

Published in final edited form as:

Psychol Bull. 2013 September ; 139(5): 1036–1061. doi:10.1037/a0030923.

An Attentional Scope Model of Rumination

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Abstract

Rumination, defined as repetitive thinking about negative information, has been found to lead to serious maladaptive consequences, including longer and more severe episodes of major depression. In this review, we present and discuss research findings motivated by the formulation that individual differences in cognitive processes that control how information is processed influence the likelihood that thoughts will become repetitive and negative. A number of studies have demonstrated that a tendency to ruminate (i.e., trait rumination) is related to difficulties updating working memory (WM) and disengaging from and forgetting no-longer-relevant information. Other investigators have documented that trait rumination is also associated with an enhanced ability to ignore distracting information and to more stable maintenance of task-relevant information. In contrast to trait rumination, a state of rumination has been found to be related to widespread deficits in cognitive control. In this paper we discuss how the current accounts of control functioning cannot explain this pattern of anomalous control functioning. To explain these findings, including unexpected and contradictory results, we present an attentional scope model of rumination that posits that a constricted array of thoughts, percepts, and actions that are activated in WM or available for selection from LTM affects the control functioning of trait ruminators. This model explains, at a cognitive level, why rumination is particularly likely to arise when individuals are in a negative mood state; it also accounts for a number of findings outside of the rumination-control literature and generates several novel predictions.

Rumination is generally defined as repetitive thinking about negative personal concerns and/or about the implications, causes, and meanings of a negative mood (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Although rumination usually occurs automatically in response to internal cues (e.g., Hertel, 2004; Lyubomirsky, Kasri, & Zehm, 2003; Martin & Tesser, 1996), individuals who tend to ruminate often do not consider rumination to be intrusive or unwanted. In fact, they often believe that rumination will lead to new insights and understanding about their negative mood; consequently, they passively (or even actively) engage in rumination (e.g., Lyubomirsky & Nolen-Hoeksema, 1993; Papageorgiou & Well, 2003; Simpson, & Papageorgiou, 2003). Once individuals begin to ruminate, however, it is likely to be self-perpetuating and can easily become uncontrollable and continue even when it is not wanted (e.g., Papageorgiou & Wells, 2003; Roelofs, Papageorgiou, Gerber, Huibers, Peeters, & Arntz, 2007).

In large part because of its maladaptive consequences, rumination has generated considerable theoretical and empirical interest. Perhaps most consistently, investigators have found that rumination significantly worsens mood (e.g., Moberly & Watkins, 2008; Nolen-Hoeksema & Morrow, 1993; Vickers & Vogeltanz-Holm, 2003). Interestingly, in an experience sampling study, Moberly and Watkins (2008) also found that negative mood can increase rumination, suggesting that there is a reciprocal relation between these two

constructs. Indeed, a “downward spiral” of rumination and negative mood has been posited to lead to episodes of Major Depressive Disorder (MDD; see Nolen-Hoeksema et al., 2008). Because rumination continues to exert negative effects on mood and thinking in clinically depressed individuals, it may also lengthen and intensify episodes of MDD (e.g., Kuehner & Weber, 1999). Finally, investigators have found that forms of ruminative thought similar to that observed in response to depressed mood can also exacerbate other negative affective states, such as grief, stress, and anger, as well as eating disorders, such as bulimia (Rusting & Nolen-Hoeksema, 1998; Sukhodolsky, Golub, & Cromwell, 2001; Davis, Nolen-Hoeksema, & Larson, 1998; Nolen-Hoeksema, Stice, Wade, Bohon, 2007; Roger & Najarian, 1998).

Aims of this Paper

In this review, we present and discuss findings from research motivated by the formulation that variations in cognitive processes that control how information is processed influence the likelihood that thoughts will become repetitive and negative. Although researchers have made significant advances identifying and delineating the control processes that underlie rumination, little work has been done to synthesize the findings from this literature. Nolen-Hoeksema et al. (2008) briefly touched on the issue of how the functioning of cognitive control mechanisms may affect rumination, but these authors focused primarily on elucidating ways in which rumination can become maladaptive. Joormann (2010) and Koster, De Lissnyder, Derakshan, and De Raedt (2011) also reviewed some of these findings, but focused on a select subset of studies, primarily those that examined depressed samples and that emphasized the difficulties experienced by trait ruminators in processing and disengaging from negatively valenced information. Although these reviews clearly are important, we demonstrate in this paper that the patterns of findings emerging from this burgeoning field are broader and more complex than has previously been documented.

In the first section of this paper we critically review research examining the relation between rumination and cognitive processes that control how information is processed. In the second section, we evaluate past accounts and characterizations of control functioning in individuals with high levels of rumination with the intention of identifying unexplained and unexpected patterns of findings that are theoretically significant. Finally, we describe an attentional scope model of control functioning that integrates findings from studies examining the effects of mood on control functioning with results of investigations of rumination. We demonstrate how this model can explain the diverse range of findings that has been documented thus far, including findings that have not yet been adequately explained, and we use this model to generate several additional predictions.

Articles Included in the Review

To ensure that we reviewed all of the available relevant research, we conducted literature searches through pubmed and psycINFO using the keywords of “rumin*” with a variety of other terms that could be related to control-related processes that affect how information is processed such as “attention*,” “inhibition,” “suppression,” “interference,” “executive,” “control,” “regulation,” “learning,” “memory,” “reward,” “punishment,” etc. In this review, we focus on cognitive mechanisms that are related both to cognitive control over information processing and to rumination. We do not review forms of cognitive processing that are unrelated to cognitive control. For example, the level of construal (abstract versus concrete) of thoughts may affect the amount of repetitive thinking in which individuals engage, but abstract thinking is not a cognitive control mechanism. In Table 1 we present a summary of the relevant research findings; for each study in the Table we summarize the design, measures, sample, and findings.

Measuring Rumination

Because the way in which rumination is operationalized has important implications for how findings of studies are interpreted, we will first briefly review the various methods that have been used to measure rumination. Most studies of rumination have used self-report questionnaires, typically the Ruminative Responses Scale (RRS; Nolen-Hoeksema & Morrow, 1991), to measure individuals' tendency to ruminate when they are in a negative, sad, or depressed mood. Research using the RRS has demonstrated that a tendency to ruminate is sufficiently stable to be trait-like, and remains stable despite changes in levels of negative affect (Nolen-Hoeksema et al., 2008). Using the RRS, investigators have found that individuals with a high tendency to ruminate (i.e., trait ruminators) are more likely to experience depression than are individuals who tend to ruminate less (e.g., Just & Alloy, 1997; Spasojevic & Alloy, 2001).

A number of researchers have focused on particular subtypes of rumination. For example, Treynor, Gonzalez, and Nolen-Hoeksema (2003) found in an unselected community sample (i.e., in individuals who were not prescreened for depression symptoms or status) that the RRS measures two subtypes of rumination that they labeled brooding and reflection. Whereas brooding is defined as moody pondering, reflection is defined as repetitive thinking focused on one's problems. Evidence suggests that the brooding component is particularly maladaptive; it is unclear, however, whether reflection is maladaptive or adaptive (see Nolen-Hoeksema et al., 2008), and whether the reflection subscale of the RRS is valid for use in clinically depressed participants (Whitmer & Gotlib, 2011).

Although the vast majority of studies have used the RRS to measure rumination, investigators have also used other self-report questionnaires, such as the Anger Rumination Scale (ARS), which assesses rumination about angry experiences (Sukhodolsky, Golub, & Cromwell, 2001), and the rumination subscale of the Rumination-Reflection Questionnaire (rumin-RRQ), which assesses rumination about past events regardless of affective state (e.g., anger vs. sadness; Trapnell & Campbell, 1999). Thus, different investigators have emphasized the importance of one form of rumination over another. Because there is little evidence indicating that different types of control functioning are specific to a particular form of rumination, we will generally use the term "trait rumination" in this review. We will return to this issue of specificity later in this paper.

In another line of research, investigators have induced rumination in participants in order to examine how the active occurrence of ruminative thought, that is, a *state* of rumination, affects cognitive functioning. Researchers generally induce rumination by presenting participants with a series of statements that require them to focus their attention on themselves and their current emotions and feelings. For example, statements may ask participants to "think about why you turned out this way," and to "describe the possible consequences of your feelings" (Nolen-Hoeksema & Morrow, 1993). Investigators typically compare the effects of the rumination induction with the effects of inducing participants to distract themselves, thereby preventing them from engaging in naturally occurring rumination. The most commonly used distraction induction procedure requires participants to focus their attention on external topics that are unrelated to themselves or their feelings, such as thinking about "the expression on the face of the Mona Lisa," or about "the shiny surface of a trumpet" (Nolen-Hoeksema & Morrow, 1993), although some investigators studying clinically depressed individuals have used different distraction techniques to increase the effectiveness of the induction (e.g., Donaldson, Lam, & Mathews, 2007; Joormann, Siemer, & Gotlib, 2007). Researchers have found that whereas inducing rumination increases or prolongs depressed mood, inducing distraction alleviates negative mood in participants who are initially dysphoric or depressed (see Nolen-Hoeksema et al.,

2008). Interestingly, however, rumination inductions seem to have little effect on nondysphoric participants (see Nolen-Hoeksema et al., 2008), possibly because individuals cannot ruminate if they are not in a negative mood, or because nondysphoric individuals can spontaneously and quickly recovery from a rumination induction by redirecting their attention to new thoughts.

Review of Cognitive Control Literature on Rumination

In the following section, we present findings of studies that have examined control functioning in trait ruminators. Most studies have examined the relation between rumination and control processes that are related to inhibition. A growing number of studies, however, have demonstrated that rumination is also related to non-inhibitory forms of control functioning.

Rumination and Control Functioning Related to Inhibition

Researchers have used the concept of inhibition to account for a number of cognitive findings related to rumination, but have been inconsistent across studies in their definition of this term. Whereas some researchers have defined inhibition relatively narrowly as a mental process that overrides, dampens, or deactivates another mental process or behavior (e.g., MacLeod, 2007), other investigators have used the term more broadly to refer to situations in which individuals must ignore, disengage from, suppress, and resist interference from task-irrelevant information and from incorrect but prepotent response options (e.g., Friedman & Miyake, 2004). Because it is not clear that the “inhibition” tasks used by researchers studying rumination assess a cognitive process that fits the narrower definition (i.e., if an inhibitory process actually deactivates unwanted mental representations; e.g., see MacLeod, Dodd, Sheard, Wilson, & Bibi, 2003), we will use the broader view of the term inhibition in this paper.

Linville (1996) was the first theorist to propose that inhibitory deficits can increase the likelihood that negative thoughts will become repetitive by, for example, facilitating the retrieval of no-longer-wanted negative information from long-term memory (LTM) and making it more difficult for ruminators to remove negative thoughts from working memory (WM). In this section, we review studies that have tested Linville’s formulation. Before we begin, however, it is important to note that although Linville proposed that rumination is related to a widespread deficit in inhibition, investigators have argued that inhibition is not a unitary process but, instead, can be separated into distinct functions. For example, Friedman and Miyake (2004) distinguished between inhibition involved in the resolution of interference caused by distracting information in the environment and inhibition caused by information that was previously, but is no longer, relevant. Moreover, other investigators have argued that these forms of inhibition are also distinct from behavioral inhibition, or inhibition of prepotent motor responses (e.g., MacLeod, 2007; Nigg, 2000). Thus, this research raises the question of whether rumination is related to widespread inhibitory deficits or to difficulties with specific types of inhibition. In this section we review evidence indicating that rumination is related to deficits in some forms of inhibition, but not in others.

Inhibition of previously relevant information—The results of a number of studies suggest that rumination is related to a decreased ability to inhibit no-longer-relevant information in LTM. A deficit in this cognitive process can increase the likelihood that information will be retrieved repeatedly from LTM, thereby making thoughts repetitive. Hertel and Gerstle (2003) first examined this process using a think/no-think (T/NT) task. This task requires participants to first memorize a set of paired associates consisting of a positive or negative adjective and a neutral noun. Then, when participants are cued with the adjective, they repeatedly practice recall of some of the nouns (Think) and suppression of

other nouns (No-think). Hertel and Gerstle found in a group of dysphoric and nondysphoric participants that a tendency to ruminate was not associated with the ability to recall the practiced nouns, but was associated with increased recall of the suppressed nouns, regardless of valence of the cue. Joormann and Tran (2009) found similar results with a directed forgetting task: trait rumination in an unselected sample was related to greater forgetting of no-longer-relevant information, regardless of emotional valence, but not to the ability to remember relevant information. This task is similar to the T/NT with the exception that it requires participants to forget an entire list of words after one instruction. These findings suggest that trait rumination is associated with poorer intentional suppression of information.

More recently, Whitmer and Banich (2010) used a Retrieval-Induced Forgetting (RIF) task to examine whether rumination is related to automatic deficits in individuals' ability to inhibit information in LTM. In the RIF task, participants first learn lists of exemplars from different categories (e.g., banana-fruit) and are then cued to practice repeatedly retrieving a subset of exemplars from a subset of categories. When participants practice retrieving a subset of exemplars in a category, related information that is unwanted (i.e., the unpracticed exemplars for the same category) is automatically inhibited to facilitate retrieval of the desired exemplar. Thus, when participants are later asked to recall all learned exemplars of all the categories, they will be less likely to recall unpracticed exemplars from practiced categories than they are unpracticed exemplars from unpracticed categories (Anderson & Spellman, 1995). Whitmer and Banich found in an unselected sample of participants that trait rumination was associated with greater recall of unpracticed exemplars from practiced categories, suggesting that trait ruminators have difficulties automatically inhibiting information that is irrelevant but strongly associated with the relevant information.

