Ruminative Thinking: Lessons Learned From Cognitive Training

Nilly Mor and Shimrit Daches
School of Education, Hebrew University of Jerusalem

Abstract
Impairments in cognitive processes have been theorized to play a critical role in ruminating, a well-established risk factor for depression. In this review, we outline central theories that present cognitive impairments as causal contributors to ruminative thinking and review relevant findings from cross-sectional and prospective studies. We then focus on experimental evidence gathered within the paradigm of cognitive bias modification (CBM). Although CBM has generated considerable interest in relation to anxiety and depression, it has only recently emerged in the field of rumination. After considering the purpose and possible advantages of CBM procedures, we review CBM work related to rumination and discuss key limitations and implications within this developing area of research. Among our recommendations, we outline ways to contrast and integrate cognitive theories of rumination, as well as to obtain stronger bias modification procedures.

Keywords
cognitive bias modification, rumination, depression, cognitive control, training

Received 10/12/14; Revision accepted 2/24/15

People who ruminate think repetitively about why they feel sad and about possible consequences of feeling sad (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Although ruminators believe that rumination can help them understand themselves better and feel better, research has shown otherwise. Prospective as well as experimental research has revealed that rumination worsens negative mood (e.g., Moberly & Watkins, 2008; Nolen-Hoeksema & Morrow, 1993; Thomsen, Yung Mehllsen, Christensen, & Zachariae, 2003). Moreover, rumination has been identified as a core risk factor for depression; it predicts the onset of new episodes, contributes to more severe and protracted episodes, and is associated with relapse and poor recovery (Nolan, Roberts, & Gotlib, 1998; Roberts, Gilboa, & Gotlib, 1998). Recently, rumination has been acknowledged as a trans-diagnostic process (e.g., Watkins, 2009), contributing to a large number of psychiatric conditions including anxiety disorders, substance abuse, and bulimic behavior (Kocovski, Endler, Rector, & Flett, 2005; Nolen-Hoeksema, Stice, Wade, & Bohon, 2007). Ruminating has been theorized as both a transient response to negative mood (e.g., Martin & Tesser, 1989, 1996) and as a stable, trait-like tendency to engage in repetitive and passive self-focus in response to depressed mood (Nolen-Hoeksema et al., 2008). Stable ruminative tendencies are thought to bring about depression and related disorders by promoting negative thinking and impairing problem solving and instrumental behavior (Nolen-Hoeksema et al., 2008). A subtype of rumination, brooding, is characterized by “a passive comparison of one’s current situation with some unachieved standard” (Treynor, Gonzalez, & Nolen-Hoeksema, 2003, p. 256). Brooding is particularly maladaptive and is strongly linked to depression and other negative outcomes (e.g., Treynor et al., 2003).

Because of its pervasive maladaptive consequences, empirical work as well as theory have explored underlying mechanisms that promote and maintain ruminative thinking. Despite significant interest in ruminative thinking, key questions such as “What drives individual differences in rumination?” and “Why do some people continue to ruminate even though rumination is clearly harmful for them?” remain unanswered. Most theories that have
attempted to provide answers to these questions suggest that cognitive deficits and biases in processing emotional information have a causal role in rumination (e.g., Joormann, 2010; Koster, De Lissnyder, Derakshan, & De Raedt, 2011). Until recently, evidence in support of these theories has been correlational and therefore has not provided an adequate test of the causal assumptions made by the theories (for a review, see Whitmer & Gotlib, 2013). However, the development of the paradigm of cognitive bias modification (CBM) has made it possible to assess such causal connections. CBM procedures repeatedly encourage biases in attention, interpretation, or memory and assess the effects of such training on emotional symptoms (see Hertel & Mathews, 2011). Although CBM has been used mostly in relation to anxiety (for a review, see Hallion & Ruscio, 2011), recent work has applied CBM principles in an attempt to understand depression and rumination.

The aim of the present article is to review recent research that examined the effects of CBM procedures on ruminative thinking. Our review consists of several parts. We first provide an overview of central theories that postulate that cognitive factors have a causal role in rumination. This overview is followed by a section that outlines relevant findings from cross-sectional, prospective, and experimental designs that examine the association between the proposed cognitive factors and rumination. Next, we review findings from CBM research that manipulated these cognitive factors to later assess their effect on rumination. The findings have theoretical implications for cognitive models of rumination, as well as practical measurement and clinical implications. We conclude by presenting these implications and proposing future research directions.

**Cognitive Theories of Rumination**

The central feature of rumination that sets it apart from other cognitive risk factors for emotional disorders is its perseverative nature. Rumination is an unproductive style of thinking that is difficult to control or stop (Nolen-Hoeksema et al., 2008). This perseverative nature led researchers to postulate that cognitive deficits and biases may cause ruminative thinking. Specifically, two main cognitive features of rumination have been proposed as core causative factors in rumination: deficits and biases in functions of cognitive control (e.g., Koster et al., 2011) and abstract and nonconcrete verbal processing (e.g., Watkins, 2008).

**Deficits and biases in cognitive control in rumination**

In daily life, people often have to switch between different thoughts and actions in response to changing task demands and internal needs. The ability to adjust and orient cognitive resources to optimize performance and complete goal-directed behaviors has been referred to as cognitive control (Miller & Cohen, 2001). Cognitive control involves the operation of a number of interrelated lower level cognitive abilities that together govern thought and behavior (e.g., Baddeley, 1996; Burgess, 1997; Logan, 1985; Rabbitt, 1997). These abilities include inhibition of irrelevant content or prepotent responses, shifting back and forth between tasks or mental sets and updating and monitoring of currently activated representations to assess their relevance and replace irrelevant content (Miyake & Friedman, 2012).

Cognitive control has an important role in emotion regulation (e.g., Joormann & Vanderlind, 2014), and impaired control has been implicated in the development and maintenance of psychopathology (e.g., Banich et al., 2009). Models of emotional disorders refer to global impairments or deficits in cognitive control, to biases that involve processing of valenced or schema-congruent information, or to the combination of both global impairments and specific biases.

Some views have related rumination to broad deficits in cognitive control, regardless of the valence of the processed material. Specifically, ruminators are thought to exhibit impaired ability to flexibly shift attention or inhibit irrelevant information (e.g., Davis & Nolen-Hoeksema, 2000; Whitmer & Banich, 2007). These deficits may make it difficult for ruminators to stop ruminative thoughts once they emerge. Linville (1996) was the first to suggest that deficits in the attentional mechanism of inhibition may underlie rumination. Inhibition, a cognitive gatekeeper, limits access to consciousness of irrelevant information or internal thoughts that compete for attention while pursuing a goal. Ruminative thoughts, as argued by Linville, unintentionally enter consciousness because they are relevant to alternative goals the person holds or because of weakened inhibition that fails to guard against goal-irrelevant ruminative thoughts. Linville also postulated that stress and depression may weaken the ability to inhibit goal-irrelevant thoughts, which in turn may foster ruminative thinking. Such a depression-related impairment in inhibition has also been suggested in cognitive models of depression (e.g., the resource allocation model of depression, Ellis & Ashbrook, 1988).

