



## Review

## Shedding light on the association between repetitive negative thinking and deficits in cognitive control – A meta-analysis

Ulrike Zetsche<sup>a,\*</sup>, Paul-Christian Bürkner<sup>b</sup>, Lars Schulze<sup>a</sup><sup>a</sup> Freie Universität Berlin, Department of Clinical Psychology and Psychotherapy, Berlin, Germany<sup>b</sup> University of Münster, Department of Statistics, Faculty of Psychology, Münster, Germany

## HIGHLIGHTS

- Repetitive negative thinking (RNT) is a major risk factor for mood and anxiety disorders.
- Deficits in cognitive control have been discussed as a mechanism underlying RNT.
- This meta-analysis shows that RNT is associated with deficits in only one cognitive control function.
- RNT is associated with deficits in discarding no longer relevant material from working memory.

## ARTICLE INFO

## Keywords:

Repetitive negative thinking  
Rumination  
Worry  
Cognitive control  
Inhibition  
Discarding

## ABSTRACT

Individuals who experience recurrent negative thoughts are at elevated risk for mood and anxiety disorders. It is thus essential to understand why some individuals get stuck in recurrent negative thinking (RNT), whereas others are able to disengage eventually. Theoretical models propose that individuals high in recurrent negative thinking suffer from deficits in controlling the contents of working memory. Empirical findings, however, are inconclusive.

In this meta-analysis, we synthesize findings from 94 studies to examine the proposed association between RNT and deficits in cognitive control. We included numerous effect sizes not reported in the primary publications. Moderator analyses tested the influence of variables, such as stimuli valence, cognitive control function (e.g., shifting, discarding), or type of RNT (i.e., rumination or worry).

Results demonstrated an association between repetitive negative thinking and deficits in only one specific cognitive control function, namely difficulty discarding no longer relevant material from working memory ( $r = -0.20$ ). This association remained significant after controlling for level of psychopathology. There was no substantial association between RNT and deficits in any other cognitive control function. All other moderators were not significant. We discuss limitations (e.g., primary sample sizes, reliability of paradigms) and highlight implications for future research and clinical interventions.

## 1. Introduction

Most individuals with a mental disorder experience elevated levels of recurrent negative thoughts. Depressed individuals, for example, tend to ruminate on past failures or losses, whereas anxious individuals often worry about future events. Although the focus of such negative thoughts may differ between disorders, the style of thinking has been shown to be the same. It has been found to be recurrent, negative in valence, and difficult to control (Ehring & Watkins, 2008). Repetitive negative thinking (RNT), such as rumination or worry, has thus been considered a transdiagnostic process (Harvey, 2004).

In the past decades, research has identified various negative

outcomes of RNT (Ehring & Watkins, 2008; Watkins, 2008). For example, dysphoric individuals induced to ruminate experienced increased depressed mood, difficulty in social problem solving, and biases in memory recall. Similarly, individuals induced to worry showed increases in both, anxious and depressed mood (McLaughlin, Borkovec, & Sibrava, 2007). Furthermore, longitudinal studies have consistently demonstrated that higher levels of rumination predict higher levels of future depression, and ultimately the onset of future depressive episodes in initially non-depressed individuals (for a review, see Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Likewise, there is evidence that higher levels of worry predict higher anxiety levels even after controlling for initial anxiety levels. High trait worry has also been

\* Corresponding author at: Freie Universität Berlin, Department of Clinical Psychology and Psychotherapy, Habelschwerdter Allee 45, 14195 Berlin, Germany.  
E-mail address: [u.zetsche@fu-berlin.de](mailto:u.zetsche@fu-berlin.de) (U. Zetsche).

found to predict the onset and symptom level of posttraumatic stress disorder (Watkins, 2008).

Given this comprehensive evidence for the negative outcomes of RNT, it is important to ask why some people get caught in a spiral of recurrent negative thoughts, whereas others are able to disengage from these thoughts eventually. Several authors have proposed that deficits in cognitive control abilities may underlie the tendency to get stuck in recurrent negative thoughts (e.g., Joormann, 2010; Koster, De Lissnyder, Derakshan, & De Raedt, 2011). Cognitive control processes help to continuously update and control the contents of working memory (WM). As such, they help to keep irrelevant information from entering working memory, to manipulate contents held in WM, and to expel no longer relevant information from WM. When individuals are in a negative mood, mood-congruent cognitions are activated in working memory (Siemer, 2005). Most individuals will eventually replace these negative contents with more pleasant cognitions in order to repair their mood (Joormann & Siemer, 2004). If cognitive control is impaired, however, individuals will have difficulty discarding negative cognitions from WM, resulting in prolonged RNT.

Indeed, several studies indicate an association between high levels of trait rumination and deficits in cognitive control (for reviews, see Whitmer & Gotlib, 2013; Yang, Cao, Shields, Teng, & Liu, 2017). Some studies also support an association between high trait worry and deficits in cognitive control (e.g., Fox, Dutton, Yates, Georgiou, & Mouchlianitis, 2015; Stout, Shackman, Johnson, & Larson, 2015). Other studies, however, have failed to find such associations (e.g., Aker, Harmer, & Landro, 2014; Goeleven, De Raedt, Baert, & Koster, 2006). Thus, the magnitude and pattern of the association between RNT and cognitive control deficits are still unclear.