Other investigators have examined whether rumination is related to difficulties disengaging from no-longer-relevant information that is still active in WM. Joormann, Gotlib, and colleagues (Joormann & Gotlib, 2008; Joormann, Nee, Berman, Jonides, & Gotlib, 2010; Zetsche, D'Avanzato, & Joormann, 2012) have demonstrated with modified versions of the Sternberg task that trait rumination is associated with difficulties removing no-longer-relevant information from WM, even in the presence of explicit instructions to do so. On each trial in this task, participants are presented with two lists of words in different ink colors and are subsequently told that only the words presented in one, but not in the other, ink color are relevant; shortly afterwards, they are presented with a probe word and are asked to indicate whether or not that word was from the relevant list. Individuals' ability to remove no-longer-relevant information from WM is indexed in this task by comparing the additional time it takes them to respond to a word from the no-longer-relevant list versus a new word (if the word from the no-longer-relevant list was not effectively removed from WM, it will lead to more interference). In clinically depressed participants, trait rumination has been found to be related to greater interference when the to-be-removed list is composed of emotionally negative words, but not of emotionally positive words. Thus, higher levels of trait rumination are associated with greater difficulty intentionally removing no-longer-relevant negative words from WM.

Other studies, using backward inhibition (BI) paradigms (Mayr & Keele, 2000), have demonstrated that trait rumination is also related to difficulties disengaging from activated in WM when instructed to switching attention to a new task. Participants are posited to automatically inhibit previous task sets when switching to new tasks in order to make the transition to the new task easier and quicker. If, however, participants are required to return immediately to the inhibited task (second presentation of task A in an ABA sequence), it will take them longer to do that than to switch to a less recently inhibited task set (task A in a CBA sequence) because they will need to overcome the inhibition of the task set. The

difference in reaction time to ABA versus CBA sequences indicates how effectively participants were able to inhibit task sets. Whitmer and Banich (2007) found in an unselected sample of participants that trait rumination was related to decreased inhibition of previous task sets even when controlling for level of depressive symptoms. De Lissnyder, Koster, Derakshan, and De Raedt (2010) found a similar pattern of results in a sample of dysphoric and nondysphoric participants on an emotional version of the BI paradigm, with the exception that trait rumination was related specifically to deficits inhibiting negative task sets (angry faces) and not positive task sets. These findings suggest that a tendency to ruminate is related to difficulties automatically removing no-longer-relevant task sets from WM when switching attention elsewhere.

Recently, Whitmer and Gotlib (2012b) induced rumination or distraction in clinically depressed and never-depressed participants to examine whether ruminative thinking leads to difficulties inhibiting no-longer-relevant task sets on a BI task with neutral stimuli. Compared to the distraction induction, the rumination induction led depressed participants to demonstrate slower switching between tasks, but did not affect task set inhibition. Interestingly, Whitmer and Gotlib found the opposite pattern of results when they examined level of trait rumination across all participants regardless of induction type or group status: higher trait rumination was related to decreased task set inhibition but not to slower switching. This finding suggests that trait rumination is related to inhibitory deficits independent of whether participants are actually ruminating. In understanding the nature of the relation between trait rumination and inhibitory difficulties, it is possible that difficulties inhibiting mental sets increases individuals' susceptibility to rumination, for example, by making it less likely that they will be able to disengage from unwanted negative thoughts when they occur. It is also possible, however, that a third factor underlies the relation between trait rumination and deficits of task set inhibition. At present, it is not clear what this third factor could be. A number of negative cognitive styles such as neuroticism, pessimism, and perfectionism have been found to be correlated with a tendency to ruminate, but it is not obvious why any of these variables would be related to impaired task set inhibition. Moreover, to date, investigators have not reported a relation between the inhibition of previously relevant information and measures of negative cognitive styles. Nevertheless, it is important that investigators examine explicitly the possible nature of these causal pathways.

It is important to note that our conclusion that state rumination does not impair BI does not mean that state rumination will not impair the inhibition of previously relevant information in other contexts. Watkins and Brown (2002) proposed that state rumination leads to cognitive impairment by overloading limited executive resources. In this context, the inhibition of previous task sets during task switching seems to reflect automatic processes (Arbuthnott, 2008; Li & Dupuis, 2008; Mayr, 2001). Indeed, investigators have demonstrated that this inhibition cannot be invoked or prevented strategically (Hubner, Dreisbach, Haider, & Kluwe, 2003; Mayr & Keele, 2000). Thus, state rumination may be more likely to impair forms of inhibition that rely on executive resources for implementation than forms of inhibition that are more automatic.

In sum, the results of these studies suggest that individuals who tend to ruminate when they are in a negative mood find it difficult to disengage from or forget information that is no longer relevant; these findings have been obtained in studies assessing both intentional and automatic processing, regardless of whether this information is still active in WM or is stored in LTM. Moreover, these difficulties have been documented in samples of unselected, nondysphoric, dysphoric, and clinically depressed participants; they have also been found when controlling for individual differences in depressed mood, suggesting that these effects of trait rumination are independent of level of depression.

Ability to ignore distracting information—Joormann et al. (2010) examined whether depressed participants who exhibit difficulties removing no-longer-relevant information from WM also have difficulties ignoring distracting information in the external environment that is unrelated to ongoing task demands. A deficit of this type would suggest that trait ruminators have little control over the contents of their WM, making it easier for external information to trigger rumination. Joormann et al. examined the ability to ignore external distracters by adding a condition to the modified Sternberg task described above in which participants were required to ignore new irrelevant words when they were first learning the lists of words. Joormann et al. found that although trait rumination was related to greater difficulty disengaging from no-longer-relevant information, it was not related to difficulties ignoring external distracters.

Zetsche and Joormann (Zetsche et al., 2012; Zetsche & Joormann, 2011) have also examined whether trait rumination is related to the ability to ignore external distracters using an emotional Erikson Flanker task. In this task, participants must indicate whether a target word is positive or negative while ignoring distracters of a conflicting valence (conflict condition) or a neutral valence (control condition). Zetsche et al. (2012) found, in clinically depressed and never-depressed participants, that trait rumination was unrelated to the ability to ignore distracters, even though in the same participants on the modified Sternberg task, trait rumination was associated with difficulty disengaging from no-longer-relevant information. It is noteworthy in this study that a diagnosis of depression, independent of ruminative tendencies, was related to the opposite pattern of functioning: compared with healthy controls, depressed participants had difficulty ignoring distracters, but not removing no-longer-relevant information from WM. Thus, depressed mood does not appear to be driving the deficits that have been found to be associated with trait rumination. Interestingly, in an unselected sample of participants, Zetsche and Joormann (2011) found that trait rumination was actually associated with an *enhanced* ability to ignore distracting negative information. Thus, trait ruminators are, if anything, better able than nonruminators to ignore external distracters.

Several investigators have used the Stroop task to examine the relation between rumination and the ability to ignore distracters. In the Stroop task, participants must name the ink color of a color-name word while ignoring the content of the word (external distracters). The ability to ignore distracter interference is measured by the time it takes participants to respond to trials that contain conflicting information (e.g., to respond “red” to the word “GREEN” presented in red ink) compared to trials without conflicting information. In an unselected sample, Altamirano, Miyake, and Whitmer (2010) examined whether the performance of trait ruminators on a modified version of the Stroop task was related to their ability to maintain a task goal. In this modified Stroop task, the majority of the trials were congruent (e.g., the word “RED” was presented in red ink). On these trials, therefore, participants could make the correct response by using information provided by either the ink color (the task goal) or the content of the word. Thus, on most trials, participants did not need to maintain the task goal of naming the ink color and could easily forget the task goal without a decrement in performance. In contrast, on the infrequent incongruent trials in which the word and ink color provide different color information (e.g. the word “GREEN” presented in red ink), participants must use the task goal to respond correctly. Thus, participants who are better able to maintain the task goal in WM will perform better on the incongruent trials because they are able to attend to task-relevant information, which in turn minimizes the interference caused by distracting information (Kane & Engle, 2003). Altamirano et al. found that trait rumination was associated with decreased interference from distracting words on the infrequent incongruent trials, suggesting, as do Zetsche and Joormann’s (2011) findings, that nondepressed trait ruminators are better than nonruminators at ignoring external distracters. This finding is slightly different from Zetsche

and Joormann's results, however, because it suggests that ruminators are better than nonruminators at ignoring distracters primarily because they are better able to maintain a task goal. Interestingly, in a separate letter-naming task, Altamirano et al. found that the same participants had greater difficulty switching to a secondary goal upon presentation of a cue. Thus, nondepressed trait ruminators may be adept at maintaining a single task goal in the modified Stroop task, but may have difficulty switching to secondary task goals, potentially because they cannot effectively disengage from previously relevant task goals.

Kropfingier and Simons (2011) and Meiran, Diamond, Toder, and Nemets (2011) also used a Stroop task to examine whether trait rumination is related to the ability to ignore distracters. Because the version of the Stroop task used by these researchers was not designed to examine goal maintenance, incongruent trials occurred frequently enough to make it unlikely that participants would forget the task goal. In samples of clinically depressed and never depressed participants, Meiran et al. did not find trait rumination to be related to Stroop performance. Kropfingier and Simons also did not find trait rumination to be related to any behavioral measures of Stroop performance in samples of dysphoric and nondysphoric participants. Interestingly, however, when examining the difference between incongruent and congruent trials in event-related potentials (ERPs), Kropfingier and Simons found that trait rumination in the dysphoric participants was related to a larger N450 signal. Previous investigators have suggested that the N450 signal reflects cognitive control mechanisms involved in suppressing word-related information (e.g., West & Alain, 2000); further, other researchers have found that the amplitude of the N450 is attenuated in populations known to have difficulties ignoring external distracters, such as clinically depressed individuals and older adults (e.g., Holmes & Pizzagalli, 2008; West & Alain, 2000). Thus, increased amplitude of the N450 in trait ruminators may reflect greater suppression of external distracters that is not well assessed by the behavioral measure. This finding is generally consistent with reports by Joormann and Zetsche (2011) and Altamirano et al. (2010) that trait ruminators are better at ignoring external distracters than are nonruminators. This conclusion should be treated with caution, however, given that no behavioral measures were related to rumination; thus, an increased N450 signal in trait ruminators could also reflect inefficient or excessive use of cognitive control.

Finally, only one study has examined whether a state of rumination affects the ability of depressed participants to ignore external distracters. Philippot and Brutoux (2008) examined the effect of rumination versus distraction inductions on performance on a color-word Stroop task in dysphoric and nondysphoric participants. In contrast to the findings presented above, Philippot and Brutoux found that a rumination induction made it more difficult for dysphoric (but not for nondysphoric) participants to ignore distracting words in the Stroop task, suggesting that for dysphoric participants, a rumination induction led to greater interference from external distracters. Thus, the relation between the ability to ignore distracters and rumination differs depending on whether investigators induced rumination or examined a naturally occurring tendency to ruminate.

In summary, in samples of unselected and control participants, a tendency to ruminate has been found to be associated with an increased ability to ignore external distracters, as measured by a Stroop task and an emotional Flanker task (Altamirano et al., 2010; Zetsche & Joormann, 2011). In samples that included a dysphoric group, Kropfingier and Simons (2011) did not find a relation between trait rumination and behavioral measures of the ability to ignore distracters in a Stroop task, but neural data suggest that trait rumination was related to increased cognitive control in the presence of external distracters. Finally, in samples of depressed individuals, a tendency to ruminate has been found to be unrelated to resistance to distracter interference, as measured with an emotional Flanker task, color-word Stroop task, and a modified Sternberg task, despite being associated with greater interference from

previously relevant information or with other cognitive deficits in the same participants (Joormann et al., 2010; Meiran et al., 2011; Zetsche et al., 2012).

In general, researchers had not predicted this pattern of findings. A state of rumination is posited to drain limited executive resources from task-relevant processing. Given that trait ruminators are expected to be in a naturally occurring state of rumination, investigators had posited that trait ruminators would exhibit difficulty ignoring external distracters, a process that depends on executive resources. Indeed, Philippot and Brutoux (2008) found evidence supporting this postulation, demonstrating that dysphoric participants had greater difficulty ignoring external distracters on Stroop task following a rumination induction than they did following a distraction induction. Thus, it is unlikely that a naturally occurring state of rumination is driving the relation between trait rumination and increased resistance to distracter interference. Instead, these findings suggest either that increased resistance to distracter interference increases individuals' susceptibility to rumination when they become depressed or, alternatively, that a third factor is driving the relation between trait rumination and increased resistance to distracter interference. As we noted above, although a number of negative cognitive styles such as neuroticism, pessimism, and perfectionism have been found to be correlated with a tendency to ruminate, investigators have not found any of these styles to be related to increased resistance to distracter interference.

Ability to attend to previously ignored information—Using the Negative Affective Priming (NAP) task, investigators have found that trait ruminators are faster than are nonruminators to respond to previously ignored information (Joormann, 2006; Zetsche & Joormann, 2011, although see Goeleven, De Raedt, Baert, & Koster, 2006, for a failure to replicate). In the NAP task, participants must respond to a target word of a particular valence (negative, neutral, or positive) and not to a distracter word of a different valence (the prime trial). On an immediately subsequent (probe) trial, the target may or may not be the same valence as the distracter word on the previous trial. Participants typically take longer to respond to a target word of that same valence during the probe trial than they do to a target word of a different valence (i.e., the negative priming effect), suggesting that conflict arises when individuals must respond to information that was previously distracting.