Although it has been argued that rumination is associated with global deficits in cognitive control, and more specifically with inhibition, later work provided a more detailed perspective on the role of inhibition in depressive rumination. Joormann and colleagues (e.g., Joormann, 2010; Joormann & Vanderlind, 2014) have proposed that ruminators show biases in multiple inhibitory processes (e.g., Friedman & Miyake, 2004; Hasher & Zacks, 1988) that involve mood-congruent material.
These biases involve resisting distraction from irrelevant information, combating interference from information that is no longer relevant, attending to previously ignored content, and halting prepotent responses.

Other theories posit that the vicious cycle of ruminative thinking and negative mood is maintained by an impaired ability to exert control when faced with negative stimuli in the environment as well as an inability to disengage from negative thoughts. For example, the impaired disengagement hypothesis (Koster et al., 2011) attributes rumination to a combination of reduced conflict signaling and attention control. Conflict signaling refers to situations in which negative and self-evaluative thinking is evoked (e.g., in response to external stressors or internal cues such as negative affect or memories) against a backdrop of one’s current goals and long-standing self-views. The conflict between the transient negative thoughts and one’s goals and beliefs often leads to disengagement from negative thinking. However, according to the theory, conflict signaling may be impaired or reduced if negative thinking is congruent with one’s goals and beliefs. The second cognitive factor contributing to rumination, reduced attention control, refers to a specific inability to disengage from self-referring negative information. The theory suggests that people may become trapped in a maladaptive ruminative cycle when impaired conflict signaling or attention control leads to ruminative thinking, which in turn intensifies negative mood and interferes with problem solving and with task performance, leading to further rumination and to further impairment in attention control and conflict signaling.

Other models describe broader impairments in cognitive control and depict rumination as a product of both global impairments and specific biases. Hertel (2004) suggested that rumination is a mental habit that develops when cognitive control is impaired. The mental habit of rumination involves frequently thinking about negative personal or other concerns and perceiving, interpreting, and remembering events in a rumination-congruent manner. According to Hertel, those who are characterized by a ruminative habit of thinking have impaired self-control. Therefore, in situations that do not provide external control, habitual ruminators are likely to show difficulty focusing, sustaining, or switching attention and to fall into ruminative patterns of negative thinking.

Hertel’s model has been instrumental in the development of a recent model of ruminative thinking (Watkins & Nolen-Hoeksema, 2014) that distinguishes between episodes of state rumination and habitual rumination. According to the model, state rumination is triggered by perceived discrepancies between one’s goals and current state, but habitual rumination develops through repeated association of contextual factors and ruminative responses. In contrast to trait rumination, state rumination often depends on situational constraints. Although many people may ruminate at one time or another, not everyone develops a maladaptive habit of rumination. Watkins and Nolen-Hoeksema (2014) noted that deficient cognitive control may affect the formation of habitual rumination by impairing the ability to flexibly regulate processing in response to situational demands. However, the model is unclear as to whether deficient control refers to difficulty disengaging attention from negative content, inhibiting no-longer-relevant material, or to reduced effortful control and an inability to inhibit performance of a habitually cued behavior once it has been activated.

A somewhat discrepant view on the role of attention and cognitive control in rumination was presented by the attentional scope model of rumination (Whitmer & Gotlib, 2013). Rather than propose that ruminators are characterized by an impaired ability to control emotional content, this model maintains that a narrowed scope of attention is responsible for ruminative thinking. Specifically, the model proposes that negative mood facilitates rumination by narrowing the scope of attention, limiting the available thoughts, promoting perseverative thinking, and reducing flexibility and inhibition of irrelevant information as well as impairing the ability to switch to other information. Moreover, the model suggests that individual differences in attentional scope may account for trait rumination and that those who are characterized by a narrow attention scope would more readily engage in rumination in response to negative mood than those who are characterized by a broad attentional scope. It further argues that having a narrow attentional scope makes it difficult for ruminators to disengage from no-longer-relevant information but it also assists in remaining focused on relevant information and resisting distractions (e.g., Altamirano, Miyake, & Whitmer, 2010). Although the model has implications pertaining to attention to affective material, it emphasizes the structure of thinking rather than its content, and the effects of a narrowed scope of information processing are not limited to negative content.

**Cross-sectional and prospective evidence concerning deficits in cognitive control.** Several studies have shown that rumination is associated with deficits in cognitive control. Davis and Nolen-Hoeksema (2000) reported that compared with nonruminators, ruminators exhibited deficient flexibility and made more perseverative errors on the Wisconsin Card Sorting Test, which requires participants to sort cards according to shifting sorting criteria. Although this study was the first to examine general control processes, other studies tried to delineate rumination-related deficits in inhibition, shifting and updating.

A number of studies found that ruminators exhibit impaired inhibition but intact switching ability. For
example, De Lissnyder, Derakshan, De Raedt, & Koster, 2011) used a mixed antisaccade task, in which participants are requested to direct their gaze either away from an abrupt cue (antisaccade) or toward the cue (prosaccade). Ruminators had slower antisaccade latencies compared with nonruminators, indicating a difficulty inhibiting or disengaging from irrelevant information. However, consistent with Whitmer and Banich (2007) this study did not find evidence for impaired switching between the prosaccade and the antisaccade tasks. Similarly, in a sample of depressed and nondepressed individuals, Whitmer and Gotlib (2012) used the backward inhibition task to examine inhibition of no-longer-relevant task sets and switching ability. In this paradigm, participants were required to shift between three tasks. The changing sequence of tasks afforded a computation of indexes of inhibition (i.e., performing a task that was recently replaced by another) and switching (i.e., performing a new task). Again, trait rumination was related to decreased inhibition but not to slower switching, controlling for state rumination and depression.

In contrast, several studies did report rumination-related deficits in shifting. De Lissnyder, Koster, Derakshan, and De Raedt (2010) examined switching and inhibition when performing both emotional and nonemotional tasks. Compared with low-ruminators, high ruminators exhibited an inhibition bias on the emotional task and a shifting deficit on the nonemotional task. Owens and Derakshan (2013), who examined switching between two randomly ordered spatial location tasks, found that compared with low-ruminators, high ruminators made more switching errors, and when the irrelevant task was the predominant task, they did not switch to the relevant task even when given more preparation time.

Studies have also examined task switching and inhibition of a prepotent response (maintaining attention despite a distracting stimulus dimension) and updating of working memory. In one study rumination was associated with deficient shifting but with improved inhibition (Altamirano et al., 2010), but in another study rumination (among adolescents) was linked to deficient set switching only among boys. Inhibition of a prepotent response was related to rumination only among adolescents with low levels of depressive symptoms, but an opposite pattern was exhibited among those with high levels of depressive symptoms (Wagner, Alloy, & Abramson, 2015). Updating of working memory was assessed in a task in which participants performed several arithmetic operations (Meiran, Diamond, Toder, & Nemets, 2011) and on each trial updated a number that they memorized following the previous arithmetic operation. Rumination was associated with reduced ability to update working memory.

Thus, the link between rumination and deficient inhibition, shifting, and updating, was examined in several studies. Findings are relatively consistent regarding impaired inhibition, but not regarding shifting and updating. Only one study examined updating, and the different paradigms employed using different stimuli sets across diverse samples make it difficult to paint a specific picture regarding shifting deficits in rumination. Although these findings may suggest that deficits in cognitive control contribute to rumination, the cross-sectional nature of the studies reviewed so far, does not allow for inferences regarding causation. The possible causal direction cannot be ruled out based on cross-sectional research.

