Research paper

# The interplay between cognitive risk and resilience factors in remitted depression: A network analysis

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A R T I C L E   I N F O

A B S T R A C T

*Background:* Individuals in remission from depression are at increased risk for developing future depressive episodes. Several cognitive risk- and resilience factors have been suggested to account for this vulnerability. In the current study we explored how risk- and protective factors such as cognitive control, adaptive and maladaptive emotion regulation, residual symptomatology, and resilience relate to one another in a remitted depressed (RMD) sample.
*Methods:* We examined the relationships between these constructs in a cross-sectional dataset of 69 RMD patients using network analyses in order to obtain a comprehensive, data-driven view on the interplay between these constructs. We subsequently present an association network, a concentration network, and a relative importance network.
*Results:* In all three networks resilience formed the central hub, connecting perceived cognitive control (i.e., working memory complaints), emotion regulation, and residual symptomatology. The contribution of the behavioral measure for cognitive control in the network was negligible. Moreover, the directed relative importance network indicates bidirectional influences between these constructs, with all indicators of centrality suggesting a key role of resilience in remission from depression.
*Limitations:* The presented findings are cross-sectional and networks are limited to a fixed set of key constructs in the literature pertaining cognitive vulnerability for depression.
*Conclusions:* These findings indicate the importance of resilience to successfully cope with stressors following remission from depression. Further in-depth studies will be essential to identify the specific underlying resilience mechanisms that may be key to successful remission from depression.

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## 1. Introduction

Depression is a highly prevalent, severe mental illness that is related to substantial individual suffering (e.g., Cuijpers et al., 2004; Lima and Fleck, 2007). In terms of disability, estimations suggest that major depressive disorder (MDD) is among the leading causes of burden of diseases worldwide (e.g., Demyttenaere et al., 2004). Current treatment options (psychological, pharmacological, and neurostimulation interventions) are

moderately successful in achieving initial symptom reduction but long-term effects are less encouraging, with research showing that recurrence of MDD (i.e., experiencing a depressive episode after having exhibited full and/or partial remission from a previous depressive episode) is high in the general population (35% after 15 years), and even higher in those treated at specialized mental health centers (60% after 5 years and 85% after 15 years; Hardeveld et al., 2010). This has led to the realization that studying individuals remitted from depression (RMD) is crucial in understanding who remains well after initial remission and who is at-risk for new depressive episodes (e.g., De Raedt and Koster, 2010; Marchetti et al., 2012).

Current research has successfully identified a number of interindividual variables that seem to play a key role in risk as well as resilience in RMD. At the level of information-processing, previous depressive episodes have a negative impact on cognitive control processes (Vanderhasselt and De Raedt, 2009), which are crucial for goal-directed behavior. Importantly, cognitive control has been found to play a major role in emotion regulation, the

process of influencing which emotions one has, including when and how these emotions are experienced (Gross, 1998). For instance, cognitive control impairments have been associated with maladaptive emotion regulation strategies such as rumination, self-blame, and catastrophizing (e.g., Hoorelbeke et al., accepted for publication; Joormann and Gotlib, 2008; Whitmer and Banich, 2007), known to have detrimental effects on mental well-being (Aldao and Nolen-Hoeksema, 2010; Garnefski and Kraaij, 2006). Moreover, cognitive control moderates the effects of maladaptive emotion regulation on mood in daily life, with for instance low levels of cognitive control predicting a stronger increase in negative affect following rumination (Pe et al., 2013). Furthermore, in the context of remission from depression, impaired cognitive control has shown to predict rumination, linking cognitive control impairments to recurrent depressive symptoms in a RMD sample (Demeyer et al., 2012). Importantly, cognitive control impairments may also disrupt adaptive emotion regulation processes (Cohen et al., 2014; Joormann and D'Avanzato, 2010; Joormann and Vanderlind, 2014), which are key to resilience and mental well-being (Gross and John, 2003; Hu et al., 2014; Kalisch et al., 2015). Despite increasing research linking RMD to information-processing factors that are involved in emotion regulation strategies, which subsequently influence resilience or alternatively increase depressive symptoms, there are limitations to the current available research. Most importantly, research has often tested simple, unidirectional relationships between these constructs, which ignores the notion that many of the constructs involved can have reciprocal relationships. For instance, there is empirical evidence showing that levels of cognitive control can influence ruminative tendencies (Cohen et al., 2015) as well as evidence that levels of rumination influence cognitive control (Philippot and Brutoux, 2008). Currently, there is very little work integrating risk- and protective factors in RMD.