Joormann (2006) demonstrated in an unselected sample that trait ruminators had less difficulty than did nonruminators at responding to a previously ignored valence (i.e., decreased negative priming [NP] effect), regardless of whether it was positive or negative, suggesting that they had less conflict to overcome when attending to previously rejected information. Zetsche and Joormann extended Joormann's study by using a prospective design to examine whether performance on the NAP was associated with rumination not only at Time 1, but also six months later (Time 2). In contrast to Joormann's earlier findings, Zetsche and Joormann did not find a relation between RRS scores and an NP effect at Time 1. They did find, however, that a smaller NP effect at Time 1 predicted increased rumination at Time 2, even after controlling for depressed mood and RRS scores at Time 1. Although the correlational nature of this study means that third-factor explanations cannot be ruled out, these findings suggest that decreased NP plays a role in the onset and/or maintenance of rumination.

It is important to note that the precise cognitive processes underlying the NP effect are not yet clear (e.g., see Mayr & Axel, 2007). Some investigators have argued that distracting stimuli are deactivated via inhibitory processes during the prime trial, and that the NP effect reflects the extra time needed to overcome this inhibition during the probe trial (e.g., Tipper, 2001). According to this account, trait ruminators may have exhibited a reduced NP effect because they did not sufficiently inhibit the distracter valence during the prime and, therefore, had less inhibition to overcome during the probe. If this account is correct, it

suggests that trait ruminators have difficulties keeping external distracters from entering WM. However, findings from other studies described above indicate that ruminators do not have such difficulties. Moreover, investigators using the NAP task have used only two or three valences (negative, positive, and, in one study, neutral); therefore, each valence must have been recently relevant – that is, it must have been the target valence on a recent trial. Thus, trait ruminators may have had difficulties inhibiting the distracting valence on the prime trial because that valence was recently relevant, an explanation consistent with findings that trait ruminators have difficulties inhibiting previously relevant information.

In contrast to this inhibition account, Neill and colleagues (e.g., Neill & Mathis, 1998) proposed that the NP effect may be due to participants categorizing distracting information as irrelevant during a prime trial, which leads to conflict and slower responses when that information become relevant during the probe trial. In this context, if trait rumination is related to a better ability to ignore external distracters, as the evidence reviewed above suggests, then it is possible that trait ruminators did not encode distracting information during the prime trial sufficiently to learn that such information is irrelevant. Thus, they will have less conflict to overcome (i.e., deciding whether this information is relevant or irrelevant) when they must attend to that information during the probe trial (see Lazar, Kaplan, Sternberg, & Lubow, 2012, for a similar discussion). In sum, therefore, although trait ruminators exhibit anomalous performance on the NAP task, the precise reason for this pattern of functioning is not yet clear.

Prepotent Response Inhibition—Watkins and Brown (2002) examined the effects of rumination and distraction inductions on interference control by investigating whether rumination leads to increased interference from automatic counting tendencies (e.g., “4, 5, 6, 7”) when participants are required to generate a random sequence of numbers in a random number generation (RNG) task. These investigators found that, compared with the distraction induction, the rumination induction increased the probability that depressed (but not control) participants would engage in habitual counting sequences. Based on these results, Watkins and Brown concluded that rumination overloads the executive resources involved in the suppression of unwanted, prepotent responses.

Because performance on the RNG may reflect cognitive processes other than response inhibition (e.g., Jahanshahi, Saleem, Ho, Dirnberger, & Fuller, 2006), Whitmer and Gotlib (2012a) used a stop-signal task, which has been linked more clearly to prepotent response inhibition (e.g., Logan, 1994), to examine the differential effects of rumination and distraction inductions. In the stop-signal task, participants must press a different button when presented with an “X” than with an “O” (75% of the trials), but must withhold a response when presented with a beep (the stop-signal; 25% of the trials). Importantly, the beep is not presented until after the onset of the target letter, and the onset latency of the beep is variable; that is, the beep is presented later (increasing the difficulty of the task) if the participant successfully suppress his/her response on the previous trial. Thus, a measure of stopping ability (SSRT) is obtained by computing the difference between participants’ mean reaction time to the targets and the mean latency of the onset of the stop-signal. Smaller differences indicate better response inhibition, in that participants need less time to overcome a prepotent response. Whitmer and Gotlib found that, compared with induced distraction, induced rumination increased the SSRT in depressed, but not in healthy control, participants, supporting Watkins and Brown’s (2002) assertion that rumination interferes with individuals’ ability to suppress prepotent responses.

Investigators examining response inhibition in trait ruminators have reported mixed findings. Lau, Christensen, Hawley, Gemar, and Segal (2007) did not find a relation between scores on the RRS and stopping ability on the stop-signal task in depressed

participants using emotional stimuli. In contrast, however, using an anti-saccade task, De Lissnyder, Derakshan, De Raedt, and Koster (2011) found that dysphoric and nondysphoric trait ruminators had difficulties suppressing reflexive saccades towards cues flashed on the sides of the screen. It is possible, therefore, that the anti-saccade task is a more sensitive measure of response inhibition than is the stop-signal task.

In summary, investigators have reported deficits in response inhibition in each study in which state rumination was induced in depressed participants; the relation between trait rumination and response inhibition is less reliable. This pattern of findings suggests that trait ruminators will exhibit deficits in response inhibition only if they are in a naturally occurring state of rumination at the time they are assessed. This interpretation is consistent with Watkins and Brown's (2002) postulation that ruminative thinking overloads executive resources, making it difficult for individuals to use those resources to suppress unwanted behavior. It is also noteworthy that the studies in which rumination was induced found deficits only in depressed or dysphoric participants, and not in nondepressed participants. Thus, depressed individuals appear to have difficulties stopping or suppressing rumination once it begins (e.g., Watkins & Brown, 2002), and that this initial inability to override rumination may lead to overloaded executive resources and impaired response inhibition.

Rumination and Non-Inhibitory forms of Control Functioning

Although most research has focused on control processes related to inhibition, the results of a growing number of studies suggest that control mechanisms other than inhibition are also related to the repetitive nature of rumination.

Non-inhibitory switching processes—When individuals switch their attention to new tasks or goals, they must inhibit mental representations of previous task goals/sets and activate mental representations of new task demands/goals (Koch et al., 2010). Investigators typically measure switching-related processes by examining switch costs, or the extra time it takes to switch task sets compared to repeating the same task set. It is important to note that switch costs reflect processes involved in inhibiting and disengaging from the no-longer-relevant task set (i.e., BI), as well as non-inhibitory switching processes (NISPs), such as those involved in the activation of the new task set. As we described in the previous section, rumination is related to difficulties inhibiting previous task sets (e.g., less BI), but because investigators have yet to identify a trial comparison that isolates NISPs from BI, it is more difficult to determine whether rumination is also related to NISPs. Nonetheless, given that switch costs reflect both BI and NISPs, it is possible to deduce a relation between rumination and NISPs if rumination continues to be related to switch costs (i.e., $BA > AA$) after controlling for its association with BI (as measured with the $ABA > CBA$ comparison).

To date, however, with only a few exceptions, studies of rumination that have assessed switch costs have not also measured BI; therefore, it is not possible in these studies to determine whether the switching deficits exhibited by ruminators reflect deficits in both NISPs and BI. While Davis and Nolen-Hoeksema (2000) did not find an association between rumination and switch costs, most other investigators have reported a relation between these two constructs (e.g., Altamirano et al., 2010; De Lissnyder, Koster, Goubert, Onraedt, Vanderhasselt, & De Raedt, 2012). Meiran, Diamond, Toder, and Nemets (2011) also found that trait rumination in depressed individuals was related to decreased preparation for an upcoming switch when participants were given increased time to prepare, and De Lissnyder and colleagues (2012) found that switching deficits were related to the level of rumination reported by participants following a stressful exam period, suggesting that individuals who exhibit greater switch costs are more likely to engage in rumination following stress. Given the correlational nature of this study, however, a third-variable

explanation cannot be ruled out and direct manipulations are needed to further examine causal mechanisms. And as we noted above, even if switching deficits do increase individuals' susceptibility to rumination, it is not clear whether this vulnerability is influenced by deficits in BI, in NISPs, or in both.

Two cross-sectional studies have now controlled for deficits in BI while examining the relation between trait rumination and switch costs: one that examined an unselected sample using neutral stimuli (Whitmer & Banich, 2007) and one that examined a sample containing a large number of dysphoric participants using emotional stimuli (De Lissnyder et al., 2010). Interestingly, these two investigations yielded contradictory findings. Whitmer and Banich (2007) found that depressive rumination was either weakly (Study 1) or not at all (Study 2) related to switch costs. Because these associations were statistically weaker than was the relation between depressive rumination and BI, Whitmer and Banich argued that a tendency to engage in depressive rumination is related only to aberrant BI. In contrast, De Lissnyder and colleagues (2010) found that trait rumination was more strongly related to switch costs than it was to BI, suggesting that deficits in trait ruminators affect both BI *and* NISPs.

As we noted above, Whitmer and Gotlib (2012b) found that inducing rumination in depressed participants led to greater switch costs than did a distraction induction, but did not affect BI. Given that switch costs reflect both BI and NISPs, these findings suggest that state rumination primarily impairs NISPs, and not inhibitory processes, during switching. Interestingly though, and as we also noted above, across all participants in Whitmer and Gotlib's study, trait rumination was related to decreased BI but not to increased switch costs. Thus, state rumination does not appear to lead trait ruminators to exhibit deficits in BI. Instead, deficits in BI seem to increase vulnerability to rumination. In this context, if we assume that dysphoric trait ruminators are more likely to be in a naturally occurring state of rumination than are nondysphoric trait ruminators, these findings can explain why Whitmer and Banich (2007) found that trait rumination in an unselected sample is related more strongly to deficits in BI than to NISPs, while De Lissnyder et al. (2010) found that trait rumination in a sample of dysphoric individuals was related to deficits in both BI *and* NISPs. In addition, the use of emotional stimuli by De Lissnyder et al. may have further increased state rumination in their sample and, thereby, exacerbated deficits in NISPs.

Individuals in a state of rumination may be slower to activate a new task set than are nonruminating individuals because they are attending to their negative personal concerns more than they are to the ongoing task. Moreover, if they are directing attentional resources to their negative personal concerns, they will have fewer resources to devote to NISPs. Because NISPs may require the use of more executive resources than does BI (see our discussion of this issue above), state rumination should lead to greater impairment in NISPs than in BI. Moreover, if individuals in a state of rumination are not attending to the task, they will form weak representations of task sets, which may be easily abandoned or inhibited when they are no longer relevant. The finding that, unlike state rumination, trait rumination is not related to impaired NISPs is consistent with other findings suggesting that trait rumination is not related to general difficulties on tasks that require executive resources (e.g., see Altamirano et al., 2010). These findings suggest instead that trait ruminators exhibit deficits only in select contexts, such as when they must inhibit or disengage from previously processed information.

WM updating—Rumination may be related to difficulties flexibly updating the contents of WM. For example, Meiran et al. (2011) reported that in a depressed sample, trait rumination was related to difficulties on a task that required participants to update a number maintained in WM after performing an arithmetic operation on the number. Joormann, Levens, and Gotlib (2011) examined mental sorting costs, or the additional time it took depressed and

nondepressed participants to reverse the order of words maintained in WM versus remembering them in the order in which they were presented. Joormann et al. found that trait rumination was related to larger sorting costs for negative words, even when controlling for severity of depressive symptomatology, suggesting that trait ruminators have difficulty updating the format of information maintained in WM.

Bernblum and Mor (2010) reported that, in an unselected sample, trait rumination was related to slower “refreshing,” a process postulated to be a component of WM updating (e.g., Johnson, Reeder, Raye, & Mitchell, 2002) because it renews the activation of select components of information held in WM. Interestingly, ruminators exhibited slower refreshing if at least some of the information that was maintained in WM was valenced (Study 2), but exhibited slower refreshing regardless of whether the to-be-refreshed information was neutral or emotionally valenced (Study 1). It is not clear, however, why this pattern was obtained. If trait ruminators were simply more likely than were nonruminators to automatically allocate attentional resources to emotional information (which would explain their slower refreshing in the presence of emotional information in Study 2), then they should be faster, not slower, to refresh emotional information, as found in Study 1. Further work is required to elucidate the role of emotion in refreshing. Given that refreshing is postulated to play an integral role in WM updating (e.g., Johnson et al., 2002), it is possible that deficits in selectively refreshing WM underlie the difficulties in updating exhibited by trait ruminators (Joormann et al., 2011; Meiran et al., 2011).

Reward and punishment learning—Some investigators have found evidence that individuals who tend to ruminate are less likely than are nonruminators to learn from negative feedback of the need to exert attentional control to override previously learned reward contingencies. For example, even after controlling for group differences in depressive symptomatology, Davis and Nolen-Hoeksema (2000) found that trait ruminators were less likely than were nonruminators to be influenced to by negative feedback and more likely to continue to use a no-longer-correct rule to sort cards in the Wisconsin Card Sorting Task (WCST). Similarly, Whitmer and Banich (2011) found that trait rumination and other forms of repetitive thought were related to difficulties learning from negative feedback about the need to reverse stimulus-reward associations in a reversal-learning task. In the WCST, trait rumination was not related to impaired switching in a task that explicitly instructed participants when to switch, suggesting that their deficits in the WCST were driven by their inability to learn from the negative feedback of the need to switch, instead of by their ability to switch *per se*.