In line with this causal direction, several studies induced rumination in samples of depressed or dysphoric individuals and assessed the effects of ruminative thinking on deficits in cognitive control. For example, Watkins and Brown (2002) demonstrated that among depressed individuals rumination compared with distraction led to difficulty inhibiting prepotent responses on a random number generation task. Similarly, Philippot and Brutoux (2008) used the Stroop task, and found that rumination among dysphoric individuals, inducing rumination led to reduced inhibition. In another study (Whitmer & Gotlib, 2013), inducing rumination in depressed people led to slower switching between tasks but did not affect inhibition.

These experimental findings add complexity to the link between rumination and cognitive control deficits. They suggest that among people who already experience depressive symptoms, rumination may impair cognitive control. It is possible that the causal pathways linking rumination and cognitive control are different for depressed and nondepressed individuals. It is also possible that a bidirectional and reciprocal relation exists between cognitive control deficits and rumination. One way to test for a bidirectional association is using a prospective design. In a recent study, adolescents completed measures of depressive symptoms, rumination, and cognitive control at baseline and at a follow-up session approximately 15 months later. Higher levels of baseline rumination were associated with decreased selective attention and attentional switching at follow-up. In contrast, baseline levels of cognitive control functioning did not predict change in rumination over time (Connolly et al., 2014). This study did not support theoretical accounts suggesting that cognitive control deficits contribute to the development of rumination. Clearly, more studies using a prospective design are needed to clarify this relationship.

**Cross-sectional and prospective evidence concerning biases in cognitive control.** Empirical research that tested the assertion that trait ruminators exhibit...
biases in cognitive control has examined a variety of biases pertaining to processing of emotional information, including inhibiting or disengaging from negative content, updating working memory involving negative content, and shifting attention between tasks with negative and neutral content.

Inhibition biases are often examined using the negative affective priming task (NAP; e.g., Goeleven, De Raedt, Baert, & Koster, 2006; Joormann, 2006). In this task, participants are required to respond to a negative stimulus that they had to ignore on a prior trial. Typically, due to inhibitory processes, people exhibit a slower response to previously ignored stimuli. However, ruminators have been found to show a reduced inhibition of negative content, even when controlling for levels of depressive symptoms (Joormann, 2006). It is important that the link between trait rumination and inhibition bias was not replicated in a sample of depressed individuals, using negative facial stimuli (Goeleven et al., 2006), suggesting that rumination involves verbal rather than visual processing.

A number of studies reported that ruminators show biases in updating the contents of working memory. For example, Joormann and Gotlib (2008) used a modified Sternberg task to examine working memory updating in depression and rumination. In this task, participants are required to make a judgment about a target word after being asked to ignore a list of words that they previously had to memorize. Among depressed individuals, higher levels of rumination were associated with more intrusion from negative stimuli. These results were replicated in a similar paradigm, when controlling for depression (Zetsche, D’Avanzato, & Joormann, 2012). However, using the emotional flanker task in which participants classify a target word while controlling the interference of incongruent distractors, no rumination-related bias was found (Joormann & Gotlib, 2008; Zetsche et al., 2012). Using a different conceptualization of updating, Bernblum and Mor (2010) examined rumination-related biases in refreshing, the ability to briefly think back to a just activated thought or percept. In this task, participants are presented simultaneously with neutral and emotional stimuli and are subsequently asked to refresh (i.e., bring up from memory) one of the words. It was found that when emotional words were task-relevant, nonbrooders were slower to refresh emotional compared with neutral words, whereas brooders were slow in refreshing both. However, when emotional words were irrelevant, brooders showed biased refreshing of neutral words in the presence of emotional distractors, but nonbrooders did not. These findings highlight the interference that emotional content poses for brooders. Similar difficulties manipulating negative information in working memory were found among high ruminators, in a depressed sample (Joormann, Levens, & Gotlib, 2011). When instructed to remember a set of negative words in the reverse order from which they were presented, high ruminators were slower than low ruminators to indicate the location of a negative word. No difference between high and low ruminators were found when asked to memorize negative words in the same order they were presented. Finally, ruminators had difficulty forgetting emotional material (both negative and positive) and experienced more intrusions from novel negative stimuli (Joormann & Tran, 2009).

Thus, an extensive body of research provides consistent evidence regarding rumination-related biases in inhibition, shifting, and updating of valenced information. In addition to these cross-sectional studies, a few studies used a prospective design to assess whether biases in cognitive control predict future rumination. Zetsche and Joormann (2011) examined the link between performance on tasks that assess different aspects of interference control, depressive symptoms, and rumination, cross-sectionally and in a 6-month follow-up. Participants performed both a verbal and a pictorial NAP task. Rumination was not related concurrently to inhibition biases, measured by the NAP task. However, lower levels of inhibition of negative information at baseline did predict increased rumination 6 months later. Another study that used a prospective design in a sample of remitted depressed adults (Demeyer, De Lissnyder, Koster, & De Raedt, 2012) found that impaired shifting to and from emotional information predicts rumination and depressive symptoms 1 year later. Moreover, the link between impaired shifting and depression was fully mediated by rumination. Another prospective study revealed that the capacity to switch attention in working memory when processing emotional material was associated with increased rumination in response to stress at a 6-week follow-up assessment (De Lissnyder et al., 2012). Although these prospective studies examined different measures of biases in cognitive control, investigated nondepressed as well as remitted depressed individuals, and assessed varied time spans, they paint a consistent picture, suggesting that a difficulty in inhibiting and shifting away from negative content contributes to future rumination.

**Abstract verbal processing in rumination**

Another cognitive factor that has been postulated to serve a causal role in rumination and may be responsible for the negative consequences of rumination is abstract and overgeneral thinking (Watkins, 2008; Watkins & Teasdale, 2001, 2004). Watkins proposed that there are distinct processing modes that characterize ruminative thinking and that a particularly maladaptive mode of ruminative
Cross-sectional and prospective evidence concerning abstract and verbal processing

It is surprising that despite the prevailing view that ruminate thinking is characterized by analytical and abstract verbal thinking, only a few studies have examined these features in rumination. In two studies, McAuliffe, Borkovec, and Sibrava (2007) demonstrated that rumination is characterized by a predominance of verbal thoughts as compared with imagery. Similarly, Goldwin and colleagues (Goldwin & Behar, 2012; Goldwin, Behar, & Sibrava, 2013) demonstrated that compared with non-ruminative mental activity, rumination was more abstract and involved more verbal thoughts than images. Moreover, individuals with high trait rumination evidenced lower levels of imagery-based activity as well as lower levels of concreteness when they engaged in depressive rumination (Goldwin et al., 2013). Ruminative thinking, and particularly its maladaptive form, brooding, has also been associated with reduced specificity of autobiographical memories (Romero, Vazquez, & Sanchez, 2014), and was found to mediate the relationship between reduced memory specificity and depression (Debeer, Hermans, & Raes, 2009).

There is solid evidence supporting the view that abstract and verbal-analytical rumination is particularly harmful. A number of studies have experimentally induced concrete versus abstract rumination. Abstract analytical and evaluative rumination was found to increase overgeneral memory (Watkins & Teasdale, 2001, 2004), and global negative self-judgments (Rimes & Watkins, 2005), to impair social problem solving (Watkins & Moulds, 2005), and to moderate the relationship between trait rumination and emotional response to failure. Among participants who were instructed to think in an abstract fashion, trait rumination predicted negative emotional responses to failure, but a similar relation was not found among those who were trained in concrete thinking (Moberly & Watkins, 2006).

