Self-regulation through rumination: Consequences and mechanisms

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When confronted with negative events, such as an argument with our spouse or criticism by the boss, oftentimes we engage in mental activity reflecting on these events. Typically, we aim to understand why these events occurred, how we contributed to such events, and how to avoid them in the future. Despite the adaptive consequences of reflecting on one's feelings, research indicates that persistent thinking about negative feelings may have negative consequences. In the context of depression, for instance, such persistent negative thinking, termed "rumination", has been found to be one of the most important risk factors for the development of depressive symptoms (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Moreover, even in non-depressed, healthy individuals, rumination can be observed and also leads to negative cognitive as well as affective consequences (Watkins, 2008).

In this chapter we will discuss rumination as an important self-regulatory strategy. We start by introducing some of the basic conceptualizations of rumination where different theories have highlighted stable as well as momentary aspects of rumination. Then, we discuss the research on the cognitive and biobehavioral consequences of rumination in more detail. In order to understand the persistent nature of rumination we will then turn to the psychological mechanisms underlying rumination. Finally, we discuss some of the future directions in experimental research on rumination including recent innovative approaches to reduce excessive rumination.

1. Definition of rumination

There are many different conceptualizations of rumination (for a review, see Smith & Alloy, 2009). Here we will discuss the main approaches to this concept. One of the most dominant theories of rumination is the Response Styles Theory (RST), where rumination is conceived as "behaviors and thoughts that focus one's attention on one's depressive symptoms

and on the implications of these symptoms" (Nolen-Hoeksema, 1991, p. 569). Within this

definition, several features are important. First, it states that rumination is focused on (depressed)

mood state instead of certain *cognitive themes* (Joormann & Gotlib, 2010; Nolen-Hoeksema et al.,

2008). Then it mentions the content of rumination to indicate that people try to use it purposefully

to understand and control their negative affect (Nolen-Hoeksema, 2000). Finally, this

conceptualization proposes a very close link between rumination and depressive symptoms

(Nolen-Hoeksema et al., 2008). It is noteworthy that, despite some supportive evidence for each

of these features, there still is extensive discussion about these features.

In the RST, rumination can be an intrapersonal process but also a social process where

individuals engage in ruminative processing together (co-rumination (Nolen-Hoeksema, 1991).

Unlike the RST, in which communicating feelings to others can be considered as a component of

rumination, other researchers contend that the basic component of rumination is cognitive

ideation, because it is usually thought that rumination has negative consequences (Giorglo et al.,

2010) while repetitive emotional expressions can sometimes be useful (Derlega et al., 1993).

Additionally, several models have defined rumination as being part of a pattern of "persistent

negative thought" where these negative thoughts do not necessarily merely involve thinking

about negative affect but include also other type of thinking such as anxious anticipation

(Brosschot, 2010).

According to RST (Nolen-Hoeksema, 1991) rumination is considered a trait-like response

style to distress as research observed stable tendencies in responding with rumination to distress.

This conceptualization led to the development of measures of trait rumination. The most

commonly used measure is the Ruminative Response Scale (RRS; Nolen-Hoeksema & Morrow,

1991), a 22-item scale that assesses ruminative responding to sad mood. The RRS has high

internal consistency and acceptable concurrent validity (Nolen-Hoeksema & Morrow, 1991).

Factor analysis of this questionnaire revealed two subtypes of rumination; reflective pondering and brooding (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). Reflective pondering is a more adaptive form of rumination that indicates the amount of thinking about potential solutions to reduce negative affect, whereas brooding is maladaptive and indicates passively focusing on symptoms of distress and on the meaning of those symptoms. This distinction is nowadays frequently applied in the literature although in clinically depressed individuals the distinction between these two factors is blurred (Whitmer & Gotlib, 2011).

