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Cognitive control moderates the association between stress and rumination

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ABSTRACT

Background and Objectives: A prospective design was used to examine whether inter-individual differences in cognitive control ability, for non-emotional and emotional material, play a moderating role in the association between the occurrence of a stressful event and the tendency to ruminate.
Methods: At baseline, the Internal Switch Task (IST) was administered in an undergraduate sample to measure the ability to switch attention between items held in working memory. Six weeks after baseline, self-report questionnaires were administered at 4 fixed moments during their first examination period at university, measuring stressors, rumination and depressive symptoms.
Results: Results revealed that impaired cognitive control, reflected in larger switch costs, moderated the association between stress and increased rumination. Interestingly, a larger switch cost when processing emotional material was specifically associated with increased depressive brooding in response to stress. No effects with reflective pondering were observed.
Conclusions: Implications for understanding the underlying mechanisms of rumination are discussed.
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1. Introduction

Over the past two decades, rumination has evolved as a construct of growing interest to researchers and clinicians. *Rumination* is considered an emotion-regulation strategy in which an individual focuses repetitively on the causes, consequences, and meanings of negative mood states. In some models, rumination is thought to be a stable individual difference factor (Nolen-Hoeksema, 1991), but other models emphasize that rumination is also reactive to stress (Smith & Alloy, 2009). Although individuals believe that ruminating will help them to improve their mood, the tendency to ruminate can cause a fixation on problems and amplify negative affect. This inflexible self-focused attention has several detrimental effects (for reviews, see Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008; Watkins, 2008). Previous research has shown that rumination is associated with impaired problem solving, reduced task performance, and with negative affect. Furthermore, rumination is considered an important cognitive vulnerability factor for depression. Numerous studies have demonstrated that rumination in response to stress is associated concurrently with depressive symptoms and prospectively with the onset, duration, and severity of depressive symptoms, and with slower recovery from depression (Nolen-Hoeksema et al., 2008).

Recently, researchers have postulated that rumination has to be considered as a multidimensional construct. Factor analytic studies have found support for two different types of rumination (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). The first, *reflective pondering* is considered the more adaptive type of rumination and reflects the degree to which individuals engage in cognitive problem solving to improve their mood. The second, *depressive brooding*, is considered the more maladaptive type of rumination and reflects the degree to which individuals passively focus on the meaning and symptoms of distress. Mainly the depressive brooding type of rumination is associated with both high concurrent and high future depressive symptoms (Joormann, Dkane, & Gotlib, 2006; Treynor et al., 2003).

The observation that rumination has several detrimental effects has inspired research into the mechanisms underlying rumination. Recently, a wealth of research has begun to investigate the dynamic interplay between rumination and information processing impairments. Two distinct hypotheses have been postulated with regard to the relationship between rumination and information processing. On the one hand, it is held that a ruminative thinking style, continuously focusing on negative thought content, depletes cognitive resources required for problem solving and task

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performance (Watkins & Brown, 2002). On the other hand, it has been proposed that information processing impairments contribute to ruminative tendencies (De Raedt & Koster, 2010; Koster, De Lissnyder, Derakhshan, & De Raedt, 2011; Whitmer & Banich, 2007). These latter models hold that cognitive control impairments may contribute to higher levels of rumination upon encounter of stress. Although there is empirical support for the first proposal (see Watkins, 2008), there only is emerging research on the second proposal. This is remarkable because an enhanced understanding of factors contributing to rumination may allow for targeted interventions to reduce the development or magnification of depressive symptoms. We first describe the ideas and research related to the second proposal.

The ability to control cognition and to disengage from negative cognitions is thought to be a crucial information processing factor related to the tendency to ruminate (Koster et al., 2011). *Cognitive control* refers to the ability to override pre-potent responses and to inhibit the processing of irrelevant or previous relevant information. These abilities are related to the functioning of executive control processes, such as inhibition, switching, and updating in working memory (Miyake, Friedman, Emerson, Witzki, & Howerter, et al., 2000). Impaired cognitive control mechanisms of working memory hamper cognitive control over irrelevant thought content (e.g., negative thoughts), enhancing ruminative thinking. Therefore, Koster et al. (2011) argued that impaired cognitive control is a risk factor for prolonged rumination in confrontation with stressors and a negative mood state. Indeed, rumination is related to impaired cognitive control when processing non-emotional information (Davis & Nolen-Hoeksema, 2000; De Lissnyder, Derakshan, De Raedt, & Koster, in press; Whitmer & Banich, 2007) as well as emotional information (De Lissnyder, Koster, & De Raedt, in press-a, in press-b; De Lissnyder, Koster, Derakshan, & De Raedt, 2010; Joormann, 2006; Joormann et al., 2007; Joormann & Gotlib, 2008; Lau, Christensen, Hawley, Gemar, & Segal, 2007). Previous research showed that particularly depressive brooding was related to the cognitive control impairments. However, these studies have used cross-sectional designs and are unable to make inferences about the causal relationship between information processing impairments and rumination. Therefore, we set out to test the hypothesis that impaired cognitive control exacerbates rumination, using a prospective design examining whether inter-individual differences in cognitive control ability, for non-emotional and emotional material, plays a moderating role in the association between the occurrence of a stressful event and the tendency to ruminate.