Cognitive Bias Modification

Although theory suggests that cognition plays an important causal role in ruminate thinking, only recently has the novel paradigm of CBM been adopted to examine this causal relationship. In addition to providing a test of the causal hypotheses postulated by the various theories of rumination, a close examination of CBM research has the potential to provide answers to a number of questions. It is important to note that the small number of studies that employ CBM procedures in relation to rumination precludes a systematic evaluation of these issues. Nevertheless, we outline these issues as guidance in reviewing available evidence and in formulating directions for future research.

First, the strict experimental control afforded by CBM paradigms allows researchers to assess mechanisms of operation. It is common practice in CBM research to examine the effects of the training on the putative bias and on the symptom of interest, as well as assess whether the effect of the training on symptoms is mediated by training effects on the bias itself (e.g., Salemink, van den Hout, & Kindt, 2010). Thus, in the current review, we evaluate the strength of the evidence pointing to a change in cognitive mechanisms (i.e., biases or deficits in cognitive control and abstract verbal thinking) in the course of CBM, and whether these changes have contributed to changes in rumination.

Second, the CBM paradigm makes it possible to modify elements of the intervention to determine the effective ingredients of the procedure (e.g., Rohrbacher, Blackwell, Holmes, & Reinecke, 2014). Furthermore, moderators of the causal relationship can also be examined. Such moderators may include situational constraints as well as characteristics of the individuals undergoing the training. For example, it has been shown that CBM was less effective among those who are vulnerable to depression (e.g., Haefel, Rozek, Hames, & Technow, 2012), but more effective among people with poorer preintervention ability to regulate oneself and exercise control (Salemink & Wiers, 2012), or with higher levels of attention bias (Kuckertz et al., 2014). In the current review, we report findings pertaining to possible moderators of the effects of CBM on rumination. As in prior research on the effects of CBM on anxiety, we examine whether CBM training is differentially effective for those with high and low levels...
of bias as well as those with high and low levels of rumination. Moreover, because different rumination-related biases have been noted among depressed and nondepressed individuals (e.g., Goeleven et al., 2006), we investigate whether training effects differ between these two groups.

Finally, given the important role that rumination serves as a risk factor for a variety of psychiatric conditions, a central question is whether the effects of CBM on rumination transfer to related cognitive processes, such as memory and interpretation, as well as to emotional symptoms. Therefore, in this review we examine rumination as well as additional cognitive and emotional outcomes.

Although interest in CBM research has increased tremendously in the past several years, many questions remain unanswered with regard to the optimal design of the training. One of the few existing meta-analyses reviewing findings obtained in CBM research reported that studies that included multiple training sessions tended to yield stronger effects than studies that employed a single session (Hallion & Ruscio, 2011). Other design parameters that received attention include explicit versus implicit training (e.g., Krebs, Hirsch, & Mathews, 2010; Mobini et al., 2014; Schartau, Dalgleish, & Dunn, 2009; Watkins, Baeyens, & Read, 2009) and CBM as a standalone intervention compared with an adjunct to therapy (e.g., Watkins et al., 2012). Thus, in the current review we attempt to delineate specific parameters that may produce stronger training effects. We review available CBM studies separately for the various cognitive theories we reviewed earlier.

**Review of CBM research**

**Training involving cognitive control deficits.** Several studies examined the effects of multisession training of cognitive control functioning on rumination and symptoms of depression. In two studies, Onraedt and Koster (2014) examined the effects of working memory training on rumination and depression. In the first study, ruminators were randomly assigned to 6 days of training in one of three conditions. The active training condition consisted of a nonemotional adaptive dual n-back task. The n-back (Kirchner, 1958) is a complex cognitive task known to involve a number of cognitive control functions including holding to-be-remembered information online, monitoring and manipulating the to-be-remembered information, response selection, implementation of strategies to facilitate memory, organization of material before encoding, and verification and evaluation of representations that have been retrieved from long-term memory. In the dual n-back participants are presented with two independent sequences of stimuli (auditory and visual), and they indicate for each sequence when the current stimulus matched one from n steps earlier in the sequence. In an active control condition, participants performed a single one-back task, which was similar to the training task except that participants monitored only one stream of stimuli and only one step back in the sequence. The third condition was a no training condition. In the second study, participants were allocated either to the dual n-back condition or to the no training condition. In both studies, although the performance on the dual n-back task improved in the training group compared with the control groups, no transfer effects were observed on emotional or nonemotional working memory tasks and no treatment gains in rumination or depression were obtained. Another recent study (Wanmaker, Geraerts, & Franken, in press) examined the effects of a dual n-back training in a sample of clinically depressed and anxious people. Although there was training-related improvement on the n-back task, there were no effects on transfer working memory tasks, rumination and symptoms of depression and anxiety.

The null effects may be attributed to several factors. Most notably, the mechanism of action by which the training would affect rumination is unclear, because the training task engages multiple control processes such as inhibition of irrelevant material, monitoring of ongoing performance, updating of working memory, and management of simultaneous tasks (Jaeggi, Buschkuehl, Jonides, & Perrig, 2008). Nevertheless, some have argued that the specific cognitive processes that are responsible for training-related improvement on the task are unknown, and that training may reflect only a change in the capacity of the focus of attention (e.g., Lilienthal, Tamez, Shelton, Myerson, & Hale, 2013). In the studies reported here, the specific mechanisms of change are also unclear because the training did not affect measures of working memory that were examined following training and that were thought to be related to rumination. Furthermore, several procedural features of the studies may have interfered with the ability to detect training effects: The samples in two studies were relatively small and the third had high dropout, and participants did not show pretraining impairments on measures of cognitive control. In the third study, null effects were reported even though the training included a large number of sessions (for a comparison, see Schweizer, Grahn, Hampshire, Mobbs, & Dalgleish, 2013).

Other researchers (Siegle et al., 2014; Siegle, Ghinassi, & Thase, 2007) have examined the effects of an adjunct intervention designed to increase cognitive control on rumination and depression. Depressed participants were assigned to treatment as usual (TAU) or to cognitive control therapy in addition to TAU. The TAU intervention included medication management, supportive group therapy that was
based on principles of dialectical behavioral therapy (Linehan, Heard, & Armstrong, 1993) and milieu therapy. The cognitive control intervention included six sessions, 30 min long, over 2 weeks. The training was composed of two computerized tasks. The first task was based on Wells’s Attention Control Training intervention (Wells, 2000) that requires participants to direct their attention to unique sounds in a naturalistic soundscape recording, focus on one sound at a time, switch between sounds, and distinguish specified stimuli from background noises. The second task is an adaptive variant of the Paced Auditory Serial Attention Task (PASAT; Gronwall, 1977) that involves continuously adding serially presented digits in working memory, with the pace automatically adjusted based on participants’ performance.

