al., 2010; Lin, Xie, Yan, Chen, & Yan, 2019). However, one of the advantages of network analysis consists of assessing the partial correlation between each pair of nodes, while controlling for the effects of all other nodes (Hevey, 2018), which may be a reasonable explanation for the absence of a unique connection between RNT and insomnia. Indeed, this surprising result concurs well with more recent findings highlighting there was no evidence for a prospective association between insomnia symptoms and RNT when accounting for the effects of depressive symptoms (Cox et al., 2022). Nevertheless, evidence from studies using this approach is mixed, with some authors also revealing that RNT predicted insomnia both cross-sectionally and prospectively, even after controlling for anxiety and depression (Frøjd et al., 2022). These topics are deferred to future work clarifying the nature of the RNT-insomnia link controlling for potential comorbid and confounding factors.

The present findings provided important implications for clinical treatment. The high centrality strength of RNT in the network analysis suggests that this construct may represent a potentially good therapeutic target for interventions. Targeted prevention programs directly focusing on RNT could be effective at reducing psychopathological symptoms. Much work on the potential of RNT-based protocols has been carried out and qualified RNT as a promising target for selective prevention of multiple disorders (e.g. depression and anxiety; Dozois et al., 2009). Several evidence-based treatment approaches (e.g. metacognitive therapy, Wells et al., 2012; mindfulness-based techniques, Feldman et al., 2010) aimed at directly targeting RNT components (e.g. rumination) have been proposed and resulted to be beneficial for mitigating intrusive and uncontrollable thinking as well as their associated critical consequences on mental health. Concerning this last point, longitudinal research is primarily needed to establish the causal ordering of the relation between RNT and specific psychopathological symptoms. Longitudinal network analysis could be an advanced and effective statistical method to accomplish this purpose.

These findings must be considered within the context of the study limitations. First, the edges were calculated using cross-sectional data, precluding estimations of causal interactions. In this regard, the causal pathway between RNT and the psychopathological domains should be further explored using repeated assessment of participants over time, e.g. by employing an ecological momentary assessment design to collect real-time longitudinal data. Second, the mere employment of self-report measures may have resulted in recall bias. Third, the relatively small size of our sample may affect the stability of the centrality indices. This point is especially relevant since some centrality measures (e.g., betweenness) are strongly affected by sample variation (Hallquist et al., 2021). Fourth, we did not assess metacognitive beliefs about RNT, as well as other psychiatric conditions that might be related to RNT (e.g., post traumatic stress disorder, PTSD; substance use disorder, SUD), which should be considered in future investigations. Fifth, the non-clinical sample is included. Notwithstanding notable data of prevalence of subclinical psychotic experiences (e.g. auditory verbal hallucinations) in the general population has been suggested (e.g. de Leede-Smith & Barkus, 2013), the future inclusion of participants meeting diagnostic criteria for a psychotic disorder should be encouraged. Lastly, future studies are warranted to analyse a more disaggregated network structure, i.e. with individual symptoms as nodes, thus evaluating which specific symptoms may serve as bridges between different psychopathological clusters.

Despite these limitations, this work contributed to provide evidence of the complex interactions between RNT and psychopathological symptoms through a comprehensive model of network analysis. Results revealed that RNT plays a crucial role in the network and is more strongly connected with specific domains of psychopathology. The central position of RNT in the estimated network emphasized RNT as an important therapeutic target for psychopathology prevention and treatment protocols.

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Declarations

Conflict of Interest The authors declare no competing interests.

References

Ballesio, A., Zagaria, A., & Lombardo, C. (2023). Perseverative Cognition and Psychotic-Like Experiences in Young Adults: A Cross-Lagged Panel Model. *Psychopathology*, 1–6. Advance online publication. https://doi.org/10.1159/000528859

Bastien, C. H., Vallières, A., & Morin, C. M. (2001). Validation of the Insomnia Severity Index as an outcome measure for insomnia research. *Sleep Medicine, 2*(4), 297–307. https://doi.org/10.1016/S1389-9457(00)00065-4

Berger, M., Li, E., & Amminger, G. P. (2020). Treatment of social anxiety disorder and attenuated psychotic symptoms with cannabidiol. *BMJ Case Reports, 13*(10), e235307. https://doi.org/10.1136/bcr-2020-235307

Boffo, M., Mannarini, S., & Munari, C. (2012). Exploratory structure equation modeling of the UCLA loneliness scale: a contribution to the Italian adaptation. TPM: Testing, Psychometrics, *Methodology in Applied Psychology*, 19(4).