In studies that require behavior to be overridden, it is difficult to distinguish between deficits in switching processes that are needed to override the behavior and deficits in the ability to integrate negative feedback into the learning history of stimuli (e.g., is it a good or a bad stimulus?) in order to learn of the need to exert control. In a recent study, Whitmer, Frank, and Gotlib (2012) examined reward and punishment learning in a probabilistic selection task that does not require participants to override thoughts, only to learn slowly over multiple trials how likely a stimulus is to be punished or rewarded. Whitmer et al. found that compared to depressed participants in a distraction induction, depressed individuals who were induced to ruminate had greater difficulty learning the probability that a stimulus would be punished, but were able to learn the probability that a stimulus would be rewarded. Thus, a state of rumination appears to impair depressed persons’ ability to learn from punishment, which in turn may decrease their likelihood of spontaneously (i.e., in the absence of an explicit command) exerting cognitive control over their negative thoughts.

Attentional control over self-relevant information—Investigators have proposed that ruminators have difficulties exerting attentional control over self-relevant information,

which could increase their level of self-focus. To examine this possibility, Daches, Mor, Winquist, and Gilboa-Schechtman (2010) had participants encode words from a list self-referentially by asking them to provide an autobiographical memory that they associated with each word. Daches et al. then gave participants a speeded semantic classification task (e.g., is the word part of the category “time” or the category “family?”). This task included both words that had been encoded self-referentially and novel words. To examine attentional control to self-relevant information, Daches et al. compared reaction times in mixed blocks that contained both self-referentially encoded and novel words with reaction times in blocks that were composed entirely either of self-referentially encoded words or of novel words. These investigators found that brooding rumination (measured with the RRS) was related to slower reaction times in the mixed block than in the homogeneous blocks, suggesting that brooding is associated with impaired attentional control over self-relevant information. Unexpectedly, reflective rumination was related to better attentional control over self-relevant information. Although Daches et al. controlled for several variables that might have accounted for the findings, such as depressed mood, differences in valence, meaningfulness of autobiographical memories (which were not correlated with rumination), and previous exposure to stimuli, several questions remain unanswered. For example, it is not clear why reflection was related to better control over self-referential information given that it is also, by definition, self-referential thinking. It is also not clear whether a stronger bias towards self-relevant information increases individuals’ susceptibility to brooding or, instead, whether increased state rumination in brooders is driving the relation between brooding and self-referential bias. Indeed, given that individuals with elevated scores on the brooding subscale are more likely to be in a ruminative state than are their high-reflection counterparts (e.g., Moberly and Watkins, 2008), this latter possibility could explain why participants high in brooding, but not participants high in reflection, exhibited an attentional bias towards self-relevant information.

Generalizability of Control Functioning to Multiple Subtypes of Rumination

It is important to reiterate that although we have been treating rumination as a homogenous construct, investigators have distinguished between different subtypes of rumination, such as brooding and reflection (Treynor et al., 2003). To date, however, there is not sufficient evidence to conclude that different forms of control functioning are specific to certain subtypes of rumination. For example, the majority of studies that have examined the brooding and reflection subscales of the RRS have found cognitive difficulties to be related to scores on both of these subscales. A number of studies have found deficits specific to one of the two subscales, but these results do not form a clear pattern. For example, De Lissnyder and colleagues (2010, 2011, 2012) have found evidence that switching and inhibitory deficits are specific to brooding. In contrast, Joormann et al. (2010) and Zetsche and Joormann (2011) both have found inhibitory deficits to be associated with reflection and not with brooding. Mor and Bernblum (2010) found that deficits in refreshing were specific to brooding in one study, but related to both brooding and reflection in another study. Daches et al. (2010) found that, in the presence of self-referential information that was unrelated to the ongoing task, brooding was related to deficits in attentional control, whereas reflection was related to better attentional control. In sum, despite occasional findings that cognitive deficits are specific to one subscale of the RRS, no reliable pattern has emerged in the literature. As investigators continue to examine the specificity of cognitive deficits to different types of rumination, it is important to bear in mind that the distinction between brooding and reflection has been found to be blurred in clinically depressed individuals (Whitmer & Gotlib, 2011), and that in unselected samples brooding may be more strongly related to naturally occurring states of rumination than is reflection (Moberly & Watkins, 2008).

While the majority of the studies reviewed here have examined depressive rumination (e.g., with the RRS), in two investigations similar findings have been obtained with other forms of negative repetitive thought. Whitmer and Banich (2009) demonstrated that a tendency to engage in anger rumination (ARS) and a state-independent form of rumination (rumin-RRQ) were both related to difficulties inhibiting no-longer-relevant information stored in LTM. Similarly, Whitmer and Banich (2011) found that difficulties in perseveration and in learning from punishment were related to both adaptive and maladaptive forms of repetitive thought that occur in the context of a negative mood, such as intellectual self-reflection, depressive reflection, depressive brooding, anger rumination, and worry. Clearly, however, more research is needed to examine the similarities and dissimilarities between rumination, as measured with the RRS, and other forms of negative repetitive thought with respect to control functioning.

Finally, it is not clear whether the forms of control functioning reviewed here are also associated with repetitive thought that is focused on positive information or that occurs in the context of a positive mood (e.g., Feldman, Joormann, & Johnson, 2007). Some investigators have argued that there are significant commonalities between positive and negative forms of repetitive thought (e.g., Segerstrom, Stanton, Alden, & Shortridge, 2003; Watkins, 2008), such as their repetitiveness. In this context, therefore, it is possible that similar control mechanisms are related to both positive and negative repetitive thought. Future research is needed to examine this question, and we recommend that investigators measure and manipulate forms of repetitive thought other than depressive rumination. Only by doing so will we gain a more comprehensive understanding of the etiology and effects of repetitive thought.

Evaluating Accounts of Control Functioning in Rumination

In this section of the paper we review existing accounts and characterizations of control functioning in rumination. A major aim of this section is to identify findings and patterns from this literature that have not been explained by these accounts. We believe that the significance of these findings and patterns have not been addressed because they do not fit well with any theoretical accounts of control functioning and rumination.

A Resource Depletion Account

A frequently cited explanation for the cognitive deficits exhibited by ruminators is that a state of rumination usurps limited executive resources from task-relevant processing (e.g., Hertel, 1998; 2004; Levens, Muhtadie, & Gotlib, 2009; Philippot & Brutoux, 2008; Watkins & Brown, 2002). This account posits that executive resources are needed for ruminative thinking: those resources are needed to update WM with more negative thoughts, to retrieve from LTM new memories related to negative personal concerns, and to keep attention focused on those thoughts despite possibilities for distraction. According to the resource depletion account, if ruminating individuals are required to engage in a task that is unrelated to their rumination, their high use of executive resources for rumination will impair their performance on this task because they have depleted resources that would otherwise have been available for task-relevant processing.

It is important to note that the depletion account posits that rumination should not affect information processing that is easy and automatic (i.e., processing that does not depend on executive resources), only information processing that requires a higher level of executive resources. For example, in the Stroop task, ruminating participants will be able to read the word because that process is easy and automatic, but will have difficulty responding to the ink color because executive resources are needed to keep their attention focused on the target information in the presence of distracting information. Executive resources are used

for multiple purposes, including switching, inhibition, monitoring, and updating (e.g., Miyake et al., 2000); given that state rumination is posited to generally deplete executive resources, it should lead to a widespread impairment of executive control. Consistent with this account, researchers have found that inducing state rumination in depressed participants leads to widespread deficits in executive control. For example, investigators have found that rumination impairs the ability of depressed participants to resist interference from external distracters in the Stroop task, to activate new task sets when switching, to suppress prepotent responses, and to generate random numbers, potentially reflecting deficits in inhibition, monitoring, and updating abilities (Philippot & Brutoux, 2008; Watkins & Brown, 2002; Whitmer & Gotlib, 2012a,b).

If we assume that participants who report a high tendency to ruminate are in a naturally occurring state of rumination at time of study, the resource depletion account may also explain why trait ruminators are impaired on a number of tasks that require the use of executive resources, such as difficulties with intentionally suppressing irrelevant memories (e.g., Hertel & Gerstle, 2003) or with inhibiting prepotent responses (De Lissnyder et al., 2011). The depletion account, however, fails to explain a number of research findings. For example, the depletion account predicts that trait ruminators should exhibit difficulties ignoring external distracters on tasks like the Stroop and Erikson Flanker task because responding to target information in the presence of external distracters requires executive resources. Indeed, as we noted above, a rumination induction has been found to impair the ability of dysphoric participants to ignore external distracters in a Stroop task (Philippot & Brutoux, 2008). Trait rumination in unselected samples, however, has been found to be related to a *better* ability to ignore external distracters in the Stroop and Flanker tasks (Altamirano et al., 2010; Zetsche & Joormann, 2011). Moreover, Altamirano et al. (2010) found that nondepressed trait ruminators were better than were nonruminators at ignoring external distracters because they were better at maintaining the emotionally neutral task goal (i.e., “name the ink color”) in WM. It is not clear how depletion of executive resources or a state of rumination could lead to increased maintenance of neutral task goals and to increased resistance to external distracters.

The depletion account also does not explain why depressed trait ruminators have difficulties in situations that require flexible thinking but are not impaired in their ability to ignore external distracters (Joormann et al., 2010; Krompinger & Simons, 2011; Meiran et al., 2011; Zetsche et al., 2012). A failure to find a relation between trait rumination and the ability to ignore external distracters does not, by itself, contradict the depletion account; if trait ruminators are *not* in a naturally occurring state of rumination at the time of a study, then they would not be expected to exhibit impaired executive control. What is inconsistent with the depletion account, however, is that in these same studies, in the same experimental session, and in one case, even in the same task, trait rumination was found to be related to deficits on other measures of executive control, such as the ability to remove no-longer-relevant information from WM and to prepare for an upcoming task switch (Joormann et al., 2010; Meiran et al., 2011; Zetsche et al., 2012). Thus, if trait ruminators exhibited deficits because they were in a ruminative state, they should have exhibited deficits both in flexibility and in their ability to ignore external distracters. Indeed, studies using rumination inductions have found that a state of rumination has such an effect (Philippot & Brutoux, 2008; Whitmer & Gotlib, 2012b). It is also possible that trait rumination was unrelated to the measure of the ability to ignore external distracters because such measures are less sensitive to cognitive deficits than are measures of other forms of control. This possibility, however, seems unlikely given that in the same studies depression status was found to be related to the opposite pattern of deficits (e.g., see Joormann et al., 2010). Moreover, deficits in flexibility but not in the ability to ignore external distracters have been found in trait ruminators across a number of studies even though several different tasks have been used to assess resistance

to distracter interference, such as the Flanker task, the Stroop task, and a novel task designed to examine distracter interference. Thus, a resource depletion account does not explain why depressed trait ruminators will have difficulties in situations where flexibility is needed, but not in situations that require continued processing of task-relevant information in the presence of prepotent (i.e., automatically processed) external distracters.

The depletion account also cannot explain the pattern of deficits associated with trait rumination in Whitmer and Gotlib's (2012b) study. As we noted above, Whitmer and Gotlib found that, compared to a distraction induction, a rumination induction impaired the ability of depressed participants to switch between task sets, as reflected by increased switch costs, but did not impair their ability to disengage from the previous task set. In contrast, across all participants in both induction conditions, trait rumination was related to the opposite pattern (i.e., to decreased inhibition of the previous task set but not to switch costs). Thus, trait ruminators appear to exhibit inhibitory deficits regardless of whether they are actively ruminating (i.e., using limited resources), a finding that is inconsistent with the depletion account.

Findings from four studies conducted by Smallwood and his colleagues (Smallwood, Davies, Heim, Finnigan, Sudberry, O'Connor, & Obonsawin, 2004; Smallwood, Obonsawin, Baracaia, Reid, O'Connor, & Heim, 2003) also cannot be explained by the depletion account. In these studies, participants completed cognitive tasks that required encoding, recall, and/or sustained attention (i.e., tasks that should require cognitive control) while task-unrelated thought (TUT) was measured with either post-task questionnaires or thought probes. A tendency to engage in depressive rumination (RRS), particularly in the absence of a dysphoric mood, was associated with significantly *less* TUT, more task focus, and *better* performance on memory tests. The negative relation between scores on the RRS and TUT is particularly noteworthy given the similarities between these two scales. For example, both scales contain multiple items asking about how much participants thought about recent events. It is also noteworthy that the relation between rumination and decreased TUT was stronger when controlling for level of depressive symptoms, which, in contrast to trait rumination, was related to *higher* levels of TUT. The depletion account predicts that trait ruminators would exhibit poorer task performance and more TUT, reflecting increased rumination about negative personal concerns, not better performance and less TUT.

Finally, the depletion account is also inconsistent with findings that nondepressed trait ruminators exhibit better performance in situations that require cognitive control. For example, Ray, Ochsner, Cooper, Robertson, Gabrieli, and Gross (2005) found that nondepressed trait ruminators are better than nonruminators at increasing and decreasing their emotional response to a negative picture when instructed to use reappraisal, a process that requires executive control, at least as assessed by relative increases and decreases in amygdala activity, a brain structure that is posited to reflect the intensity of experienced negative emotion (e.g., Ochsner, Bunge, Gross, & Gabrieli, 2002). A state of rumination could lead to increased negative reactions to negative pictures because state rumination increases the accessibility of and attention to negatively valenced information (e.g., Lyubomirsky et al., 1998). It is not clear from the depletion account, however, how state rumination could make it easier for trait ruminators than for nonruminators to decrease their negative response. Nor can the depletion account explain Daches et al.'s (2010) finding that a tendency to reflect (subscale of the RRS) in an unselected sample was related to a better ability to ignore task-irrelevant self-relevant information, a process that presumably requires executive resources.