As predicted, participants in the cognitive control training condition, but not those in the TAU condition, experienced a significant reduction in rumination and brooding following the intervention. Furthermore, only in the cognitive control training condition, rumination change was positively related to a physiological index of pupil dilation that reflects task-related processing. Although this physiological index increased from pre- to posttraining in the cognitive control condition (suggesting increased cognitive control), this increase was not related to the change in rumination. Instead, an opposite pattern was observed whereby a treatment-related gain in task-related processing in the cognitive control condition was inversely related to change in rumination. Both treatment groups showed improved depression, with no group differences in depression levels following the intervention. However, participants in the TAU group did use more intensive outpatient services in the year following the intervention than did those in the cognitive control training group.

This work, too, leaves open some questions regarding the mechanisms of action in the cognitive control intervention. First, the cognitive intervention was used in addition to the provision of TAU rather than as a stand-alone intervention. Further limiting the ability to infer specific mechanisms from the intervention are the lack of a no-treatment or an active control condition and the fact that the cognitive intervention was a composite of two different cognitive interventions. Finally, the treatment-related decrease in rumination was not positively associated with an increase in cognitive control. Addressing some of these limitations, Vanderhasselt et al. (2015) examined the effect of cognitive control training using the PASAT task (along with a biological technique designed to enhance prefrontal activation) on brooding in a sample of depressed participants. Within-person changes in brooding were observed following the training, and these changes were related to changes in working memory. Unfortunately, no control training was used, and therefore it is unclear whether these effects are specific to the training of working memory training.

These limitations notwithstanding, this work is informative in a number of ways. It is important to note the large effect size associated with change in rumination following cognitive control training. This change is of particular significance given the severity of depression in the study by Siegle et al. (2014) and the clinical significance of the findings. These studies also delineate possible moderators of the intervention on ruminative thinking. The largest decrease in rumination was seen in participants who exhibited higher preintervention levels of engagement in a cognitive control task in the first study, and among those who exhibited the most training-related change in working memory functioning in the second study. The change in rumination in both studies was not accompanied by a change in depressive symptoms.

**Training involving biases in cognitive control.** Studies employing CBM procedures that require participants to process emotional stimuli have targeted a variety of cognitive operations, though the majority of studies have focused on attention to and inhibition of negative content. Iacoviello et al. (2014) used a training procedure based on the n-back task. Participants in this study were 21 individuals diagnosed with major depressive disorder who were randomly assigned to a training group or a control group. The training consisted of 8 sessions of an individually tailored and progressively challenging emotional n-back task that included a sequence of emotional faces. Participants had to indicate whether the displayed emotion is the same as the emotion n faces back. In the control condition, participants completed the same task with neutral shapes. Although depression levels decreased in both conditions, the reduction in the emotional training group was significantly larger. There was also a nonsignificant reduction in rumination and memory for negative self-referential material in the emotional training condition and a comparable increase in the control training condition. The group difference on these measures was nonsignificant. Unfortunately, the small sample rendered this study underpowered to detect the desired effects.

An important feature of this study is the use of an active control condition that presented participants with a similar training but without the need to process emotional content. The fact that both groups demonstrated reduced depression following the intervention, suggests that perhaps both deficits and biases are involved in depression. Thus, an adequate sample size as well as a no-treatment condition could have provided a direct test of differential and common effects of deficits and biases in cognitive control on rumination. The use of the n-back task as a basis for training limits the ability to specify the
cognitive mechanisms involving emotional stimuli that may be causal in depression and rumination. Moreover, no treatment differential effects were noted on measures of cognitive control, further limiting the ability to draw conclusions regarding cognitive mechanisms of change.

In another study, training was based on the pairing of cognitive control and emotional processing (Cohen, Mor, & Henik, 2015). Participants performed a single session of training in which they were presented with an arrow version of the flanker task (Eriksen & Eriksen, 1974) and indicated the direction of a middle arrow while ignoring two distracting arrows on either side that were either congruent or incongruent with the direction of the target arrow. The incongruent flanker stimuli are known to recruit cognitive control. Following the flanker stimulus, participants were presented with a negative or a neutral picture. Participants were randomly allocated to either a training condition or a control condition in which they were presented with the same proportion of congruent and incongruent flanker trials as well as the same proportion of neutral and negative pictures. However, in the training condition on most trials, incongruent flanker stimuli preceded negative pictures, whereas in the control condition, congruent stimuli preceded the negative pictures on most of the trials. Thus, in the training condition, participants learned to pair recruitment of cognitive control with the presence of negative stimuli. There was a significant reduction in emotional interference caused by the negative pictures in the experimental group, but not in the control group, supporting the efficacy of the training. Furthermore, following the training, ruminative thinking when recalling a negative personal event was lower among participants in the training compared with the control condition. A treatment effect on sad mood was also observed, whereby trait rumination was associated with a training-related increase in sad mood in the control but not in the training condition.

An advantage of this paradigm is the use of a training procedure that integrates a “pure” cognitive process (i.e., inhibition) with emotional content (i.e., negative pictures). Using an inhibitory task (i.e., flanker) that did not possess emotional value demonstrates that a nonemotional inhibitory process attenuates emotional interference, and in turn rumination. Furthermore, because treatment groups differed in pairing of cognitive control with emotional content and not in the overall degree of control, this study suggests that a specific deficit in employing inhibition when processing emotional information may drive ruminative thinking.

Several studies have focused on the effects of training to attend away from emotional stimuli or inhibit such stimuli, on ruminative thinking. These studies used the well-studied training procedure based on the dot probe task (MacLeod, Mathews, & Tata, 1986). Arditte and Joormann (2013) explored the effects of this procedure in a single session of attention bias modification (ABM). Participants were presented simultaneously with two faces, followed by a letter probe that appeared in the spatial location of one of the faces. In the negative training condition, participants were trained to direct attention toward a negatively valenced emotional face, in the positive training condition they were trained to direct attention toward a positively valenced emotional face, and in the neutral condition participants were exposed to the same stimuli set, but attention was not directed in a particular form. Although neither the train-negative nor the train-positive condition produced a significant main effect on attention biases or emotional reactivity, there was a moderation effect of trait rumination: High trait rumination was associated with more positive bias following the positive training compared with control training.

Yang, Ding, Dai, Fang, and Zhang (2014) examined the effects of ABM on depressive symptoms and ruminative thinking in a sample of dysphoric participants, who did not meet criteria for a current major depressive disorder. Participants were randomly assigned to one of three conditions: ABM, placebo control, and assessment only. In the ABM condition, a probe replaced the neutral word on most of the trials, whereas in the placebo control condition it replaced the neutral and depressive words with equal frequency. Participants completed 8 training sessions, as well as a posttraining assessment and several follow-up assessments, up to 7 months following the training. A large training-related decrease in attention bias was observed in the ABM condition, but not in the two other conditions. There was also a significant decrease in depression as well as rumination scores in the ABM condition but not in the control conditions. These differences were maintained at 2, 4, and 8 weeks following the training. It is important that the change in attention bias mediated the change in rumination. Training-related change in rumination mediated the effect of training on depressive symptoms. The close match between the stimuli content and depression, the large number of training trials each session, and the large number of sessions presented in a short time (2 weeks) may all account for these training effects.

Comparing the two studies that used a similar ABM procedure, it is tempting to conclude that attention biases operate differently in healthy versus depressed individuals and in ruminators versus nonruminators. It is possible that it is more difficult to train healthy participants to disengage from negative stimuli or to engage with positive stimuli, because the stimuli valence is not a salient enough construct for them. However, the studies differ on a number of important features including the type of attention required (attend versus disengage) number and length of training sessions and stimulus modality and...
valence (words versus faces, negative versus positive). Therefore, any inferences based on the different pattern of findings should be made with caution. These studies also point to the need to examine multiple outcome measures that are both cognitive and emotional, as effects on these outcomes are not necessarily synchronous.