Borsboom, D. (2017). A network theory of mental disorders. *World Psychiatry, 16*(1), 5–13. https://doi.org/10.1002/wps.20375

Borsboom, D., & Cramer, A. O. (2013). Network analysis: An integrative approach to the structure of psychopathology. *Annual Review of Clinical Psychology, 9*(1), 91–121.

Cacioppo, J. T., & Cacioppo, S. (2018). Loneliness in the modern age: an evolutionary theory of loneliness (ETL). *In Advances in experimental social psychology, 58*, 127–197. Academic Press.

Capra, C., Kavanagh, D. J., Hides, L., & Scott, J. (2013). Brief screening for psychosis-like experiences. *Schizophrenia Research, 149*, 104–107. https://doi.org/10.1016/j.schres.2013.05.020

Carney, C. E., Harris, A. L., Moss, T. G., & Edinger, J. D. (2010). Distinguishing rumination from worry in clinical insomnia. *Behaviour Research and Therapy, 48*(6), 540–546.

Castronovo, V., Galbiati, A., Marelli, S., Brombin, C., Cugnata, F., Giarolli, L., ... & Ferini-Strambi, L. (2016). Validation study of the Italian version of the Insomnia Severity Index (ISI). *Neurological Sciences, 37*(9), 1517–1524.

Chen, J., & Chen, Z. (2008). Extended Bayesian information criteria for model selection with large model spaces. *Biometrika, 95*(3), 759–771.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Routledge.

Cohen, S., Kamarck, T., & Mermelstein, R. (1994). Perceived stress scale. *Measuring Stress: A Guide for Health and Social Scientists, 10*(2), 1–2.
Cosci, F., & Fava, G. A. (2021). When anxiety and depression coexist: The role of differential diagnosis using clinimetric criteria. *Psychotherapy and Psychosomatics, 90*(5), 308–317. https://doi.org/10.1159/000517518
Costantini, G., Epskamp, S., Borsboom, D., Perugini, M., Mõttus, R., Waldorp, L. J., & Cramer, A. O. J. (2015). State of the aRt personality research: A tutorial on network analysis of personality data in R. *Journal of Research in Personality, 54*, 13–29.
Cox, R. C., & Olatunji, B. O. (2022). Concurrent and prospective links between sleep disturbance and repetitive negative thinking: Specificity and effects of cognitive behavior therapy for insomnia. *Journal of Behavioral and Cognitive Therapy, 32*(1), 57–66.
Cramer, A. O., Waldorp, L. J., van der Maas, H. L. J., & Borsboom, D. (2010). Comorbidity: A network perspective. *The Behavioral and Brain Sciences, 33*, 137–193. https://doi.org/10.1017/S0140525X09991567
Dalgleish, T., Black, M., Johnston, D., & Bevan, A. (2020). Transdiagnostic approaches to mental health problems: Current status and future directions. *Journal of Consulting and Clinical Psychology, 88*(3), 179.
de Leede-Smith, S., & Barkus, E. (2013). A comprehensive review of auditory verbal hallucinations: Lifetime prevalence, correlates and mechanisms in healthy and clinical individuals. *Frontiers in Human Neuroscience, 7*, 367.
Dozois, D. J., Seeds, P. M., & Collins, K. A. (2009). Transdiagnostic approaches to the prevention of depression and anxiety. *Journal of Cognitive Psychotherapy, 23*(1), 44–59.
Eadeh, H. M., Markon, K. E., Nigg, J. T., & Nikolas, M. A. (2021). Evaluating the viability of neurocognition as a transdiagnostic construct using both latent variable models and network analysis. *Research on Child and Adolescent Psychopathology, 49*(6), 697–710.
Ehring, T., & Watkins, E. R. (2008). Repetitive negative thinking as a transdiagnostic process. *International Journal of Cognitive Therapy, 1*(3), 192–205. https://doi.org/10.1680/ijct.2008.1.3.192
Ehring, T., Zetsche, U., Weidacker, K., Wahl, K., Schönfeld, S., & Ehlers, A. (2011). The Perseverative Thinking Questionnaire (PTQ): Validation of a content-independent measure of repetitive negative thinking. *Journal of Behavior Therapy and Experimental Psychiatry, 42*(2), 225–232. https://doi.org/10.1016/j.jbtep.2010.12.003
Epskamp, S., & Fried, E. I. (2015). Package 'bootnet.' *Bootstrap Methods For Various Network Estimation Routines, 5*, 1–1.
Epskamp, S., & Fried, E. I. (2018). A tutorial on regularized partial correlation networks. *Psychological Methods, 23*, 617–634.
Epskamp, S., Cramer, A. O., Waldorp, L. J., Schmittmann, V. D., & Borsboom, D. (2012). qgraph: Network visualizations of relationships in psychometric data. *Journal of Statistical Software, 48*(4), 1–18.
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
Everaert, J., & Joormann, J. (2019). Emotion regulation difficulties related to depression and anxiety: A network approach to model relations among symptoms, positive reappraisal, and repetitive negative thinking. *Clinical Psychological Science, 7*(6), 1304–1318.
Feldman, G., Greeson, J., & Senville, J. (2010). Differential effects of mindful breathing, progressive muscle relaxation, and loving-kindness meditation on decentering and negative reactions to repetitive thoughts. *Behaviour Research and Therapy, 48*(10), 1002–1011.
Fonseca-Pedrero, E. (2017). Network analysis: A new way of understanding psychopathology? *Revista De Psiquiatria y Salud Mental, 10*(4), 206–215. https://doi.org/10.1016/j.rpsm.2017.06.004
Forbes, M. K., Wright, A. G. C., Markon, K. E., & Krueger, R. F. (2019). The network approach to psychopathology: Promise versus reality. *World Psychiatry, 18*, 272–273.
Forbes, M. K., Wright, A., Markon, K. E., & Krueger, R. F. (2021). Quantifying the reliability and replicability of psychopathology network characteristics. *Multivariate Behavioral Research, 56*(2), 224–242. https://doi.org/10.1080/00273171.2019.1616526
Freeman, D., Dunn, G., Startup, H., & Kingdon, D. (2012). The effects of reducing worry in patients with persecutory delusions: Study protocol for a randomized controlled trial. *Trials, 13*(1), 1–7.
Friedman, J. H., Hastie, T., & Tibshirani, R. (2014). Glasso: Graphical lasso- estimation of Gaussian graphical models. *R Package Version, 1*, 8.