In contrast to theories that consider rumination as a stable trait, some views proposed that rumination is stress-reactive and variable across time (for reviews, see Martin & Tesser, 1996; Smith & Alloy, 2009). Indeed, research indicates that meaningful differences can be found between trait and state rumination using measures that allow measuring fluctuations in rumination. For example, Moberly and Watkins (2008), found that momentary rumination (assessed via two items that inquire about the extent to which participants are currently focused on their feelings and problems), predicted subsequent negative affect independently from the prediction by trait rumination. Other studies found interactive effects of state and trait rumination. For instance, state rumination was related to impaired cardiovascular recovery from emotional stress, but only among those who are low in trait rumination (e.g., Key, Campbell, Bacon, & Gerin, 2008). Moreover, some studies have demonstrated poor stability across time of trait rumination (e.g., Kasch, Klein, & Lara, 2001), and recent diary studies have shown significant variation in rumination across days and even hours of the day (e.g., Genet & Siemer, 2012; Takano & Tanno, 2011). Taken together, these findings support the notion of rumination as a variable process where there are separate influences of trait versus state rumination.

Other contemporary models emphasize the notion that rumination is a transdiagnostic risk factor for a variety of disorders, instead of being depression-specific (e.g., Watkins, 2008). This

has led to the development of several measures, such as the Repetitive Thinking Questionnaire (Mahoney, McEvoy, & Moulds, 2012) and the Perseverative Thinking Questionnaire (Ehring et al., 2011), that examine repetitive thinking in a wide range of situations instead of focusing specifically on negative affect. In different disorders, rumination may take a somewhat different form. For instance, in the cognitive model of social phobia, Clark and Wells (1995) suggest that the content of rumination is concentrated on social interaction, instead of negative affect (Kashdan & Roberts, 2007). In such theories, the notion of rumination is usually used interchangeably with that of post-event processing, where socially anxious individuals dwell on previous social encounters and failures (Mellings & Alden, 2000). Research has implicated repetitive negative thinking not merely in affective disorders but has indicated that rumination plays an important role in health and somatic problems such as hypertension (e.g., Brosschot, Verkuil, & Thayer, 2010; Gerin et al., 2012).

2. Physiological Aspects of Rumination

In recent years there has been marked progress in understanding the underlying neurobiological and physiological mechanisms associated with rumination.

2.1 Neural mechanisms of rumination

Most research on the neural mechanisms of rumination has been performed on both healthy and depressed individuals by having them undergo experimental tasks with emotional or self-relevant stimuli. It has been observed that depressed persons show enhanced amygdala activity in response to negative stimuli and this is correlated with self-reported measures of rumination (Siegle, Carter, & Thase, 2006; Siegle, Steinhauer, Thase, Stenger, & Carter, 2002). This finding has been confirmed and refined by another fRMI study showing that the amygdala response while up-regulating negative mood was correlated with trait rumination also in healthy

controls, thus suggesting that in depressed as well as non-depressed individuals similar neural mechanism are involved in repetitive thinking (Ray et al., 2005).

However, hyperactive amygdala reactivity is by no means the only brain response involved in rumination. Cooney, Joorman, Eugène, Dennis, and Gotlib (2010) have demonstrated that a much more complex network (perhaps multiple networks) is associated with the tendency to ruminate. In that study, depressed individuals who were engaged in rumination showed increased activation in important areas, such as the amydgala, the subgenual cortex, the rostral anterior cingulate/medioprefrontal cortex, the dorsolateral prefrontal cortex, the posterior cingulate cortex, and the parahippocampus. This result confirms that rumination recruits a wide range of brain areas that are typically involved in emotional processing, self-focus, self-referential thinking, attentional control, and autobiographical memory.

More recently, depressive brooding has become the focus of increasing research. This maladaptive form of rumination has been associated with a variety of negative consequences, such as both concurrent and future depressive symptoms over 1 year (Treynor et al., 2003; Siegle, Moore, & Thase, 2004), therefore the understanding of its specific neural substrate is an important area of research. For instance, Berman, Nee, and colleagues (2011) reported that depressed individuals with higher brooding scores are characterized by increased spatial variability in the activation of the left inferior frontal gyrus. Despite this intriguing finding, such research on brooding (and rumination) has been carried out in mixed samples consisting of both depressed and non-depressed individuals, so that the related findings could have been confounded by features specific for clinical depression, such as impaired attentional control. Consequently, Vanderhasselt, Kühn, and De Raedt (2011) tried to bridge this gap by selecting healthy brooders with no history of previous depressive episodes. This study demonstrated that those with higher levels of depressive brooding reported also increased activity in the right dorsolateral prefrontal cortex when

successfully disengaging from negative information. In sum, this study shows that depressive rumination impacts specifically on emotional task performance and is associated with neural substrates that can be distinguished from depression.