In sum, depletion of executive resources by state rumination may explain why trait ruminators exhibit some types of control deficits, but cannot explain a number of other

empirical findings. It is important to emphasize that differences in mood also do not appear to explain these findings. Indeed, all of the findings in the relevant studies remained significant when investigators controlled for mood or depressive symptomatology, and depressive mood often had the opposite effect on performance (e.g., it led to more TUT and to difficulties ignoring external distracters). The resource-depletion account appears to have the greatest difficulty explaining the results of studies that use unselected or nondepressed participants. This is of particular interest given that nondepressed trait ruminators are less likely than are their depressed counterparts to be in a naturally occurring state of rumination. Indeed, there is no evidence that nondepressed trait ruminators were actually ruminating while they were participating in any single study. Instead, these studies together suggest that trait ruminators are more likely than are nonruminators to robustly maintain thoughts that are emotionally neutral, task-relevant, and adaptive. For example, in nondepressed and unselected samples, trait rumination has been found to be related to stronger maintenance of an emotionally neutral task goal, to better responding to task-relevant information in the presence of external distracters, to increased task focus, and to a decreased tendency to engage in task-irrelevant thinking about personal concerns (e.g., Altamirano et al., 2010; Smallwood et al., 2003; 2004; Zetsche & Joormann, 2011). Thus, the results of a considerable number of published studies cannot be explained with the resource-depletion account of rumination.

Valence-Specific Accounts

In recent reviews, Joormann (2010) and Koster et al. (2011) offered explanations for the control deficits exhibited by trait ruminators. Although these accounts do not contradict the postulation that that state rumination can, through resource depletion, cause cognitive deficits, in general, these accounts posit that deficits in control functioning increase individuals' susceptibility to rumination when they are in a negative mood. More specifically, these accounts suggest that a tendency to ruminate is related to difficulty controlling attention to emotionally negative, but not to neutral or positive, information. Further, these valence-specific control deficits will increase rumination because they will make it more difficult for ruminators to keep negative information from entering WM and to disengage from it after it enters WM. Although these accounts address some critical findings from the rumination-control literature, they do not adequately account for other results. For example, these accounts do not explain why ruminators do not have difficulties blocking information from entering WM if that information was not recently relevant, or why trait rumination is related to improved performance in certain situations that require executive control (e.g., Altamirano et al., 2010; Daches et al., 2010; Ray et al., 2005; Smallwood et al., 2003; 2004; Zetsche & Joormann, 2011).

Moreover, it is not clear that trait ruminators have more difficulty exerting control over negative information than they do over neutral or positive information. These two reviews, especially Joormann's (2010) review, focused primarily on studies of depressed samples; indeed, in studies of clinically depressed individuals, trait rumination has been found consistently to be associated with greater control deficits for negative than for positive information (Joormann & Gotlib, 2008; Joormann et al., 2010, 2011; Zetsche et al., 2012). In non-clinically depressed or dysphoric samples, however, there is little evidence of valence-specific control deficits. For example, Hertel and Gerstle (2003) did not find a valence-specific deficit, and De Lissnyder et al. (2010) found a valence-specific deficit for task set inhibition, but not for switch costs. Moreover, in samples of unselected or nondepressed individuals, trait rumination has been found to be related to deficits for all types of stimuli, regardless of emotional valence, when participants were presented with negative and positive stimuli (Joormann, 2006; Joormann & Tran, 2009), neutral and negative stimuli (De Lissnyder et al., 2012), or only neutral stimuli (e.g., Altamirano et al.,

2010; Davis & Nolen-Hoeksema, 2000; Whitmer & Banich, 2007). Only one study that examined an unselected sample of participants found deficits for negative but not for positive stimuli (Zetsche & Joormann, 2011). These investigators, however, did not examine whether deficits were statistically significantly greater for negative than for positive information. Moreover, trait rumination in this study was related to a *better* ability to ignore emotionally negative distracters, which is contrary to the postulation that nondepressed trait ruminators have difficulties exerting control over negative information. Thus, trait ruminators appear to exhibit valence-specific deficits only when they are clinically depressed.

The accounts offered by Joormann (2010) and Koster et al. (2010) also do not explain why rumination should be related to cognitive deficits in the processing of information that is not negatively valenced. For example, in the context of these accounts, it is unclear why rumination would be related to difficulties disengaging from positive information (Hertel & Gerstle, 2003; Joormann, 2006; Joormann & Tran, 2009). It is also not apparent in these accounts why trait ruminators would have difficulties disengaging from both positive and negative information when they are not depressed and only from negative information once they become depressed.

In this context, it is noteworthy that investigators have found that the mechanisms involved in processing the emotional salience of information appear to be more sensitive to negative than to positive information in depressed individuals (e.g., see Gotlib & Joormann, 2010). Investigators have also found that this heightened sensitivity leads depressed individuals to process negative ahead of positive information and, moreover, that a state of rumination in depressed individuals exacerbates this negative processing bias (see Koster et al., 2011). For example, depressed individuals who are induced to ruminate recall more negative memories and generate more negative predictions about the future than do participants who are given a distraction induction (e.g., Lyubomirsky, Caldwell, & Nolen-Hoeksema, 1998; McFarland & Buehler, 1998). Depressed individuals who report a high tendency to ruminate are also more likely to attend to negative than to positive information (e.g., Donaldson et al., 2007; Joormann et al., 2006; Lau et al., 2007; Raes, Hermans, Williams, & Mark, 2006). Interestingly though, a negative processing bias is generally not found in trait ruminators who are not depressed (e.g., Daches et al., 2010; Donaldson et al., 2007; Joormann et al., 2006; Morrison & O'Conner, 2008; Lau et al., 2007), nor do rumination inductions in these individuals increase their focus on negative information (e.g., Lyubomirsky, Caldwell, & Nolen-Hoeksema, 1998; McFarland & Buehler, 1998).

A negative processing bias can actually have beneficial effects when depressed trait ruminators must disengage from positive information because it will decrease the salience and importance of that information, thereby decreasing the amount of cognitive resources needed to redirect attention. Thus, this negative processing bias should make it as easy for depressed trait ruminators to disengage from positive information as it is for nonruminators. In contrast, a negative processing bias should make it even more difficult for depressed trait ruminators to disengage from negative information because representations of negative information will be more robust; therefore, greater cognitive effort will be needed to override these representations.

In summary, in individuals who are not depressed, trait rumination is related to problematic control functioning, such as difficulties disengaging attention from no-longer-relevant information, regardless of the emotional valence of the information that is being processed. In trait ruminators who are depressed, a negative processing bias, driven by "bottom-up" salience detection mechanisms, may mitigate their difficulties disengaging from positive information. Thus, anomalous control functioning in trait ruminators should generally affect

how they process information, regardless of emotional valence (e.g., Joormann, 2010; Koster et al., 2011), but difficulties disengaging attention from positive information should be attenuated by a negative processing bias in depressed trait ruminators. Below, we address theoretical implications of these formulations.

Rumination, Mood, and the Attentional Scope Model

A number of investigators have attempted to determine that variations in control functions that are related to rumination are not due simply to differences in mood by, for example, statistically controlling for individual differences in depressive symptomology, and assessing trait rumination when individuals are in different depressive states. Such efforts are important in assessing whether the cognitive underpinnings of rumination exert effects independent of mood, but it is nevertheless clear that mood plays a critical role in the etiology of rumination. Indeed, rumination is hypothesized to occur when an individual is in a negative or depressed mood state, and to become stronger and more sustained as mood becomes more negative (e.g., Nolen-Hoeksema et al., 2008). Thus, negative mood is hypothesized to affect cognitive functioning in a way that increases the likelihood that rumination will occur. In this section of the paper, we describe the attentional scope model of mood. This model postulates that negative (or low positive) mood narrows attentional scope by reducing the array of thoughts, percepts, and actions (e.g., low-level motor programs) currently in WM or available for selection from LTM; positive mood, in contrast, has the opposite effects. We posit that the breadth of attentional scope affects the likelihood that rumination will occur. In addition, we reexamine findings from the control-rumination literature in the context of this attentional scope model. We posit that the pattern of control functioning exhibited by trait ruminators reflects a narrowed attentional scope.

The Attentional Scope Model of Mood

A large literature has documented that mood can affect the valence of individuals' thoughts through mood-congruent biases in attention, interpretation, and memory (e.g., see Forgas, 2002; Gotlib & Joormann, 2010; Seimer, 2005). Given this mood-congruence effect and the negative content of ruminative thought (Nolen-Hoeksema et al., 2008), it is not surprising that rumination is more likely to occur when individuals are in a negative mood. It is important to note, however, that rumination is not only *negative* thinking, but is also *repetitive* and *perseverative* thinking (Nolen-Hoeksema et al., 2008). A negative processing bias may increase the number of negative thoughts experienced by an individual, but it is not clear how this process would lead individuals to perseverate or focus repetitively on the same subset of negative thoughts. Thus, it is important to understand not only how mood affects the content of thoughts, but also how mood may affect control functioning in a way that alters the structure and process of thinking (Schwarz & Clore, 2007), leading thoughts to become more repetitive and perseverative.

One of the most prominent accounts of how mood affects the structure of thinking is the attentional scope model. This model posits that mood changes the scope of attentional selection; that is, the array of thoughts, percepts, and actions (e.g., low-level motor programs) that will be activated in WM or available for selection from LTM can become either wider or narrower depending on individuals' mood or emotional state (e.g., Baas, De Dreu, & Nijstad, 2008; Clore, Gasper, & Garvin, 2004; Clore, Schwarz, & Conway, 1994; Clore & Huntsinger, 2008; Derryberry & Tucker, 1994; Easterbrook, 1959; Fredrickson, 1998; 2001; Friedman & Forster, 2010; Forgas, 2002; Isen, 2000; Storebeck & Clore, 2005; Tucker & Williamson, 1984). Investigators have posited that positive and negative emotions signal the level of safety of an environment, and consequently lead to increased or decreased exploration of that environment by widening or narrowing the scope of attentional selection, respectively (e.g., Easterbrook, 1959; Fredrickson, 1998; 2001; Tucker & Williamson,

1984). Evidence of this effect of mood on attentional scope comes from a number of studies. For example, using a global-local visual processing task, Fredrickson and Branigan (2005) found that experimentally induced states of amusement widened participants' perceptual attention, leading them to be more likely than individuals in a neutral state to categorize a stimulus by its global form than by its more specific local form. Negative affect, in contrast, reduces individuals' ability to detect peripheral targets (e.g., Burke, Heuer, & Reisber, 1992; Gasper, 2004; Gasper and Clore, 2002; Reeves & Bergum, 1972). Other investigators have found a similar effect when examining the scope of memory selection in LTM. For example, participants in whom a positive mood was induced were more likely to categorize weak exemplars of a category as belonging to that category than were participants in a neutral mood (Isen and Daubman, 1984). In contrast, participants in whom a negative mood was induced were more likely to exclude fringe exemplars than were participants in a neutral mood (e.g., Mikulincer, Kedem, & Paz, 1990; Mikulincer, Paz, & Kedem, 1990). Thus, whereas positive mood appears to increase access to a wider array of memories in LTM, including memories that would otherwise have been less accessible in that particular context, greater negative affect reduces the array of information accessible in LTM.

Attentional scope also affects processing at the level of WM: individuals with a narrower attentional scope will maintain a conceptually more limited array of information in WM over time than will individuals with a broader attentional scope (e.g., see Friedman & Forster, 2010; Gable & Harmon-Jones, 2012; Mason & Bar, 2012; Tucker & Williamson, 1984). A narrow attentional scope leads to a slower rate of conceptual change in WM because it increases the cognitive resources devoted to the limited set of information activated in WM and decreases the resources available to attend to novel information and more remote mental representations in LTM. This effect of attentional scope on resource allocation means that compared to individuals with a broader attentional scope, individuals with a narrowed attentional scope will encode information at the center of attention more deeply and maintain more robust representations of information in WM. Thus, a narrowed attentional scope can be useful when individuals need to maintain focus on the same information over time without being distracted by irrelevant information in the environment or LTM. It will, however, make it more difficult for individuals to inhibit, disengage from, or forget that information when demands change, thereby decreasing the ability of individuals with a narrowed attentional scope to flexibly explore a broader array of information over time. Investigators have demonstrated that mood affects the breadth of attentional processing at the level of WM (e.g., Ashby, Isen, & Turken, 1999; Bauml, Huhbander, 2007; Biss, Hasher, & Thomas, 2010; Compton, 2000; Dreisbach, 2006; Dreisbach & Goschke, 2004; Gable & Harmon-Jones, 2012; Johnson, Waugh, & Fredrickson, 2010; Rowe, Hirsh, & Anderson, 2007). Individuals high in negative affect, that is, with a narrowed attentional scope, have difficulty inhibiting or disengaging from information and flexibly switching to new information. They are better, however, at maintaining task-relevant information and ignoring distracting information. Individuals high in positive affect, in contrast, have increased flexibility but also increased distractibility and/or decreased stability.

It is important to emphasize that these studies demonstrate that the effect of mood on the structure of cognitive processing is independent of its effect on the emotional valence of thoughts (i.e., mood-congruent processing biases). Thus, the narrowed attentional scope of individuals experiencing high negative (or low positive) affect is not limited to negative information. Indeed, the studies described above used neutral stimuli to document the effect of mood on attentional scope.