Fritz, J., Fried, E. I., Goodyer, I. M., Wilkinson, P. O., & van Harmelen, A. L. (2018). A network model of resilience factors for adolescents with and without exposure to childhood adversity. *Scientific Reports, 8*(15774), 1–13. https://doi.org/10.1038/s41598-018-34130-2

Frøjd, L. A., Papageorgiou, C., Munkhaugen, J., Moum, T., Sverre, E., Nordhus, I. H., & Dammen, T. (2022). Worry and rumination predict insomnia in patients with coronary heart disease: A cross-sectional study with long-term follow-up. *Journal of Clinical Sleep Medicine, 18*(3), 779–787.

Fruchterman, T. M., & 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

Gan, P., Xie, Y., Duan, W., Deng, Q., & Yu, X. (2015). Rumination and loneliness independently predict six-month later depression symptoms among Chinese elderly in nursing homes. *Plos One, 10*, e0137176. https://doi.org/10.1371/journal.pone.0137176

Golbeck, J. (2013). Network structure and measures. *Analyzing the social web*, 25–44.

Gracie, A., Freeman, D., Green, S., Garety, P. A., Kuipers, E., Hardy, A., ... & Fowler, D. (2007). The association between traumatic experience, paranoia and hallucinations: a test of the predictions of psychological models. *Acta Psychiatrica Scandinavica, 116*(4), 280–289.

Gustavson, D. E., du Pont, A., Whisman, M. A., & Miyake, A. (2018). Evidence for transdiagnostic repetitive negative thinking and its association with rumination, worry, and depression and anxiety symptoms: a commonality analysis. *Collabra: Psychology, 4*(1).

Hager, N. M., Judah, M. R., & Milam, A. L. (2022). Loneliness and depression in college students during the COVID-19 pandemic: the role of boredom and repetitive negative thinking. *International Journal of Cognitive Therapy*, 1–19.