Parallel to investing the neural basis of rumination during task, researchers have increasingly focused their attention on the activity of the brain when not in a task context (i.e., resting state) and an associated neural network that has raised much interest (Broyd et al., 2009). This neural network, termed Default Mode Network (DMN), has been documented to be highly active during rest (Raichle et al., 2001) as well as to be associated with many higher order functions, such as self-referential thinking (Northoff et al., 2006). Because of this, it has been proposed that the DMN could shed new light on depression and rumination (Marchetti, Koster, Sonuga-Barke, & De Raedt, 2012). Indeed, specific DMN brain areas have consistently been associated with rumination. Berman, Peltier, and colleagues (2011), for instance, reported that during rest, temporal synchronization (i.e. functional connectivity) between the subgenual cortex and the posterior cingulate correlated with higher levels of trait rumination. Interestingly, this correlation was driven only by brooding scores, but not by reflective pondering.

2.2 Cortisol levels and rumination

Stress is a psychobiological reaction demanding cognitive, emotional, and physiological adjustments to threats or challenges to one's well-being. When an individual faces a stressor, such as receiving harsh critic from the boss, a complex sequence of adjustments takes place to prepare the body for responding. Once the stressor has disappeared it is important that the body returns to baseline (homeostasis). In fact, physiological activation and subsequent return to homeostasis is regulated by the hypothalamic-pituitary-adrenal axis (HPA) by releasing cortisol, a stress-related steroid hormone.

As rumination is continuously reactivating mental representations related to negative affect and stress, rumination could elicit and maintain inappropriately high levels of cortisol. Despite this straightforward hypothesis, the extant literature on the relationship between rumination and cortisol proves to be more complicated and we will discuss some of the key findings here (Zoccola & Dickerson, 2012). State rumination after stress manipulation in the laboratory has been consistently associated with increased levels of cortisol (Byrd-Craven, Geary, Rose, & Ponzi, 2008; Zoccola, Dickerson, & Zaldivar, 2008), whereas the link between trait rumination and stress-related hormone reaction is unclear. In fact, it has been reported that the association between trait rumination and cortisol can be positive (Roger & Najarian, 1998), negative (Zoccola et al., 2008), or absent (van Santen et al., 2011). It is also noteworthy that studies examining rumination in the context of depression oftentimes failed to find a positive relation between depression-related rumination and cortisol response. Instead they showed no or a negative association (Kuehner, Holzhauer, & Huffziger, 2007; Young & Nolen-Hoeksema, 2001). On the contrary, a robust positive relationship has been documented between cortisol levels and stress-related (state) rumination (Byrd-Craven et al., 2008; Roger & Najarian, 1998; Zoccola et al., 2008).

Taken together, these findings show that differential effects of rumination on cortisol levels can be detected, if the state vs. trait specificity or the topic of the repetitive thinking is taken into account. In studies showing evidence for a positive relation, rumination mainly has an effect on the duration of the stress response rather than elevating initial reactivity (Byrd-Craven et al., 2008). Although it is tempting to claim a causal influence of perseverative thinking on the HPA axis, alternative models that entail mutual influences have been proposed as well (Zoccola & Dickerson, 2012) and empirical data for strong conclusions is lacking.

3. Affective and Cognitive Consequences of Rumination

There is an extensive literature on the consequences of rumination. Where one could be inclined to think that negative affect elicits a reflective response that could enhance insight into the nature of one's negative feelings and problems, most research indicates that rumination is mainly associated with negative consequences. Here, especially depressive brooding – the evaluative and passive style of focusing on negative feelings and problems – has been associated with negative consequences. We will briefly describe these consequences below.