In two other studies, dysphoric and depressed participants were trained using the spatial cuing paradigm, a task that is designed to assess attention disengagement. Participants were trained to direct their attention away from negative words and toward positive words, or were allocated to a control condition in which they were not led to direct their attention in a particular pattern (Baert, De Raedt, Schacht, & Koster, 2010). Following 10 training sessions, participants’ attention bias did not change. However, among moderately to severely dysphoric participants only, there was an overall reduction in rumination, regardless of the training condition. One can only speculate about reasons for these null effects. The spatial cuing task has not been examined before in relation to rumination, and as far as we know, there is only one other study that used it in training (Bar-Haim, Morag, & Glickman, 2011). Further research using this paradigm may be needed to examine attention disengagement in rumination.

Two studies directly tested the assertion that inhibition biases in processing negatively valenced content have a causal role in rumination. In one study (Daches & Mor, 2014), high brooders were randomly assigned to four sessions of training to inhibit or to attend to negative stimuli or to a sham training condition, using a novel procedure that was based on the negative affective priming task (NAP). In this training procedure, on each trial participants were presented with two words: a target and a distractor. They were asked to indicate the valence of the target and ignore the distractor. In the attend-to-negative condition, the target was negative on most trials, whereas in the inhibit-negative condition, the distractor was negative on most trials. In the sham training condition, no inhibition was required. Compared with those in the sham training, those in the attend-to-negative condition exhibited a significant decrease in inhibition of irrelevant negative content and those in the inhibit-negative condition showed a trend toward improved inhibition of irrelevant negative content and a reduction in brooding. These findings were not replicated in a second study that used a similar procedure (Daches, Mor, & Hertel, 2014), in a single session of training. Trait rumination moderated training effects on inhibition. Nonruminators in the inhibit-negative condition maintained their level of inhibition of negative stimuli, but those in the attend-to-negative condition showed a nonsignificant trend for decreased inhibition. Participants also showed a transfer-congruent tendency in interpretation bias, with reduced bias by those trained to inhibit negative stimuli, compared with those trained to attend to negative stimuli. In contrast, ruminators in the inhibit-negative condition showed a training-incongruent decrease in inhibition of negative stimuli, but no change in inhibition when trained to attend to negative stimuli. No effects of the training on interpretation bias were observed among high ruminators. The training did not affect subsequent state rumination.

Taken as a whole, the strength of work presented in this section is its attempt to delineate specific cognitive mechanisms responsible for ruminative thinking and test them with experimental precision. Thus, most of the studies examined whether difficulty ignoring or disengaging from negative content plays a role in rumination. The constructs of inhibition or disengagement are multifaceted (MacLeod, Dodd, Sheard, Wilson, & Bibi, 2003; Nigg, 2000), as reflected in the diverse paradigms reviewed in this section. Although this diversity has the potential to illuminate different aspects of the constructs of interest, it makes comparisons between studies challenging. Even if we disregard the differences between the paradigms, the emerging picture is somewhat disappointing, with a majority of studies that fail to report a direct effect of the training on ruminative thinking.

**Training involving abstract verbal processing.** Several studies have examined the effect of concrete thinking on rumination. As a proof of a principle, Watkins and Moberly (2009) trained dysphoric participants in a week-long concreteness training (CNT) plus relaxation training (RT) or RT alone. Participants in the CNT+RT condition were provided with a rationale for the CNT and performed a training that included mental processing of standardized scenarios and personal events by using sensory focus, mental imagery, recall of specific autobiographical memories, and explicit instructions to focus attention on experience, on distinctive details and on the way events unfold. Compared with participants in the RT condition, those in the CNT+RT condition had significantly lower levels of depressive symptoms. In addition, although rumination (and particularly brooding) decreased in both conditions, the reduction was larger in the CNT+RT condition.

In another study that explored the specific active ingredients of CNT, dysphoric participants were assigned to a week-long CNT, bogus concreteness training (BGT) condition, or to a wait-list control (WL) condition (Watkins et al., 2009). In the BGT condition, participants performed an interpretation training that encouraged concrete disambiguation, but was not designed to directly foster concrete processing as the CNT. The CNT was effective in reducing depressive symptoms compared with WL, as measured by self-report and interviewer rated measures, but was more effective than BGT only on
the interviewer rated measure. Participants in the CNT condition described their personal problems in more concrete terms and expressed less self-criticism than did participants in the WL and BGT conditions. More important, those in the CNT condition showed a significant reduction in ruminative thinking, whereas those in the WL condition did not. However, similar improvements in ruminative thinking were also observed in the BGT condition.

These studies paved the way for a large-scale randomized controlled trial that explored the effect of CNT when provided for a duration of 6 weeks (Watkins et al., 2012). This study also examined the durability of change by assessing the effects of training in 3- and 6-month follow-ups. Moreover, whereas the previous two studies examined the effects of CNT in dysphoric participants, in this study, participants were diagnosed with depression and a change in diagnostic status was assessed as a treatment outcome. Participants were randomly assigned to one of three conditions: TAU, TAU with CNT, or TAU with RT. Participants in the TAU and CNT condition exhibited a larger reduction in rumination as well as a reduction in negative overgeneralization and an increase in concrete thinking compared with participants in the control conditions. However, RT and CNT had the same effect on symptoms of depression, suggesting that although both are effective in reducing symptoms, the mechanism of change may be different for these interventions.

The use of different control conditions in these studies (RT vs. BGT) has the potential to elucidate specific mechanisms associated with ruminative thinking. However, in these studies treatment-related improvements in ruminative thinking were observed in the CNT condition as well as in the control conditions. These findings, although they do not obliterate the role of concrete thinking as a causal mechanism in rumination, suggest that other factors that are active when people engage in relaxation (as in Watkins & Moberly, 2009) or when they disambiguate emotional material (as in Watkins et al., 2009) may also reduce rumination. Because rumination was examined using a self-report questionnaire, it is possible that the change in rumination is due, in part, to the convincing rationale of treatment and the positive expectancy for improvement present in the CNT as well as in the control conditions. The use of different measures of ruminative thinking in these studies makes it difficult to compare their findings in an effort to understand treatment effects on rumination. Across studies, the specific mechanisms of action in CNT remain unclear. The training included multiple components such as informing participants with treatment rationale and exposing participants to both negative and positive hypothetical and autobiographical scenarios, in addition to the purported process of concrete thinking. Moreover, the association between a decrease in rumination and the increase in concreteness was not examined, further limiting conclusions regarding mechanisms of action.

Mogoaşă, Brăilean, and David (2013) introduced a few modifications to the design of CNT. The CNT training was designed as a stand-alone treatment, the training scenarios included only standardized materials rather than autobiographical content and included a smaller number of scenarios than the treatment designed by Watkins, and the training was provided exclusively online. A small sample of undergraduate students, selected for high levels of dysphoria, were assigned to either a week of CNT or to a waitlist control condition. Compared with those in the control condition, participants in the CNT condition showed an increase in concrete thinking, but no change was observed in ruminative thinking. Because several features of CNT were modified simultaneously, it is difficult to know which factors contributed to the null findings.