An Attentional Scope Model of Rumination

A negative mood will lead to processing biases for mood-congruent information, thereby influencing the type or valence of information that becomes established in WM or activated in LTM. Rumination is not simply negative thinking, however, but repetitive and perseverative negative thinking (i.e., the same subset of negative thoughts will repeat; Nolen-Hoeksema et al., 2008). In this context, we postulate that breadth of attentional scope mediates the association between mood and the repetitive nature of thoughts. Narrowed attentional scope caused by high negative or low positive mood will limit the array of thoughts and actions that are activated and accessible at any point, increasing the likelihood that thoughts will continue to focus on the same topic over time, i.e., be repetitive. In contrast, a broader attentional scope caused by positive mood will increase the array of thoughts and actions that are activated and accessible, which should increase the likelihood that thoughts will shift away from the topic that is currently established in WM and activated in LTM to other topics that are stored in LTM or associated with environmental stimuli. Thus, by expanding the scope of attention, positive mood will decrease the probability that thoughts will become repetitive.

Although a narrowed attentional scope may mediate the relation between negative affect and rumination, it is clear that not all individuals ruminate when they enter a negative mood. Can the attentional scope model help to explain why some individuals are more likely than are others to think repetitively about a negative mood? We posit that individual differences in attentional scope that are not driven by mood (e.g., Martindale, 1981; 1995) influence the likelihood that individuals will ruminate. For example, individuals who have a more constricted attentional scope, holding constant the influence of mood, will be more likely to think repetitively when they are in a negative mood because the negative mood will further constrict their already narrow attentional scope. In contrast, individuals with an inherently broader attentional scope will be protected from rumination when they enter a negative mood because their attentional scope should remain sufficiently broad that their thoughts will continue to shift from topic to topic. If this postulation is correct, then trait ruminators, that is, individuals who report frequent rumination when in a negative mood, should exhibit a narrower attentional scope than do nonruminators, even when they are not in a negative mood and/or when investigators control for mood state.

Interestingly, although none of the studies reviewed in this manuscript has examined trait rumination in the context of an attentional scope model, we posit that the pattern of control functioning exhibited by trait ruminators can be re-interpreted as a manifestation of a constricted attentional scope. For example, a substantial number of the studies reviewed in this paper have found that, independent of mood, trait ruminators have difficulties updating WM and inhibiting (disengaging from and forgetting) no-longer-relevant information (e.g., Davis & Nolen-Hoeksema, 2000; Joormann et al., 2011; Joormann & Tran, 2009; Whitmer & Banich, 2007; 2009; 2011; Whitmer & Gotlib, 2012b). As we discussed earlier, decreased updating of WM and difficulties inhibiting no-longer-information are key characteristics of a narrowed attentional scope at the level of WM processing. This finding suggests that the attention of trait ruminators is likely to be restricted to the small set of information that was recently activated or established in WM, and closed to new and alternative lines of processing.

It is important to note that these studies alone are not sufficient to conclude that the attentional scope of trait ruminators is restricted to a limited set of information: difficulties inhibiting no-longer-relevant information may simply reflect more general impairment in controlling the contents of WM (e.g., Joormann, 2010). This more general impairment would lead a broad array of information to enter WM over time (e.g., information unrelated to the current contents of WM would be more likely to be updated into WM). If trait

ruminators have difficulties controlling the contents of their WM, then their attention should be easily distracted by prepotent distracters in the environment (e.g., a color name in the Stroop task). Importantly, however, a number of investigators have found that trait ruminators who have difficulties inhibiting recently processed information do not have difficulties inhibiting or ignoring distracting task-irrelevant information in the environment (e.g., Joormann et al., 2010; Krompinger & Simons, 2011; Meiran et al. 2011; Zetsche et al., 2012).

Moreover, the results of a number of studies examining unselected or nondepressed participants indicate that a tendency to ruminate is, if anything, related to *less* distraction by remote mental representations and to more stable maintenance of goal-relevant information. For example, Altamirano et al. (2010) and Zetsche and Joormann (2011) found that individuals with higher levels of trait rumination were better able to ignore external distracters on the Stroop and Flanker tasks. Moreover, Altamirano et al. found that trait ruminators were better than nonruminators at ignoring distracters because they were better able to maintain a neutral task goal (i.e., name the ink color) in the absence of environmental reminders. Smallwood and colleagues (2003, 2004) similarly found that a tendency to ruminate was related to decreased distraction by internal thoughts about personal concerns that were unrelated to the ongoing task. Furthermore, Smallwood et al. demonstrated that in unconstrained tasks that provide time for mind-wandering, nondepressed trait ruminators were more likely to think about the ongoing task than about personal concerns that were unrelated to the task (i.e., more remote mental representations). Importantly, all of these studies examined nondepressed participants and/or controlled for mood, indicating that the effects were not related to mood. In sum, trait ruminators exhibit key characteristics of a narrowed attentional scope: they have difficulties disengaging from no-longer-relevant information, but they also exhibit stable maintenance of useful information and are unlikely to be distracted by remote information. These findings are consistent with the postulation that, independent of mood, individual differences in attentional scope influence how likely individuals are to ruminate when they experience a negative mood.

It is important to note that attentional scope may affect processing at the level of perception, WM, and LTM retrieval. While the studies reviewed above demonstrate that WM in trait ruminators is restricted to a limited amount of information, it is not as clear whether they also have less breadth of information available for selection in LTM. The finding that trait rumination is related to reduced RIF (Whitmer & Banich, 2009), however, is consistent with this postulation. During memory retrieval, individuals with a narrow attentional scope at the level of LTM should be more likely than individuals with a broader attentional scope to retrieve the desired memory without also retrieving related memories (e.g., see Bauml & Kuhbander, 2007). Decreased recall of related information leads to less interference during memory retrieval, which in turn, decreases the need to forget related but unwanted information or to categorize such information as being irrelevant (e.g., Smith and Hunt, 2000). Indeed, Bauml and Kuhbander (2007) demonstrated that individuals with a narrowed attentional scope are less likely to forget unretrieved exemplars from practiced categories during retrieval-practice in the RIF task. Thus, a narrow attentional scope at the level of LTM can explain why trait ruminators, independent of mood, exhibit decreased forgetting of unretrieved exemplars from practiced categories during retrieval-practice. Researchers should investigate further whether trait rumination is related to a narrow attentional scope at the level of LTM by examining their performance on such tasks as the categorization task used by Isen and Daubman (1984).

Trait ruminators may also exhibit narrowed attentional scope at the level of perception. Trait rumination is related to a better ability to ignore irrelevant flanking distracters in a Flanker task (Zetsche & Joormann, 2011), which measures attentional scope at a perceptual level

(e.g., Rowe et al., 2007). A narrowed attentional scope at this level could also explain Compton, Fisher, Koenig, McKeown, and Munoz's (2003) finding that trait rumination in an unselected sample is related to a perceptual asymmetry in a chimeric face task: trait ruminators exhibited a bias to perceive information presented in the right versus the left visual field. A large body of research using such tasks has found that individuals with a constricted attentional scope attend to the right over left visual field, potentially because of differences in processing styles between left and right hemispheres (for reviews, see Derryberry & Tucker, 1994; Friedman & Forster, 2010; Tucker & Williamson, 1984).

In this context, we should note that the attentional scope model of rumination is a more complex view of the cognitive control mechanisms of rumination than are accounts that have posited that difficulties inhibiting negative information lead to rumination (e.g. Joormann, 2010; Koster et al., 2011). A narrowed attentional scope will increase cognitive resources devoted to the processing of information at the center of attention, leading to deeper encoding of information and to activation of more robust representations in WM. This, in turn, leads to more stable maintenance of information, but also to difficulties updating WM and inhibiting, forgetting, or disengaging from that information when it stops being relevant (e.g., Dreisbach & Goschke, 2004; Gable & Harmon-Jones, 2012). In this context, a narrowed attentional scope explains why trait ruminators have an enhanced ability to maintain focus on task-relevant information, and also why they have difficulties updating WM and inhibiting no-longer-relevant information.

A narrowed attentional scope will also decrease encoding of information that is not at the center of attention, which will make it easier for individuals to respond to target information in the presence of distracting information, but more difficult for them to notice important changes in the environment (e.g., Biss et al., 2010; Dreisbach & Goske, 2004). Thus, the attentional scope model explains why trait ruminators are better at ignoring distracting information and why they fail to notice changes in environmental reward contingencies. Investigators have found that because individuals with a narrowed attentional scope are less likely to notice or encode distracters, they will also be less likely to categorize such information as task-irrelevant and, therefore, less likely to experience conflict when they must later attend to that information (e.g., see Bauml & Kuhbander, 2007; Biss et al., 2010; Dreisbach & Goske, 2004). In this context, a narrowed attentional scope explains why trait ruminators can attend more easily than can nonruminators to information that was previously distracting in the NAP and RIF tasks. It is also noteworthy that investigators have postulated that many of these anomalies in control functioning are not a *consequence* of state rumination, but instead, increase *susceptibility* to rumination (e.g., Altamirano et al., 2010; De Lissnyder et al., 2012; Whitmer & Gotlib, 2012b; Zetsche & Joormann, 2011). The attention scope model is consistent with these formulations, positing that an inherently narrowed attentional scope increases susceptibility to rumination, and that these aberrations in control functioning are a manifestation of a narrowed attentional scope. In sum, therefore, the attentional scope model accounts for a range of findings from cognitive studies of trait rumination.

Interestingly, in combination with the resource depletion account, the attentional scope model can also explain findings that appear to be contradictory. For example, investigators have found that whereas nondepressed trait ruminators are better than nonruminators at ignoring distracters (Altamirano et al., 2008; Zetsche & Joormann, 2011), depressed individuals who are actively ruminating are poorer at ignoring distracters (Philippot & Brutoux, 2008). As we noted above, a narrowed attentional scope allows trait ruminators to ignore distracting information in cognitive tasks because it keeps their attention focused on task-relevant information. When trait ruminators enter a negative mood, however, the negative mood will not only constrict their attentional scope further, but will also bias their

thoughts towards negative self-relevant information. Thus, thoughts about negative personal concerns will remain the focus of these individuals' narrowed attentional scope even when a situation requires them to engage in other tasks, such as a Stroop task. This means that limited executive resources will be directed toward those ruminative thoughts instead of to task-relevant processing, making it more difficult for them to determine what information should be used to guide responses and what information should be ignored. If ruminating individuals are not able to devote sufficient executive resources to task processing, then automatic information processing (e.g., word reading in the Stroop task) will override effortful, task-relevant processing (e.g., naming the ink color), leading to increased distraction by irrelevant information (e.g., Philippot & Brutoux, 2008). Thus, individuals who are able to ignore external distracters when they are not depressed will start ruminating when they become depressed and, because their attention will become stuck on these ruminative thoughts, they will then have difficulty ignoring external distracters. Given that individuals with elevated scores on the brooding subscale of the RRS are more likely to be in a ruminative state than are their high-reflection counterparts (e.g., Moberly & Watkins, 2008), these differences in level of state rumination could explain why individuals who brood have greater difficulty ignoring self-relevant information that is not goal relevant than do more reflective individuals.

The attentional scope model is also consistent with the conclusion that abnormalities in the functioning of control mechanisms in trait ruminators are not specific to negative information, because the breadth of attentional scope is posited to affect processing of all information (e.g., Friedman & Forster, 2010). We have postulated that a narrowed attentional scope will lead individuals to become stuck on negative versus non-negative information only when a negative or a depressed mood creates a negative processing bias. Interestingly, this account suggests that in the absence of a negative processing bias, the constricted attentional scope of trait ruminators could become limited to any subset of information, even positively valenced information. Thus, the attentional scope model of rumination accounts for Ciesla and Roberts' (2002, 2007) unexpected findings that individuals high in both trait rumination (RRS) and self-esteem exhibited faster memory repair following a negative mood induction and better response to clinical treatment for depression than did individuals high in self-esteem but low in trait rumination. High self-esteem is related to a positive processing bias (e.g., Tafarodi, 1998), and may lead individuals who are in a negative mood to selectively process positive information in an effort to repair mood. If this is the case, the constricted attentional scope of trait ruminators should lead to a more sustained or repeated focus on that positive information, which in turn would lead to faster improvements in mood. Thus, the attentional scope model explains why specific combinations of positive personality traits and trait rumination can be advantageous.

A similar mechanism might also explain Ray et al.'s (2005) unexpected finding that in a nondepressed sample, trait ruminators were better than nonruminators at following instructions to increase *and* decrease their emotional responses to a negative picture. Participants were instructed to either think of positive thoughts to decrease negative affect or think of negative thoughts to increase negative affect. The attentional scope model explains why trait ruminators would be better at following explicit instructions to increase and decrease negative emotions: individuals with a constricted attentional scope should be better at maintaining thoughts, regardless of valence, that could aid in increasing or decreasing negative reactions.

The interaction of mood and attentional scope may also provide a cognitive explanation of how distraction could help to alleviate rumination. If distraction improves negative mood, it will also broaden attentional scope, thereby increasing the chances that the attention of trait ruminators will be directed toward more remote associates and away from the topic of

rumination. Importantly though, this model proposes that distraction will decrease rumination through the effects of mood on attentional scope; consequently, distraction must alter mood if it is to influence the repetitiveness of thoughts.