Hallquist, M. N., Wright, A. G. C., & Molenaar, P. C. M. (2021). Problems with centrality measures in psychopathology symptom networks: Why network psychometrics cannot escape psychometric theory. *Multivariate Behavioral Research, 56*, 199–223. https://doi.org/10.1080/00273171.2019.1640103

Hartley, S., Haddock, G., e Sa, D. V., Emsley, R., & Barrowclough, C. (2014). An experience sampling study of worry and rumination in psychosis. *Psychological Medicine, 44*(8), 1605–1614.

Harvey, A. G., Watkins, E., & Mansell, W. (2004). Cognitive behavioural processes across psychological disorders: *A transdiagnostic approach to research and treatment*. Oxford University Press, USA.

Haslbeck, J. M. B., & Waldorp, L. J. (2020). mgm: estimating time-varying mixed graphical models in high-dimensional data. *Journal of Statistical Software, 93*(8), https://doi.org/10.18637/jss.v093.i08

Heinrich, L. M., & Gullone, E. (2006). The clinical significance of loneliness: A literature review. *Clinical Psychology Review, 26*(6), 695–718. https://doi.org/10.1016/j.cpr.2006.04.002

Hertenstein, E., Feige, B., Gmeiner, T., Kienzler, C., Spiegelhalder, K., Johann, A., Jansson-Fröjmark, M., Palagini, L., Rücker, G., Riemann, D., & Baglioni, C. (2019). Insomnia as a predictor of mental disorders: A systematic review and meta-analysis. *Sleep Medicine Reviews, 43*, 96–105. https://doi.org/10.1016/j.smrv.2018.10.006

Hevey, D. (2018). Network analysis: A brief overview and tutorial. *Health Psychology and Behavioral Medicine, 6*(1), 301–328.

Højsgaard, S., Edwards, D., Lauritzen, S., Højsgaard, S., Edwards, D., & Lauritzen, S. (2012). *Gaussian graphical models*. In Graphical models with R. Boston, MA: Springer. https://doi.org/10.1007/978-1-4614-2299-0_4

Hosseinichimeh, N., Wittenborn, A. K., Rick, J., Jalali, M. S., & Rahmandad, H. (2018). Modeling and estimating the feedback mechanisms among depression, rumination, and stressors in adolescents. *Plos One, 13*(9), e0204389. https://doi.org/10.1371/journal.pone.0204389

Hughes, M. E., Waite, L. J., Hawkley, L. C., & Cacioppo, J. T. (2004). A short scale for measuring loneliness in large surveys: Results from two population-based studies. *Research on Aging, 26*, 655–672. https://doi.org/10.1177/0164027504268574journal.pone.0137176

Jones, P. J., Heeren, A., & McNally, R. J. (2017). Commentary: A network theory of mental disorders. *Frontiers in Psychology, 16*, 5–13. https://doi.org/10.3389/fpsyg.2017.01305

Kowalski, J., & Dragan, M. (2019). Cognitive-attentional syndrome - the psychometric properties of the CAS-1 and multi-measure CAS-based clinical diagnosis. *Comprehensive Psychiatry, 91*, 13–21. https://doi.org/10.1016/j.comppsych.2019.02.007

Kowalski, J., & Gawęda, Ł. (2022). 'Thinking about them is only making me feel worse'. The mediating role of metacognitive factors in the relationship between paranoia-like beliefs and psychopathology symptoms in a community sample. *Schizophrenia Research, 244*, 84–90.

Kroenke, K., Spitzer, R. L., & Williams, J. B. (2003). The Patient Health Questionnaire-2: Validity of a two-item depression screener. *Medical Care, 41*(11), 1284–1292. https://doi.org/10.1097/01.MLR.0000093487.78664.3C

Kroenke, K., Spitzer, R. L., Williams, J. B., Monahan, P. O., & Löwe, B. (2007). Anxiety disorders in primary care: Prevalence, impairment, comorbidity, and detection. *Annals of Internal Medicine, 146*(5), 317–325. https://doi.org/10.7326/0003-4819-146-5-200703060-00004

Lee, E. H. (2012). Review of the psychometric evidence of the perceived stress scale. *Asian Nursing Research, 6*(4), 121–127.