There is also evidence for the role of reduced concreteness in depressive rumination elicited in response to a traumatic event (Ehring, Frank, & Ehlers, 2008). Schaich, Watkins, and Ehring (2013) examined whether concreteness training can influence the relationship between rumination and response to an analogue traumatic stressor. Healthy participants were trained in either an abstract or a concrete mode of processing, and then watched a stressful film. Trait rumination was positively related to the number of intrusive memories about the film, their vividness, and the distress associated with them, in the abstract thinking but not the concrete thinking training condition. These findings extend previous work by showing that the role of reduced concreteness is not specific to depressive rumination.

In addition to examining the causal role of reduced concreteness in rumination, research has sought out the active ingredients of the training. The work by Watkins and colleagues (Watkins et al., 2009; Watkins et al., 2012; Watkins & Moberly, 2009) demonstrated the effects of CNT on rumination in individuals with clinical or subclinical depression. Studies that examined the effects of the training on rumination among nondepressed individuals (Mogoaşă et al., 2013; Schaich et al., 2013) failed to find such an effect. However, these studies employed a number of changes in the CNT design, making inferences regarding sample characteristics impossible. Thus, it remains unclear whether concrete thinking is helpful in reducing rumination among nondepressed as well as depressed people, and whether abstract thinking would be harmful regardless of depression. Furthermore, although relatively consistent findings point to reduced ruminative thinking in response to CNT, this reduction does not appear unique to the training, and there is no direct evidence pointing to the role of concrete thinking as the causal mechanism in change in rumination.
**Training involving other cognitive processes.** One difficulty in determining the active ingredients of CNT is that trained participants are encouraged to process information in a concrete and nonevaluative form using mental imagery, and the training does not differentiate between these components. To assess the unique role verbal processing versus imagery plays in rumination, researchers used an interpretation bias training (CBM-I) that includes a focus on mental imagery (e.g., Holmes, Lang, & Shah, 2009). Although several studies have examined the effect of CBM-I with an imagery component on depression or on intrusive and repetitive negative thinking (e.g., Blackwell & Holmes, 2010; Lang, Blackwell, Harmer, Davison, & Holmes, 2012; Williams, Blackwell, Holmes, & Andrews, 2013), only one study directly assessed the effect of such training on rumination (Torkan et al., 2014). Treatment-seeking depressed patients were allocated to 1 week of daily imagery CBM-I, to a nonimagery control training in which participants were exposed to the same positive interpretation scenarios as in the training condition but without imagery, or to a no-treatment control condition. Participants in the imagery group reported more use of imagery than those in the other two groups. In addition, among participants in the imagery condition there was a significant decrease in rumination from pre- to posttreatment. Such a change in rumination was not evident in the two other conditions. Participants in the imagery condition also exhibited a significantly larger reduction in depression compared with participants in the control groups. The two treatment groups were also assessed 2 weeks following the treatment. Although the group difference in depression remained significant, the difference in rumination was no longer significant. Because the sample size at follow-up was very small (only eight participants per group), limited conclusions can be drawn from these null findings. The evidence for a change in rumination highlights the importance of instructions, suggesting that in the absence of imagery instructions, depressed individuals might use their habitual, abstract-verbal processing style and fail to benefit from CBM-I.

Another study assessed the effect of CBM-I on state rumination (Hertel, Mor, Ferrari, Hunt, & Agrawal, 2014). Participants low in trait rumination were assigned to training conditions in which they were presented with ambiguous scenarios, imagined themselves in the situations, and completed word fragments that disambiguated the situations in either a ruminative or a benign manner. The training was successful in attaining the desired interpretive bias, as indicated by the training-congruent interpretations participants provided for novel situations. Furthermore, the ruminative training also affected memory biases, resulting in more negatively valenced errors in recalling the ambiguous novel situations. Finally, state rumination was higher in the ruminative condition compared with the benign training condition. Together, these findings provide support for Hertel’s (2004) perspective on the role of cognition in ruminative habits.

**Summary and Conclusions**

In this review, we have explored the status of deficits and biases in cognitive control and abstract and nonconcrete thinking, as core factors in rumination. Theoretical accounts that link control deficits and rumination are unclear about whether impaired control contributes to a vulnerability to ruminative thinking, or whether rumination occupies cognitive resources and impairs the ability to exert effort on alternative tasks. Cross-sectional and prospective work provided little further clarity on this issue. Divergent findings were reported across the studies that used CBM to train high ruminators based on the dual \( n \)-back task or patient samples (depressed or anxious) based on the PASAT. Whereas training using the PASAT seems promising, training with the dual \( n \)-back task has not been effective in improving cognitive control or rumination. Although there is initial evidence that dual \( n \)-back training can affect cognitive control in dysphoric individuals (Owen, Koster, & Derakshan, 2013), the efficacy and transferability this training has been the subject of intense debate (e.g., Morrison & Chein, 2011; Shipstead, Redick, & Engle, 2012). The PASAT and the \( n \)-back are assumed to measure similar working memory functions (e.g., Parmenter, Shucard, Benedict, & Shucard, 2006), and it is unclear what leads to differences in the effects of training based on these tasks. One possibility is that deficits in cognitive control play a role in ruminative thinking only among depressed individuals. Indeed, training cognitive control has beneficial effects for depressed individuals (Siegle et al., 2007; Siegle et al., 2014; Vanderhasselt et al., 2015). This is consistent with experimental work that found that among depressed people, inducing rumination impairs cognitive control (e.g., Watkins & Brown, 2002). Similar effects were not reported among nondepressed people. Depression, and particularly severe depression, is associated with global cognitive impairment. It is, therefore, possible that CBM that targets cognitive deficits would be effective only among those who exhibit such impairment. Clearly, a systematic examination of the link between deficits and rumination in depressed and nondepressed individuals is warranted.

In contrast, cognitive models have been clearer regarding the role of biases in cognitive control, mainly suggesting that impaired inhibition or disengagement from negative content contributes to and maintains rumination. In line with theory, cross-sectional as well as prospective research has pointed to such biases as correlates and
predictors of rumination. Based on this work, a number of carefully constructed studies have sought to demonstrate that training attention and inhibition biases would affect rumination. These studies vary on a number of dimensions: the clinical status of the participants, the paradigm on which the training is based, the stimuli used in the training, and the number of training sessions. Consequently, some studies failed to find effects, others found that the training affected rumination or both rumination and depression, and others found that trait rumination moderated the effects of the training on cognitive bias or on depressed affect. It appears that to obtain more consistent findings that may later translate into meaningful clinical interventions, more reliable means of targeting the putative cognitive biases need to be achieved.

The most consistent picture emerges regarding abstract and verbal-analytic thinking in rumination. Cross-sectional research demonstrated that rumination is associated with verbal and abstract thinking. Experimental manipulation of this mode of thinking has shown that using this mode of thinking worsens the effects of rumination on mood and cognition. CBM paradigms were then used to demonstrate the causal role of this mode of thinking in rumination and depression. A number of studies, conducted in subclinical or clinical samples, indeed provided causal evidence in support of the theory. However, given the clinical focus of the work, the examined CBM paradigm is a complete treatment package that includes an explicit rationale as well as procedures that tap into a number of processing dimensions (i.e., verbal, abstract, nonevaluative). An initial dismantling attempt that isolated the component of verbal versus imagery processing (Torkan et al., 2014) yielded promising effects and therefore points to a fruitful direction for future research.