In order to obtain a more comprehensive view on the interaction between information-processing and emotion regulation strategies in relation to risk and resilience we conducted a network analysis on these constructs in a RMD sample. Based on graph theory, network modeling represents an important innovation to examine the interplay between different constructs in a largely data-driven manner (Borsboom and Cramer, 2013). Within a network model each variable is represented by a node, while the edge between two nodes shows the relationship between them. Typically, studies have relied on this type of analysis to explore how observable behaviors (i.e., symptoms) relate to one another, aiming to overcome the use of unobservable, latent variables (i.e., depression) (e.g., Borsboom et al., 2011; Cramer et al., 2010; De Schryver et al., 2015; Fried, 2015; McNally et al., 2014). However, network modeling can also be employed to decipher the interrelationship between constructs (i.e., structural network analysis) and, in turn, explore the nomological universe in which the different constructs are placed (Costantini et al., 2015b). To do so, relying on weighted and directed networks represents a great advancement, in that it is possible to obtain a fine-grained representation of the centrality (i.e., the extent to which a construct plays a central role in the network) of all the constructs considered and the possible directionality among them (Borsboom and Cramer, 2013; Costantini et al., 2015a).

In order to gain further insight in the mechanisms underlying remission from depression, we propose the use of this latter approach to examine how key constructs in the context of vulnerability for depression and resilience are related in a RMD sample. For this purpose, based on the literature, we selected four key risk factors (cognitive control impairments, working memory complaints, maladaptive emotion regulation, and residual depressive symptomatology) and two protective factors (adaptive emotion regulation and resilience) for the network analyses: (1) At the level

of information-processing we obtained information about cognitive control measured with a well-validated performance based task, the Paced Auditory Serial Addition Task (PASAT; Gronwall, 1977; for a review see Tombaugh, 2006), and (2) an indicator of experienced working memory complaints, the Working Memory scale of the Behavior Rating Inventory of Executive Function (BRIEF-WM; Roth et al., 2013). Previous studies with MDD and other clinical samples indicate that self-reported cognitive functioning in daily life and performance on cognitive tasks may capture different aspects of cognitive control, as they are not necessarily associated with each other and may differ in their predictive value for well-being and symptomatology (Chan et al., 2008; Middleton et al., 2006; Mowla et al., 2008; Svendsen et al., 2012). Furthermore, the Cognitive Emotion Regulation Questionnaire (CERQ; Garnefski et al., 2001) was used to assess a broad range of emotion regulation strategies, which allows calculation of compound scores for (3) adaptive and (4) maladaptive emotion regulation processes. (5) The Remission from Depression Questionnaire (RDQ; Zimmerman et al., 2013) was used as an indicator of residual symptoms following (partial) remission from depression given that previous work indicates that residual symptomatology increases the chance of recurrence of depressive episodes (e.g., Solomon et al., 2000). This questionnaire provides a more nuanced assessment of remission than standard measures of depressive symptomatology as it combines assessment of residual depressive- and related symptoms with indicators of functioning such as sense of well-being. (6) Finally, given the importance of resilience to mental health (e.g., Griffiths et al., 2015), resilience was selected as a protective factor for the network analysis. Resilience – connoting "inner strength, competence, optimism, flexibility, and the ability to cope effectively when faced with adversity" (Wagnild, 2009, p. 105) – was assessed using the Resilience Scale (RS; Portzky et al., 2010; Wagnild and Young, 1993). This self-report measure is based on five characteristics assumed to be central to resilience: perseverance, equanimity, meaningfulness, being self-reliant, and the realization that each person is unique (for a review, see Wagnild, 2009).

In line with previous literature (Costantini et al., 2015a; McNally et al., 2014), we relied on different types of network models to obtain a more comprehensive representation of factors related to remission from depression. First, we examined simple correlational patterns (i.e, association network). Second, the underlying structure of the network was examined by means of a concentration network, where the correlations between every pair of variables were controlled for all the other variables of the network. Third, we examined a relative importance network to index predictive directionality within cross-sectional data, although this does not necessarily imply causality (McNally et al., 2014). Based on the literature we expected to find a model depicting reciprocal relationships between cognitive control and emotion regulation. Maladaptive emotion regulation strategies would link cognitive control impairments to increased residual symptomatology, whereas adaptive emotion regulation strategies would link cognitive control to resilience, which should show the opposite relation to residual symptomatology.

## 2. Methods

### 2.1. Participants

The sample consisted of 69 RMD patients that were recruited for a cognitive control training study registered as NCT02407652 at ClinicalTrials.Gov. The protocol of this training study was published online (Hoorelbeke et al., 2015). For our network analyses, baseline measures were used from the 68 participants of the