Lin, R.-M., Xie, S.-S., Yan, Y.-W., Chen, Y. H., & Yan, W.-J. (2019). Perfectionism and adolescent sleep quality: The mediating role of repetitive negative thinking. *Journal of Health Psychology, 24*, 1626–1636.

Macedo, A., Soares, M. J., Amaral, A. P., Nogueira, V., Madeira, N., Roque, C., ... & Pereira, A. T. (2015). Repetitive negative thinking mediates the association between perfectionism and psychological distress. *Personality and Individual Differences, 72*, 220–224.

Martinelli, C., Cavanagh, K., & Dudley, R. E. (2013). The impact of rumination on state paranoid ideation in a nonclinical sample. *Behavior Therapy, 44*(3), 385–394.

McComb, S. E., Goldberg, J. O., Flett, G. L., & Rose, A. L. (2020). The double jeopardy of feeling lonely and unimportant: State and trait loneliness and feelings and fears of not mattering. *Frontiers in Psychology, 11*, 563420.

McLaughlin, K. A., & Nolen-Hoeksema, S. (2011). Rumination as a transdiagnostic factor in depression and anxiety. *Behaviour Research and Therapy, 49*(3), 186–193.

Mills, A. C., Grant, D. M., Lechner, W. V., & Judah, M. R. (2014). Relationship between trait repetitive negative thinking styles and symptoms of psychopathology. *Personality and Individual Differences, 71*, 1.

Mondo, M., Sechi, C., & Cabras, C. (2022). *Psychometric evaluation of three versions of the Italian Perceived Stress Scale*. In Key Topics in Work and Organizational Psychology (pp. 1–9). Springer, Cham.

Na, E. J., Choi, K. W., Hong, J. P., Cho, M. J., Fava, M., Mischoulon, D., & Jeon, H. J. (2019). Paranoid ideation without psychosis is associated with depression, anxiety, and suicide attempts in general population. *The Journal of Nervous and Mental Disease, 207*(10), 826–831. https://doi.org/10.1097/NMD.0000000000010509-24

Newman, M. E. J. (2010). *Networks: An introduction*. Oxford University Press.

Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking Rumination. *Perspectives on Psychological Science, 3*(5), 400–424.

Nota, J. A., & Coles, M. E. (2015). Duration and timing of sleep are associated with repetitive negative thinking. *Cognitive Therapy and Research, 39*(2), 253–261. https://doi.org/10.1007/s10608-014-9651-7

Opsahl, T., Agneessens, F., & Skvoretz, J. (2010). Node centrality in weighted networks: Generalizing degree and shortest paths. *Social Networks, 32*(3), 245–251.

Pidgeon, A. M., Coast, G., Coast, G., & Coast, G. (2014). Psychosocial moderators of perceived stress, anxiety and depression in university students: An international study. *Open Journal of Social Sciences, 2*(11), 23.

Raes, F., Bastin, M., Pede, T., Belmans, E., Goossens, L., & Vanhalst, J. (2020). *Repetitive negative thinking outperforms loneliness and lack of social connectedness as a predictor of prospective depressive symptoms in adolescents*. Scandinavian journal of child and adolescent psychiatry and psychology.

Reeve, S., Sheaves, B., & Freeman, D. (2015). The role of sleep dysfunction in the occurrence of delusions and hallucinations: A systematic review. *Clinical Psychology Review, 42*, 96–115. https://doi.org/10.1016/j.cpr.2015.09.001

Segrin, C., & Passalacqua, S. A. (2010). Functions of loneliness, social support, health behaviors, and stress in association with poor health. *Health Communication, 25*(4), 312–322.

Sellers, R., Varese, F., Wells, A., & Morrison, A. P. (2017). A meta-analysis of metacognitive beliefs as implicated in the self-regulatory executive function model in clinical psychosis. *Schizophrenia Research, 179*, 75–84. https://doi.org/10.1016/j.schres.2016.09.032

Sellers, R., Wells, A., & Morrison, A. P. (2018). Are experiences of psychosis associated with unhelpful metacognitive coping strategies? A systematic review of the evidence. *Clinical Psychology & Psychotherapy, 25*(1), 31–49.