One factor constraining progress in this field is that important theoretical and methodological advances in the study of cognitive control have only partly been applied in clinical psychology research (Snyder, Miyake, & Hankin, 2015). Already decades ago, Teuber (1972) suggested that cognitive control is neither a unitary process, nor a set of independent functions. He used the term unity-diversity reflecting his observations that cognitive control deficits differ across individuals, and yet share common features. The most well-known unity-diversity framework has been put forward by Friedman and Miyake (2017), Miyake and Friedman (2012). Using structural equation modeling, the authors have shown that individual differences in various cognitive control functions modeled as latent variables were intercorrelated by  $r = 0.42\text{--}0.63$ . Correlations could neither be constrained to zero (complete diversity), nor to one (complete unity) without worsening the model fit. This indicates that different cognitive control functions reflect different processes, but also have something in common. Today, there is wide agreement that cognitive control includes both, unity and diversity (for a review, see Friedman & Miyake, 2017). The specific subfunctions (diversity) proposed by different unity-diversity models, however, differ somewhat. In their bifactorial unity-diversity framework, Miyake and Friedman (2012), Miyake, Friedman, Emerson, Witzki, and Howerter (2000) suggest a common cognitive control factor and two specific factors, namely updating and monitoring of working memory representations, and shifting between different task requirements or mental sets. In a later article (Friedman & Miyake, 2004), the authors specify that the common factor can further be subdivided into a general inhibition factor and a factor labeled resistance to proactive interference. The inhibition factor is related to tasks assessing interference resolution and inhibition of dominant responses. Resistance to proactive interference reflects inhibition of formerly activated but no longer relevant information, i.e., the ability to discard no longer relevant information from working memory (hereafter referred to as discarding). This subfunction deserves special attention in the context of this meta-analysis: individuals getting stuck in recurrent negative thoughts seem to have particular problems discarding information (i.e., thoughts) that has been activated in memory but that is no longer relevant for the task at hand. It has thus been proposed that RNT may be

associated primarily with problems in discarding no longer relevant material from working memory (Joormann & Vanderlind, 2014; Koster et al., 2011; Mogg & Bradley, 2005). This is in line with findings by Zetsche, D'Avanzato, and Joormann (2012), showing that rumination was related only to impairments in discarding no longer relevant material from working memory, but not to impairments in interference resolution.

Based on the above summarized theories and evidence, we will differentiate between different cognitive control functions when examining the link between RNT and cognitive control. Specifically, and in accordance with Friedman and Miyake (2004), Miyake et al. (2000), we will differentiate between shifting, updating, discarding, and inhibition. As outlined above, we expect that RNT will primarily be associated with a diversity component, namely difficulty in discarding no longer relevant information from WM.

Another issue is the question of whether RNT is particularly associated with problems controlling the processing of emotional material in working memory. This appears likely given that RNT is characterized by its focus on emotionally negative content (e.g., Joormann, Levens, & Gotlib, 2011). Thus, we will also examine whether the association between RNT and cognitive control over emotional material is stronger than the association between RNT and cognitive control over neutral material.

It is unclear if different forms of RNT, such as rumination and worry, are related to the same impairments in cognitive control. Rumination is characterized by a focus on past experiences and has mostly been examined in the context of depression, whereas worry focuses on future events and has mostly been examined in relation to anxiety. Studies comparing rumination and worry, however, have concluded that these two processes share more similarities than differences (e.g., Watkins, Moulds, & Mackintosh, 2005). We thus hypothesize that the underlying cognitive control deficits are also the same.

Importantly, an observed association between RNT and cognitive control deficits might be due to higher levels of psychopathology in those individuals high in RNT. Depression, for example, has been shown to be associated with deficits in cognitive control (for a review, see Snyder, 2013). It is thus important to control for variance in cognitive control deficits that are due to high levels of psychopathology (i.e., depression or anxiety) when estimating the meta-analytic correlation between RNT and cognitive control.

The major aim of the present meta-analysis is to examine the magnitude and pattern of the association between RNT and deficits in cognitive control. We hypothesize that (a) RNT is specifically related to deficits in discarding no longer relevant information from working memory, that (b) RNT is mainly associated with deficits in controlling the processing of emotional (versus neutral) material, and that (c) rumination and worry are similarly related to cognitive control deficits. Because we expect that RNT is specifically related to deficits in discarding negative material from working memory, we also test the interaction between the cognitive control function (discarding versus others) and stimuli valence (emotional versus neutral). For each analysis, we examine whether the relation between RNT and cognitive control remains when controlling the influence of psychopathology (i.e., depression or anxiety, respectively) on cognitive control.

## 2. Methods

### 2.1. Search strategy and inclusion criteria

The literature was searched for any studies assessing trait RNT (i.e., rumination or worry) and cognitive control functions within the same sample. The search was restricted to adult samples with an age range between 18 and 65 years (or an average age < 60 years if the range was unknown). Studies involving cognitive control trainings or prospective longitudinal designs were only included if baseline data was available. Studies examining the effect of experimentally induced state

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