In the past, research into cognitive control has mainly employed tasks which measure cognitive control for externally presented stimuli. However, it is questionable whether examining cognitive control for externally presented stimuli is the most adequate way to target the link with rumination as the tendency to ruminate is defined as persistently focusing on *internal* negative thoughts. Given that the ability to control internal negative information (i.e., the ability to intentionally switch attentional focus from unpleasant/negative thoughts to more pleasant/positive thoughts) could specifically be an important process underlying rumination, it would be interesting to investigate cognitive control ability for internal mental representations held in working memory. An interesting task for this purpose is the Internal Switch Task (IST) (De Lissnyder et al., in press-b). Garavan (1998) as well as Gehring, Bryck, Jonides, Albin, and Badre (2003) have used a paradigm to examine cognitive control for internal mental representations held in working memory. Recently, Chambers, Lo, and Allen (2008) developed an affective version of this paradigm using words as stimuli. We further modified this task to include emotional facial expressions and refer to this task as the Internal Switch Task (IST). Research indicates that the IST is a reliable and valid measure of internal cognitive control (De Lissnyder et al., in press-b).

Cognitive control consists of a number of different subprocesses (Miyake et al., 2000). The cognitive control functions related to rumination in the literature are mainly inhibition and switching (e.g., Davis & Nolen-Hoeksema, 2000; Joormann, 2006; Whitmer & Banich, 2007), as well as updating (e.g., Bernblum & Mor, 2010; Joormann & Gotlib, 2008). A few studies have tried to assess and to disentangle the cognitive control functions, inhibition and switching, in relation to rumination in one single design (De Lissnyder et al., in press-a, 2010; Whitmer & Banich, 2007). However, recent evidence indicates that different cognitive control functions, such as inhibition and switching, are highly interrelated (Koch, Gade, Schuch, & Philipp, 2010). Therefore, the IST is framed in functional terms of task demands, namely updating of and mainly switching between mental representations held in working memory. Although a number of more specific cognitive operations may be responsible for the observation of impaired switching between internally held mental representations, the IST provides behavioral data directly related to switching between representations in working memory, whereas this task does not allow to specify which precise factors contribute to this observation. To investigate switching impairments, switch costs are calculated. The examination of *switch costs* is crucial because they index the efficiency of switching between mental representations in working memory. In the switching literature, the reaction time switch cost is typically referred to as the difference in reaction time between switch and no-switch (or repeat) trials (Monsell, 1996).

In sum, the current study was conducted to examine whether inter-individual differences in internal switching ability plays a moderating role in the association between the occurrence of a stressful event and the tendency to ruminate. The study was conducted using a never-depressed healthy sample as their stress-reactivity is not influenced by former depressive episodes. These participants were undergraduates facing their first academic examination period. The procedure involved an initial assessment in which the IST was administered to measure switching ability between internal mental representations held in working memory and baseline levels of rumination and stress were obtained. Subsequently, six weeks after baseline, self-report questionnaires were administered at 4 fixed moments during their first examination period, measuring rumination and the occurrence of stressors.

The aims of the current study were three-fold:

(1) To investigate whether inter-individual differences in internal switching ability moderate the association between stress and rumination. We hypothesized that larger switch costs related to emotional material (T1) will be associated with increased rumination in response to stress (T2–T5).
(2) To investigate the moderating impact of inter-individual differences in internal switching ability in the activation of the differential types of rumination in response to stress. We hypothesized that the internal switching impairments (T1) will be specifically associated with increased depressive brooding in response to stress (T2–T5). No effects with reflective pondering were expected.
(3) To investigate the valence-specificity of internal switching ability for emotional material. Given that rumination is defined as persistently focusing on negative thoughts, we hypothesized that higher switch costs (T1) related to switching from negative to neutral information (angry-neutral switch, see below), compared to switching from neutral to negative information (neutral-angry switch, see below), will be associated with increased rumination/depressive brooding in response to stress (T2–T5).

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