A major negative consequence of rumination is enhanced negative affect. Studies where rumination is induced in participants show this as an important short term consequence (Lyubomirsky & Nolen-Hoeksema, 1995). Experimental studies testing the short-term effects of rumination have typically used the rumination induction procedure developed by Nolen-Hoeksema and Morrow (1993). This procedure increases ruminative thinking and has been shown to heighten negative affect and prolong negative mood in individuals with heightened depression-risk (Morrow & Nolen-Hoeksema, 1990; Nolen-Hoeksema & Morrow, 1993) and in clinically depressed participants (Donaldson & Lam, 2004; Lavender & Watkins, 2004; Watkins & Moulds, 2005; Watkins & Teasdale, 2001). It is specifically the negative, evaluative, and judgmental type of self-focused attention that is considered maladaptive (Rude, Maestas, & Neff, 2007). Importantly, negative affect is also considered an important trigger of rumination (see Smith & Alloy, 2009 for a review). Hence, there seems to be a mutually reinforcing link between rumination and negative affect.

At the long term, affective consequences of rumination are depressive symptoms such as sustained negative affect. Numerous studies have demonstrated that rumination is associated concurrently with depressive symptoms (Treynor et al., 2003) and, more importantly, prospectively with the onset (Nolen-Hoeksema, 2000), severity (Just & Alloy, 1997;

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Nolen-Hoeksema & Morrow, 1991) and duration (Nolen-Hoeksema, 2000) of depression. Furthermore, recovery from depression has been linked to rumination where higher levels of rumination predict slower and incomplete recovery (Kuehner & Weber, 1999; Schmaling, Dimidjian, Katon, & Sullivan, 2002). Thus rumination is considered one of the key cognitive risk factors for depression.

In addition to the affective consequences, rumination also has several unwanted cognitive consequences. There are a number of studies showing that inducing rumination hampers problem solving and task performance (Watkins & Brown, 2002). This led Watkins and Brown (2002) to propose that state rumination leads to cognitive impairment by overloading limited executive resources. This effect seems especially pronounced in individuals with elevated depression scores, since Philippot and Brutoux (2008) found that a rumination induction made it more difficult for dysphoric (but not for nondysphoric) participants to ignore distracting words in a Stroop task. In this context it is also interesting that individuals high in trait rumination perform less well on the Wisconsin Card Sorting Task, which suggests lower levels of cognitive flexibility (Davis & Nolen-Hoeksema, 2000).

This brief overview of the consequences of rumination indicates that rumination is a problematic self-regulatory strategy. This begs the question which processes contribute to excessive rumination.

3. Why Ruminate?

In addressing the question of factors contributing to rumination it is useful to distinguish between voluntary rumination and involuntary rumination. That is, within and across individuals parts of rumination are clearly linked to intentionally trying to understand negative affect and events occurring, whereas at other moments rumination occurs unintentionally (according to

some even unconsciously; Brosschot, 2010). Different theories of rumination have been proposed to account for these different aspects of rumination.

In the broad context of self-regulation, the Goal Progress Theory (Martin, Tesser, & Mcintosh, 1993) proposes that it is the failure to progress towards higher order goals that initiates rumination. From this perspective, rumination is strictly linked to both motivation and the self. In fact, an assumption of the theory is that the more central to one's self-concept the unattained goal is (for instance, finding a romantic partner), the greater and more pressing the ruminative response is in turn. In line with this, relief from rumination is possible only when one attains the goal, gets clear feedback about sufficient progress to it, or disengages from it (Martin & Tesser, 2006).

Alternatively, in the self-regulatory executive function (S-REF) theory, rumination is generated when people find that their present state is different from their intended one (Wells & Mathews, 1996). The maintenance of rumination is explained by overly positive metacognitive beliefs about rumination being a helpful strategy to understand and reduce negative affect (Papageorgiou & Wells, 2001).

Both theories described above consider rumination as an intentional and voluntary process. Yet, individuals characterized by high levels of rumination find it extremely difficult to stop when rumination is interfering with their functioning. Several information processing theories have been put forward to explain this observation.

A key proposal in information-processing theories is that individuals with high levels of rumination have difficulties disengaging attention from negative information or expelling negative information from working memory (Gotlib & Joormann, 2010; Koster et al., 2011). These models propose that information processing is biased to favor negative material in high

ruminators at the expense of other information which hinders more adaptive emotion regulation strategies such as cognitive reappraisal. There is substantial support for these models, where several studies found attentional bias as well as biases in the updating of working memory in high ruminators (Bernblum & Mor, 2010; Joormann & Gotlib, 2008; Koster et al., 2013). However, there have been a substantial number of studies where cognitive impairments were observed in high ruminators in the absence of emotional material (e.g., De Lissnyder et al., 2011). The latter finding suggests that cognitive impairments are more broad and not necessarily emotion-specific which demands a theoretical explanation.