This attentional scope model provides a cognitive explanation for why rumination and negative mood lead to a downward spiral of rumination and negative mood (e.g., see Lyubomirsky & Tkach, 2004). The attentional narrowing caused by negative mood leads to increased and sustained focus on negative thoughts, which exacerbates negative mood, leading to an even narrower attentional scope and to even more sustained repetitive thinking about negative information. Thus, it is important for individuals who tend to ruminate to exert control over their thoughts and emotions as soon as possible, because it will become increasingly difficult to do so as the downward spiral progresses. Unfortunately, as we noted above, trait ruminators are unlikely to exert control to regulate their mood if they are not explicitly instructed to do so.

Finally, the attentional scope model may help to explain why psychological distance from the self during processing of emotional experiences affects the likelihood that self-analysis will lead to rumination and other maladaptive consequences (e.g., Ayduk & Kross, 2008; 2010; Kross, 2009; Kross, Ayduk, & Mischel, 2005). Individuals high in self-distance perceive their thoughts and emotions as happening to a psychologically distant self, whereas individuals low in self-distance experience their thoughts and emotions directly in the first person. Interestingly, across a number of studies Kross, Ayduk, and colleagues have found that individuals who self-distance, either naturally or in response to experimental instructions, experience smaller emotional reactions and less rumination after thinking about a negative experience than do individuals who are self-immersed (i.e., who use a perspective low in self-distance). Breadth of attentional scope may be one cognitive mechanism that underlies the effect of self-distance on rumination. Indeed, Liberman and Forster (2009) demonstrated that experimentally broadening attentional scope leads to greater self-distance and that experimentally narrowing attentional scope leads to less self-distance. Moreover, investigators have found that individuals who are self-distanced report thoughts suggesting that they have a broad attentional scope; that is, their thoughts can be characterized as higher-order “big picture” mental representations of events. In contrast, self-immersed individuals report thoughts suggesting that they have a narrow attentional scope; their thoughts are concrete and focused on the details of their experience (e.g., Ayduk & Kross, 2010; Kross, et al., 2005; Liberman & Trope, 2008). If efforts to self-distance increase the breadth of attentional scope and self-immersion constricts the breadth of attentional scope, then the attentional scope model explains why self-distance leads to more rumination and self-immersion to less rumination. In this context, it is also important to note that Ayduk and Kross (2010) found that trait ruminators, assessed with the RRS, spontaneously use perspectives low in self-distance. If self-immersion corresponds to a narrow attentional scope, then this finding is consistent with our postulation that trait ruminators have a narrower attentional scope than do nonruminators. Finally, our attentional scope account is also consistent with findings that individuals high in self-distance exhibit reduced emotional reactions to negative memories. Investigators have found that a broad attentional scope decreases the attentional capture of emotionally salient information and enhances self-regulation of negative emotions (Gable & Harmon-Jones, 2012; Hanif et al., 2012). In this context, if self-distanced thinking expands attentional scope, it should not only reduce rumination, but should also reduce emotional reactions to negative information. In sum, therefore, breadth of attentional scope may mediate the effects of self-distancing on rumination and emotional reactivity, a formulation that should be examined more explicitly in future research.

Predictions of the Attentional Scope Model of Rumination

The attentional scope model of rumination generates a number of testable predictions. For example, the model predicts that factors other than mood, such as pharmacological agents, that also affect attentional scope should influence the incidence of rumination. In this context, nicotine has been found to narrow attentional focus on personally salient information and to decrease distractibility (e.g., Kassel, 1997); consequently, nicotine may also increase rumination. Indeed, Richmond, Spring, Sommerfeld, and McChargue (2001) found that trait ruminators who smoked were more likely to experience current and lifetime depressive episodes and greater depressed mood than were trait ruminators who did not smoke. Consistent with the attentional scope model, Richmond et al. argued that nicotine could lead to greater rumination, which in turn, would lead to more frequent and severe depression. Given the correlational nature of this study, however, future research is needed to examine the validity of the posited causal pathway linking nicotine, rumination, and depression. Similarly, factors that widen attention scope should lead to decreased rumination. For example, sleep deprivation has been found to lead to difficulties sustaining attention over a period of time, suggesting a wider attentional scope, and to improved mood in depressed individuals (e.g., Doran, Van Dongen, & Dinges, 2001), a finding consistent with the formulation of the attentional scope model that decreased rumination should improve depressed mood. Similarly, the tendency for exercise to broaden attentional scope (e.g., Barnes, Coombes, Armstrong, Higgens, & Janelle, 2010) may help to explain why exercise decreases ruminative thinking (e.g., Craft, 2005).

An important implication of the attentional scope model is that rumination is not simply a disorder of inhibition. Therefore, interventions designed to target inhibition, whether through training or through pharmacological intervention, will not necessarily be effective in reducing rumination. Instead, the model suggests that investigators should take into account the effects of an intervention on the breadth of attentional scope. For example, interventions that strengthen ruminators' ability to ignore external distracters may actually increase rumination because such training may further constrict attentional scope. In contrast, interventions that strengthen individuals' ability to disengage from information that is already in WM should make it easier for them to turn their attention to conceptually new information, thereby broadening their attentional scope and decreasing rumination.

Another implication of the attentional scope model of rumination is that the motivational intensity of an affective state, that is, whether the affective state increases drive towards or away from a goal, may influence rumination. Indeed, Gable and Harmon-Jones have posited that it is the motivational intensity, not the valence, of an affective state that influences attentional breadth (for a review, see Harmon-Jones, Price, and Gable, 2012). These investigators have provided evidence suggesting that, regardless of valence, affective states high in motivational intensity (e.g., desire, anxiety) will narrow attentional scope and affective states low in motivational intensity (e.g., sadness, contentment) will broaden attentional scope. Although this work is provocative, decades of research support a valence account (e.g., Isen, 2002). Moreover, Friedman and Forster (2011) have raised a number of theoretical and methodological issues concerning Gable and Harmon-Jones's motivational-intensity formulation. We will not repeat these issues here, but will simply note that little evidence supports the motivational-intensity account in the context of negative affect. Gable and Harmon-Jones (2010) found that presenting a sad picture before presenting a global-local stimulus led to a broader focus than presenting a neutral picture before the stimulus, a finding that is consistent with their account. In contrast, however, Gasper (2004; Gasper & Clore, 2002) found that, consistent with a valence account, participants who had been asked to spend time retrieving sad memories exhibited a narrower attentional scope in a subsequent global-local task than did individuals who retrieved neutral memories. Others investigators have also reported findings consistent with a valence account when examining

sad mood and stimuli (e.g., see Bridge, Chiao, & Paller, 2010; Srinivasan & Hanif, 2010; Storbeck & Clore, 2005).

Furthermore, we contend that the attentional scope model of rumination will be important even if researchers find that a motivational account is a better explanation for variance in attentional breadth than is a valence account. For example, Harmon-Jones et al. (2012) posited that mixed negative states (e.g., sadness combined with anxiety, irritability, etc.) should narrow attentional scope. In this context, it is noteworthy that Moberly and Watkins (2008) found, using experience sampling, that individuals are more likely to ruminate when they are in a mixed negative-affect state (sad, anxious, and irritable). Moreover, in a seminal study, Nolen-Hoeksema (2000) concluded that rumination is “particularly characteristic of people with mixed anxiety/depressive symptoms,” again suggesting that rumination is most likely to arise in mixed negative-affect states. It is also important to note that depression is characterized by both high levels of negative affect and low levels of positive affect (e.g., Clark and Watson, 1991), including types of positive affect that Gable and Harmon-Jones characterize as being low in motivational intensity (e.g., contentment, good mood, happiness, etc.). Thus, according to the motivational-intensity account, abnormally low levels of the type of positive affect that is low in motivation intensity should lead to a narrowed attentional scope and, thereby, according to our model, to rumination. Finally, it is important to note that Harmon-Jones et al. (2012) stated that it is possible for a sad mood to be high in motivational intensity if it drives individuals towards the goal of not being sad. In this context, it is noteworthy that trait ruminators report that they ruminate with the intention of understanding and eventually improving their mood, suggesting that rumination arises in affective states that have motivational intensity.

If the motivational-intensity account of attentional breadth is correct, our attentional scope model makes new predictions. For example, the model suggests that negative mood states are likely to lead to rumination only if they also increase motivational intensity. Even more interestingly, if the motivational-intensity account is correct, then our model predicts that positive states that are high in motivational intensity (e.g., desire, excitement) should increase repetitive thought. For example, the attentional scope model predicts that individuals will be more likely to think repetitively about a potential romantic partner than about a recent award that they won, given the higher motivational intensity in the former situation. Furthermore, we predict that because individuals who tend to ruminate depressively exhibit a narrowed attentional scope independent of mood, they will be more likely to think repetitively when they enter a positive state that is high in motivational intensity than will individuals with low ruminative tendencies.

To date, little research has examined repetitive thought in the context of positive mood. Some investigators, however, have found that mania, a state of high positive affect, is related to increased tendencies both to ruminate depressively (Knowles, Tai, Christensen, & Bentall, 2005; Thomas & Bentall, 2002) and to think repetitively about positive mood and information (e.g., Feldman, Joormann, & Johnson, 2007). The current account proposes that positive repetitive thought in mania is particularly likely to occur when individuals are experiencing positive emotions that are high in motivational intensity or when they are thinking about desired goals that elicit positive emotions high in motivational intensity. It is noteworthy that this positive repetitive thought is likely to have maladaptive consequences if individuals are experiencing positive, high-motivation, emotions about a desired goal that is unrealistic or potentially damaging to pursue, a possibility that is more likely if they are in a manic state.

We proposed earlier in this paper that personality variables that bias individuals towards the processing of positive information, such as making self-affirmations, are expected to lead to

faster mood repair in persons with a constricted scope of attention because it will be adaptive in situations in which robust maintenance of information is helpful (e.g., when maintenance of positive thoughts is sufficient to improve mood). A narrowed attentional scope may also be adaptive in problem-solving situations in which all the information that is needed is provided, and deductive reasoning is all that is required to draw conclusions, because it will reduce distraction from irrelevant information (e.g., Friedman & Forster, 2010). In contrast, however, a narrowed attentional scope should be disadvantageous in situations that require creativity or insight to resolve problems because it will be difficult for individuals to use relatively inaccessible information in LTM to generate novel solutions (e.g., Isen, 1987; Friedman & Forster, 2010; Rowe et al., 2006). In this context, the attentional scope model can account for the difficulties that depressed trait ruminators, that is, individuals with a constricted attentional scope, experience in tasks that require creative thinking, like the Mean Ends Problem-Solving Task (e.g., Donaldson & Lam, 2004; Gotlib & Asarnow, 1979). We predict that trait ruminators will also have difficulties on tasks that require broad attention, such as insight puzzles. Trait ruminators who are not in a state of rumination at time of study, however, should perform better than nonruminators on problems that require deductive reasoning. Interestingly, strong deductive reasoning that is coupled with poor insight is unlikely to help individuals deal with problems that underlie a depressed mood, which are likely to be sufficiently difficult that they require changes in perspective and/or creative solutions.

Conclusions and Directions for Future Research

In this paper we reinterpreted findings from the rumination-control literature in the context of an attentional scope model. Based on the abnormalities in control functioning exhibited by trait ruminators, we posited that they have a narrowed attentional scope, at least at the level of WM processing. This model is able to explain a range of findings from the rumination-control literature. This account also integrates results of studies examining the effect of mood on attentional selection and control mechanisms, explaining at a cognitive level why rumination is particularly likely to occur when individuals are in a negative or sad mood.

Although the attentional scope model is based on a significant body of research examining the relation between control functioning and rumination, considerable work remains to be done. For example, while substantial progress has been made using correlational approaches, it is important that investigators now make concerted efforts to examine explicitly directions of causality and to distinguish between control factors that increase susceptibility to rumination and control functioning that is affected by ruminative thinking about negative personal concerns. Researchers should examine not only how rumination manipulations affect control functioning, but also how manipulating control functioning (e.g., through training) influences susceptibility to rumination. This research is necessary if we are to advance beyond therapeutic interventions to develop more preventative approaches for individuals at risk for rumination.

A second important step is to begin to elucidate common and unique control factors that are associated with various types of repetitive thought. Unfortunately, almost all of the studies in the rumination-control literature have examined repetitive thought in the context of depressed or sad mood, either by measuring trait rumination with the RRS or by inducing rumination in depressed individuals. The attentional scope model predicts that a narrowed attentional scope will lead to multiple forms of repetitive thought, even to positive repetitive thought in the context of high approach motivation. It is possible, however, that a narrowed attentional scope plays a larger role in depressive rumination than it does in other forms of repetitive thought; it is also possible that different factors play a more prominent role in

other forms of repetitive thought. For example, cognitive avoidance may be implicated in worry but not in rumination (e.g., Borkovec, Ray, & Stober, 1998; Nolen-Hoeksema et al., 2008). Future research should also examine similarities and differences between the forms of control functioning that are related to rumination and those that are related to different populations of individuals. For example, both the elderly and individuals with attention deficit disorder have been found to exhibit inhibitory deficits (e.g., Hasher, Stolfus, Zacks, & Rypma, 1991; Quay, 1997). At this point, it is not clear how similar those deficits are to those that have been found to characterize ruminators.

A third direction for future research is to integrate the attentional scope model of rumination with control theory accounts of repetitive thought (Martin & Tesser, 1996; Watkins, 2008). Control theory accounts of rumination posit that repetitive thought is caused by a discrepancy between individuals' perceptions of their current and their desired goal states, and that if individuals perceive a goal discrepancy, they will think repetitively about that goal until it is met or abandoned. The control theory was not developed to explain findings from studies examining control functioning in rumination; indeed, studies examining control functioning in ruminators neither support nor contradict predictions made by the control theory (e.g., findings that trait ruminators have difficulties inhibiting previously relevant information are not related to the formulation that goal discrepancies drive rumination).