**Future Directions**

A natural step, given the novelty of the work reviewed here, is to delineate future directions for research utilizing the CBM paradigm in an attempt to reveal causal factors in rumination. We first outline future directions that pertain to theory development and integration, referring back to the theories we described earlier. We then recommend ways to obtain stronger bias modification procedures.

**Theory development and integration**

In this review, we outlined central theories that present cognitive impairments as causal contributors to rumination. A common abnormality, on which theories of rumination focus, is cognitive control. Specifically, a limited ability to use cognitive control to disengage from irrelevant content (Linville, 1996), broaden one’s array of thoughts (Whitmer & Gotlib, 2013), or inhibit a habitual style of thinking (e.g., abstract thinking) is thought to play a key role in rumination. Although, as we reviewed here, many findings from cross-sectional, prospective, and CBM studies provide support for the causal role of cognitive control in rumination, important theoretical questions remain unanswered.

First, the distinction between specific biases and global impairments is the most crucial distinction that awaits careful examination. Whereas this distinction is emphasized in theoretical models of rumination, it has not been directly examined empirically. Thus, it remains unclear whether the cognitive impairment in rumination necessarily involves processing of valenced content. Clarifying this issue is important beyond the field of rumination and has implications for understanding general links between cognition and emotion (e.g., Pessoa, 2013). Future CBM research should contrast global control functioning and control functioning that is specific to negative or self-relevant content in their effect on ruminative thinking. Transfer of training may be informative, and research should examine whether training biases transfers to deficits and vice versa. Similarly, an individual differences perspective can shed light on this issue. Based on this detailed review, we predict that global impairment would play a key role in rumination in a clinically depressed sample, but that in an at-risk population only biases in the processing of emotional material contribute to rumination.

Second, future research should be designed in ways that enable to distinguish between the mechanisms discussed in the various theoretical models. Cognitive control, a common factor in the models we presented, has been examined extensively. However, factors and processes that are unique to particular models, such as conflict signaling (Koster et al., 2011) or the role of external control (Hertel, 2004), have received less empirical support. Some models describe a discrete cognitive process such as disengagement (Joormann, 2006), but others describe broader constructs such as abstract thinking or mental habits (Watkins, 2008; Watkins & Nolen-Hoeksema, 2014). Although the former may be more easily translated to a cognitive task, the translation of the latter is more difficult. On the other hand, changes in a broader cognitive construct may more easily affect ruminative thinking than those that involve a specific cognitive change. The CBM paradigm makes it possible to uncover discrete mechanisms that underlie rumination because of the ability to modify elements of the intervention to determine the effective ingredients of the procedure. The aim of research, to reduce ruminative thinking or to search for specific cognitive mechanisms that are impaired in rumination, should direct research efforts.
Third, CBM research can be used to integrate diverse theoretical perspectives by combining components of the theories. For example, Watkins and Nolen-Hoeksema (2014) suggest that deficient cognitive control may affect the formation of habitual rumination and Linville's (1996) theorizing emphasized weakened inhibition of goal-irrelevant thoughts as a factor in rumination. These perspectives may be integrated by elucidating differences between state and trait rumination and exploring the process by which state rumination over goal-irrelevant content becomes habitual. Investigating the effects of training dosage as well as contextual determinants may be useful for this purpose. Another possibility involves the integration of theories on cognitive control and abstract thinking in rumination. Specifically, future work can examine how cognitive control can promote the transition from abstract thoughts to a concrete thinking style. Thus, assessing change in concrete thinking following cognitive control training is advised. Finally, because it is possible that more than one mechanism is impaired in rumination, CBM designs should examine the effect of manipulating several cognitive mechanisms on ruminative thoughts.

**Optimizing training**

Following suggestions made for CBM in other areas of psychopathology (e.g., MacLeod & Clarke, 2015; Wiers, Gladwin, Hofmann, Salemink, & Ridderinkhof, 2013), we offer avenues for refining training procedures with the aim of strengthening the effect of training on biases and on ruminative outcomes. In contrast to anxiety-related CBM, where a benchmark training procedure exists, there is no dominant training procedure in the examination of rumination. Thus, at least with respect to the study of inhibition biases in rumination, where much of the research efforts have been made, it could be useful for researchers to follow a common procedure. Doing so will allow careful development of an effective training as well as the examination of specific design parameters. Regardless of the specific training paradigm, several steps could be taken to enhance training. First, it appears that studies that provided participants with a larger dose of training were more effective in creating the desired change. Thus, future research should enhance the training by adding trials and training sessions and by altering the training schedule to foster learning (Hertel & Mathews, 2011). As indicated earlier, increasing training dose via multisession training is also important for examining the theoretical distinction between state versus habitual rumination. Second, although current findings do not favor the use of verbal or pictorial stimuli (but see Goeleven et al., 2006), given the verbal nature of rumination, stronger training effects may be obtained when using verbal stimuli, particularly when tailored to fit depressive content (e.g., Yang et al., 2014). Again, in addition to its practical value, a direct comparison of training stimuli has theoretical implications as it may relate to cognitive processes that are involved in rumination, such as impaired imagery and verbal and analytical processing. Third, it is important that future research will attempt to increase the sensitivity of measurement of bias, rumination, and associated cognitive processes and emotional outcomes. For example, changes in rumination across multiple sessions is typically measured using a trait measure that may not be sensitive to changes that occur in a span of a few weeks of training, and a standard for assessing state rumination is missing. Measurement of state rumination can be improved by creating opportunities for ruminative thinking to emerge in the lab. This can be achieved via the recall of a negative event or an induction of failure (e.g., Cohen et al., 2015).

**Closing Comments**

CBM procedures have two central aims: investigate the causal role of cognitive biases in psychopathology and supply therapeutic benefits for individuals suffering from emotional disorders. Although it is appealing to suggest that CBM for rumination has an emotional impact, the present detailed review highlights the value of CBM as a tool for learning about causality and that the clinical utility of the method is bounded by our understanding of the causal mechanisms. Once causal mechanisms have been clarified, questions concerning individual differences, transfer of training, and the long-term effects of the training can be pursued. The application of CBM to questions concerning ruminative thinking is a relatively recent endeavor, and we believe that it has great potential as a tool for understanding rumination and treating it.

**Author Contributions**

N. Mor developed the concept of the article. Sections on the main theories were drafted by N. Mor, and the rest of the article was jointly drafted by N. Mor and S. Daches. All authors approved the final version of the article for submission.

**Acknowledgments**

The authors thank Noa Avirbach, Noga Cohen, Tal Ganor, and Baruch Perlman for their insightful suggestions for improvements in this article.

**Declaration of Conflicting Interests**

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

**Funding**

This work was supported by a grant from the Israel Science Foundation (ISF 1519/13) awarded to Nilly Mor.


Dachexis, S., Mor, N., & Hertel, P. (2014). Rumination: Cognitive consequences of training to inhibit the negative. Manuscript submitted for publication.


Cognitive Training in Ruminative Thinking

J. A. Bargh (Eds.), *Unintended thought* (pp. 306–326). New York, NY: Guilford.


Downloaded from rpj.sagepub.com at The Hebrew University Library Authority on June 3, 2015