Shevlin, M., Butter, S., McBride, O., Murphy, J., Gibson-Miller, J., Hartman, T. K., ... & Bentall, R. P. (2022). Measurement invariance of the Patient Health Questionnaire (PHQ-9) and Generalized

Anxiety Disorder scale (GAD-7) across four European countries during the COVID-19 pandemic. *BMC psychiatry, 22*(1), 154.
Shin, J., Park, D. H., Ryu, S. H., Ha, J. H., Kim, S. M., & Jeon, H. J. (2020). Clinical implications of agoraphobia in patients with panic disorder. *Medicine, 99*(30), e21414. https://doi.org/10.1097/MD.0000000000021414
Simpson, J., MacGregor, B., Cavanagh, K., & Dudley, R. E. (2012). Safety behaviours, rumination and trait paranoia in a non-clinical sample. *Journal of Experimental Psychopathology, 3*(4), 612–623.
Spinhoven, P., van Hemert, A. M., & Penninx, B. W. (2018). Repetitive negative thinking as a predictor of depression and anxiety: A longitudinal cohort study. *Journal of Affective Disorders, 241*, 216–225.
Stanton, K., & Watson, D. (2014). Positive and negative affective dysfunction in psychopathology: Emotion and psychopathology. *Social and Personality Psychology Compass, 8*(9), 555–567. https://doi.org/10.1111/spc3.12132
Stewart, E., Gibb, B., Strauss, G., & Coles, M. (2020). Disruptions in the amount and timing of sleep and repetitive negative thinking in adolescents. *Behavioral Sleep Medicine, 18*, 217–225.
Tibshirani, R. (1996). Regression shrinkage and selection via the lasso. Journal of the Royal Statistical Society. *Series B (ethodological), 58*, 267–288.
Topper, M., Emmelkamp, P. M., & Ehring, T. (2010). Improving prevention of depression and anxiety disorders: Repetitive negative thinking as a promising target. *Applied and Preventive Psychology, 14*(1–4), 57–71.
van Borkulo, C. D., Borsboom, D., Epskamp, S., Blanken, T. F., Boschloo, L., Schoevers, R. A., & Waldorp, L. J. (2014). A new method for constructing networks from binary data. *Scientific Reports, 4*(5918), 1–10.
Van Borkulo, C., Boschloo, L., Borsboom, D., Penninx, B. W. J. H., Lourens, J. W., & Schoevers, R. A. (2015). Association of symptom network structure with the course of longitudinal depression. *JAMA Psychiatry, 72*(12), 1219–1226. https://doi.org/10.1001/jamapsychiatry.2015.2079
Vanhalst, J., Luyckx, K., Raes, F., & Goossens, L. (2013). *Loneliness and depressive symptoms: the mediating and moderating role of uncontrollable ruminative thoughts*. In Loneliness Updated (pp. 275–292). Routledge.
Wells, A., Fisher, P., Myers, S., Wheatley, J., Patel, T., & Brewin, C. R. (2012). Metacognitive therapy in treatment-resistant depression: A platform trial. *Behaviour Research and Therapy, 50*(6), 367–373.
Wahl, K., Ehring, T., Kley, H., Lieb, R., Meyer, A., Kordon, A., Heinzel, C. V., Mazanec, M., & Schönfeld, S. (2019). Is repetitive negative thinking a transdiagnostic process? A comparison of key processes of RNT in depression, generalized anxiety disorder, obsessive-compulsive disorder, and community controls. *Journal of behavior therapy and experimental psychiatry, 64*, 45–53. https://doi.org/10.1016/j.jbtep.2019.02.006
Watkins, E. R. (2008). Constructive and unconstructive repetitive thought. *Psychological Bulletin, 134*(2), 163–206. https://doi.org/10.1037/0033-2909.134.2.163
Zagaria, A., Ottaviani, C., Lombardo, C., & Ballesio, A. (2022). Perseverative cognition as a mediator between perceived stress and sleep disturbance: A structural equation modeling meta-analysis (meta-SEM). *Annals of behavioral medicine : A publication of the Society of Behavioral Medicine*, kaac064. Advance online publication. https://doi.org/10.1093/abm/kaac064
Zuckerman, M. (1999). Diathesis-stress models. In M. Zuckerman, Vulnerability to psychopathology: A biosocial model (pp. 3–23). *American Psychological Association*. https://doi.org/10.1037/10316-001