Nonetheless, investigators may be able to integrate these two accounts. For example, the control theory posits that a negative mood signals unsatisfactory progress towards a goal, which in turn leads to increased thinking about that goal; it does not posit, however, how negative mood changes control functioning in a way that could lead to increased thinking about that goal discrepancy. The attentional scope model suggests that the negative mood caused by a goal discrepancy will narrow attentional scope, resulting in both increased repetitive thinking about that discrepancy and difficulties generating creative ways to resolve the discrepancy. Interestingly, if individuals realize that they have achieved a goal (i.e., if there is no goal discrepancy), this should lead to positive affect that is low in approach motivation, which will expand attentional scope and decrease susceptibility to repetitive thought. Thus, the effect of mood on attentional scope should lead to an increase in repetitive thought when a goal discrepancy is perceived and to less repetitive thought when a goal has been obtained. In this context, it may be advantageous for investigators to integrate the attentional scope model and the control theory.

Finally, it will be important for researchers to elucidate the neural substrates of control functioning and attentional scope in rumination, including the neural factors that increase individuals' susceptibility to rumination and that are affected by ruminative thought. Although investigators have recently identified patterns of brain activation that are correlated with rumination (e.g., Cooney, Joormann, Eugene, Dennis, & Gotlib, 2010; Johnson, Nolen-Hoeksema, Mitchell, & Levin, 2009; Ray et al., 2005; Siegle, Steinhauer, Thase, Stenger, & Carter, 2002; Vanderhasselt, Kuhn, & De Raedt, 2011), it is clear that more research needs to be conducted in this area. Addressing these questions will allow investigators and clinicians to manipulate the degree to which individuals engage in rumination at both cognitive and neural levels. Given the well-documented role of rumination as a risk factor for the development of various forms of psychopathology, such knowledge will ultimately allow for more effective approaches to the treatment and prevention of these disorders.

Acknowledgments

This work was supported by National Institute of Mental Health Grants MH087115-01A1 awarded to Anson J. Whitmer and MH74849 and MH59259 awarded to Ian H. Gotlib. The authors thank Paula Hertel and anonymous reviewers for their invaluable comments on previous versions of this manuscript.

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Table 1

Authors	Sample & Task	Measures	Main Findings	Emotional valence of stimuli
Altamirano, Miyake, & Whitmer, 2010	Unselected undergraduates Performance on two measures of goal neglect: Modified stroop task (maintain one goal) and letter- task (maintain two goals)	RRS Controlled for: BDI	RRS related to better maintenance of a single goal, as assessed by less interference by external distracters on rare incongruent stroop trials. Relation became stronger when controlling for BDI. BDI related to worse maintenance. RRS related to difficulties switching between two goals, even when controlling for BDI.	Neutral
Berman et al., 2011	MDD and Controls fMRI study of Sternberg Task	RRS Controlled for: BDI	RRS related to difficulties removing no-longer-relevant negative information from WM	Negative, neutral, and positive
Bernblum & Mor, 2010	Unselected undergraduates Refreshing Task	RRS (B & R) Controlled for: BDI	B (studies 1 and 2) and R (study 2 only) were related to slower refreshing of words if at least one of the three words that were presented initially was emotional, regardless of whether the refreshed word itself was neutral or emotional	Neutral and negative
Compton, Fisher, Koenig, McKeown, & Munoz, 2003	Unselected undergraduates	RRS (B & R)	RRS and B, related to increased bias towards perceptual information presented in the right as compared to the left visual field, indicating a relatively reduced activation of the right posterior hemisphere.	Happy and sad chimeric faces
Daches, Mor, Winquist, & Gilboa-Schechtman, 2009	Unselected undergraduates Modified Garner's Speeded Classification Task to measure distraction by self-relevant information	RRS (B & R) Controlled for: IDD	When R, B & IDD were included in a single regression model, B was associated with more interference by self-relevant words; R with less interference by self-relevant words	Participant-generated memories (valence of memories was not related to B or R)
Davis & Nolen-Hoeksema, 2000	College undergraduates selected for high or low trait rumination Performance on Wisconsin Card Sorting Task (WCST)	RRS Controlled for: BDI, Primary Mental Abilities Task, Switching Backward Digit Span	RRS related to more perseveration and poor maintenance of previous sorting rules in WCST, even when controlling for all other variables at once. RRS not related to other measures.	Neutral
De Lissnyder, Koster, Derakshan, & Raedt, 2010	College undergraduates prescreened by BDI scores, 44% dysphoric (BDI score > 14), 56% nondysphoric (BDI score < 14)	RRS (B & R) Controlled for: BDI	RRS (particularly B) related to difficulties inhibiting negative but not positive information, and	Negative, positive, and neutral

Authors	Sample & Task	Measures	Main Findings	Emotional valence of stimuli
	Examined performance on emotional version of the backward inhibition task		difficulties switching, regardless of valence	
De Lissnyder, Derakshan, N., De Raedt, R. and Koster, E.H.W. (2011).	Dysphoric and nondysphoric Performance on an anti-saccade task	RRS (B & R) Controlled for: BDI	Increased RRS and B related to increased difficulties inhibiting pre-potent saccades.	Neutral
De Lissnyder, Koster, Goubert, Onraedt, & De Raedt (2012)	Undergraduates with no history of depression Prospective study with affective switching task	RRS (B & R) Controlled for: BDI	Larger switch costs for emotional and non-emotional material at time 1 were related to larger RRS and B scores at time 2 after a period of stress	Neutral and negative
Goeleven, De Raedt, Baert, & Koster, 2006	MDD and controls Tested inhibition with a variation of the negative affective priming task	RRS	No effect of RRS	Negative, neutral, and positive
Krompinger & Simons, 2011	Dysphoric and nondysphoric Color-word Stroop task	RRS	No effect of RRS on behavioral scores; RRS related to increased amplitude of the N450 component, which is known to reflect attentional control	Neutral
Hertel, 1998	Dysphoric and nondysphoric Fragment completion test of memory after rumination/ distraction inductions.	Rumination/Distraction inductions	Rumination induction is related to impairment in controlled memory retrieval	Neutral
Hertle & Gerstle, 2003	Dysphorics and nondysphoric	RSS	RSS related to decreased suppression, regardless of stimuli valence	Negative and positive
Joormann, 2006	Unselected undergraduates Performance on negative affective priming paradigm	RRS-full (R) Controlled for: BDI	Increased RRS & R related to less inhibition of irrelevant emotion regardless of stimuli valence	Negative and positive
Joormann, Dkane, & Gotlib, 2006	MDD and controls Measured negative processing biases with dot probe (DP) task and self-referent encoding (SRET) task	RRS (B&R) Controlled for: BDI	MDD: B but not R significantly related to increased negative attentional bias in DP task after controlling for BDI; B significantly related to memory bias in SRET task but only when not controlling for BDI Controls: no relation	Negative and positive
Joormann & Gotlib, 2008	MDD and controls Ability to intentionally forget or remove information from WM with a modified Sternberg task	RRS (B&R) Controlled for: BDI	MDD: increased RRS (B & R) related to decreased ability to inhibit no-longer-relevant negative but not positive information from WM, even after controlling for BDI. Controls: no relation	Negative and positive
Joormann, Levens, & Gotlib, 2011	MDD and controls Ability to manipulate information maintained in WM	RRS (B&R) Controlled for: BDI	MDD: RRS (but not B or R) was related to difficulties reversing the order of negative but not positive	Negative and positive

Authors	Sample & Task	Measures	Main Findings	Emotional valence of stimuli
			information held in WM. Controls: no relation	
Joormann & Tran, 2009	Unselected undergraduates Ability to intentionally forget vs. remember emotional words on the directed forgetting task	RRS Controlled for: CES-D	Ruminators had more troubles forgetting words, regardless of valence, than nonruminators.	Negative and positive
Joormann, Nee, Berman, Jonides, & Gotlib, 2010	MDD and controls	RRS (B&R) Controlled for: BDI	MDD: increased RRS (full & R, but not B) related to decreased inhibition of previously relevant negative (but not positive) information, but unrelated to ability to ignore/inhibit concurrently distracting information.	Negative and positive
Meiran, Diamond, Toder, & Nemets, 2011	MDD and controls Color-word Stroop Task; Task-switching paradigm; Working memory updating	RRS	RRS related to less preparation during task switch; difficulties with WM updating; unrelated to Stroop task	Neutral
Phillippot & Brutoux, 2008	Dysphoric and nondysphoric Rumination/distraction inductions. Performance on stroop task: RT on incongruent vs. neutral trials and RT when switching task demands: "name the color" and "name the word"	Rumination/distraction induction	Ruminating dysphorics were worse than distracted dysphorics at ignoring external distracters but not on switching between task demands Attributed to difficulties suppressing responses	Neutral
Ray, Ochsner, Cooper, Roberston, Gabrieli, & Gross, 2005	Unselected individuals fMRI Presented with neutral and negative emotional pictures; Requested to either look at them or to think positive/negative thoughts to decrease/increase, respectively, their negative emotional response to them	B; RRQ- rumination; ARS (combined measures together for analysis)	Rumination related to better up- and down-regulation of negative affect caused by negative pictures. Did not control for depressive symptoms	Negative and neutral
Smallwood, Obonsawin, Baracaia, Reid, O'Conner, & Heim, 2003	Unselected undergraduates in study 1; nondysphoric (BDI<12) and dysphoric (BDI >12) in study 2 & 3. Examined task unrelated thought during a task that required encoding of information for later recall	RRS Controlled for: BDI	RRS, particularly in nondysphoric participants, related to better recall from long-term memory and less task unrelated thought as assessed with thought probes (exp. 1 & 2) and a self-report questionnaire (exp. 3)	Neutral
Smallwood, J., Davies, J. B., Heim, D., Finnigan, F., Sudberry, M., O'Connor, R., & Obonsawin, M., 2004	Unselected undergraduates Examined task unrelated thought during a task requiring sustained vigilance for rare targets	RRS TUT questionnaire Controlled for: BDI	RRS related to decreased self-reported TUT during a sustained vigilance task	Neutral
Watkins & Brown, 2002	MDD and controls Induced into negative mood then given rumination or distraction induction	Rumination/distraction inductions	Ruminating depressives were worse at generating random numbers than were distracted depressives	Neutral

Authors	Sample & Task	Measures	Main Findings	Emotional valence of stimuli
	Performance tested on random number generation (RNG) task			
Whitmer & Banich, 2007	Unselected undergraduates Performance on a backward inhibition paradigm in two studies	RRS (B&R) ARS RRQ-reflect Controlled for: BDI	RRS (B & R) related to decreased backward inhibition in studies 1 and 2 but only to increased switch costs in study 1. ARS and RCQ-rumin related to increased switch costs but not backward inhibition in study 2	Neutral
Whitmer & Banich, 2009	Unselected undergraduates Performance on a retrieval-induced forgetting paradigm	RRS (B&R) ARS RRQ-rumin RRQ-reflect Controlled for: BDI PANAS	RRS (B & R), ARS, RCQ-rumin., but not RCQ-reflect, related to decreased inhibition of long-term memory	Neutral
Whitmer & Banich, 2011	Unselected undergraduates Learning from probabilistic negative feedback on reversal learning	RRS (B&R) ARS RCQ-reflection PSWQ Controlled for: BDI PANAS	Adaptive and maladaptive forms of repetitive thought related to worse reversal learning	Neutral
Whitmer & Gotlib, 2012a	MDD and controls Stop-signal task	Rumination/distraction inductions	Rumination induction	Neutral
Whitmer & Gotlib, 2012b	MDD and controls Backward inhibition paradigm	Rumination/distraction inductions RRS Controlled for: BDI	Rumination induction increased switch costs but did not affect inhibition RRS related to inhibitory deficits but not to increased switch costs	Neutral
Whitmer, Frank, & Gotlib, 2012	MDD and controls Rumination/distraction inductions. Probabilistic selection task	Rumination/distraction inductions	Rumination lead to difficulties learning about the likelihood that a stimulus will be associated with punishment but not reward in MDD participants more than in controls	Neutral
Zetsche & Joormann, 2011	Unselected undergraduates. Trait rumination, the negative affective priming (NAP) task, emotional Erikson Flanker task, and longitudinal effects	RRS (B & R) Controlled for: BDI	At time 1, RRS (B & R) related to better performance on Flanker task particularly for negative information. Deficits inhibiting negative information in NAP task at time 1 predicted RRS (R) at time 2, even when controlling for RRS and BDI at time 1	Negative, neutral, and positive
Zetsche, D'Avanzato, & Joormann, 2012	MDD and controls Performance on emotional Erikson Flanker Task (EFT) and a modified working memory selection task (WMST)	RRS (B & R) Controlled for: BDI	Across both samples when controlling for diagnostic status, R and B related to difficulties inhibiting negative information in WMST, and no measure related to performance on EFT	Negative, neutral, and positive

RRS = Ruminative Response Styles scale; B = brooding subscale of RRS; R = reflection subscale of RRS; RRQ-rumin = rumination portion of Rumination-Reflection Questionnaire; RRQ-reflect = reflection portion of Rumination-Reflection Questionnaire; ARS = Anger Rumination Scale; PANAS = Positive And Negative Affect Scales; PSWQ = Penn State Worry Questionnaire; BDI = Beck Depression Inventory; CES-D = Centre for

Epidemiological Studies Depression Scale; IDD = Inventory to Diagnose Depression; BAI = Beck Anxiety Inventory; STAI = State Trait Anxiety Inventory.