Recently, Whitmer and Gotlib (2012) proposed a new model called the attentional scope model of rumination which provides an integrated way to explain the consequences of rumination. The basic assumption is that trait ruminators have a narrower attentional scope than non-ruminators. More specifically, they postulate that individuals who have a narrow attentional scope when not in a negative mood will show a high tendency to ruminate, because their attentional resources will be constrained to a limited set of focal thoughts. In some circumstances, such a constrained attentional focus is adaptive when for instance concentrating on homework. However, in conditions of distress, negative mood will narrow attentional scope and, as a result, magnify focusing on a single feeling or problem, while ignoring much external information. In contrast, individuals who have a broad attentional scope tend to ruminate less even when they are in a depressed mood, because their attentional scope will be broad enough to protect them from becoming absorbed by a focal feeling or problem.

It is noteworthy that, different from other models, this model posits that trait ruminators should exhibit a narrower attentional scope independent of mood. Besides, other than biasing by negative information (Joormann, 2010; Koster et al., 2011), individuals could focus their

attention on all kinds of information when it is relevant to the task (Friedman & Förster, 2010). So, instead of inhibiting the negative information, this model posits that trait ruminators could maintain the relevant information but will have difficulties inhibiting this information when the situation changes and the information is not relevant any more. Despite the absence of direct tests of this hypothesis, many of the findings at the level of working memory and perception can also be explained by the attentional scope model of rumination.

The information-processing explanations of depressive rumination are also supported by some of the neurobiological findings. In a recent fMRI study (Foland-Ross et al., 2013) an emotional working memory task was administered in a sample with major depression to elucidate neural correlates of difficulties in cognitive control. In the depressed individuals, the dorsal anterior cingulate and parietal and bilateral insular cortices were activated significantly more when negative words had to be removed from working memory. In contrast, nondepressed participants exhibited stronger neural activations in these regions for positive than for negative material. Surprisingly, no unique correlations were observed with rumination but this may have been due to high levels of depression which are strongly confounded with rumination. These findings suggest that different neural mechanisms are involved in expelling negative material in depression where future studies should further investigate whether and how this contributes to rumination.

4. Future directions in the study of rumination

There are a number of research lines that appear particularly promising to enhance understanding and modification of rumination. Here, a major challenge is how to clarify and understand biobehavioral cascades in relation to rumination. There is some research examining

the psychophysiological consequences of rumination which shows that rumination and sustained processing of emotional information causes decreased ability to recover from emotional stimuli. Such effects have been supported by studies measuring vagal tone, heart rate variability, and the cortisol response (see Siegle & Thayer, 2004). Provided that rumination is associated with prolonged stress it is interesting that recent research also suggests an important role of rumination in influencing physical illness where, for instance, rumination plays an important role in recovery from chemotherapy (Berman et al., in press). More broadly, provided that depression is associated with inflammation (Berk et al., 2013), it would be highly interesting to better understand the long term biological consequences of rumination as prolonged stress associated with rumination could contribute to inflammation.

Moreover, it is likely that there are dynamic cascades between the cognitive and biobehavioral consequences of rumination that deserve more fine-grained investigation. Such cascades could occur in several ways. It is possible that when individuals ruminate and experience increased levels of stress that experiencing stress can give rise to more ruminative thought ("why am I feeling this way?"). In addition, rumination is also associated with reduced levels of activity (several items of the RRS for instance refers to withdrawal from social contact to analyse feelings). By social withdrawal, rumination could both lower activity levels where isolation may magnify the focus on problems and their emotional impact.

Below we describe several approaches that could shed more light on such cascading and dynamic effects associated with rumination.

4.1 Dynamic systems approach

Despite that most of the theories center around explaining the initiation and persistence of rumination, a clear and empirical way to test temporary fluctuations in rumination is to a large

extent absent. What is lacking is indeed a conceptual frame that may efficaciously account for fluctuations of ruminative thinking and its co-occurrence with negative mood, self-focus, and motivational states (Smith & Alloy, 2009).

In that regard, a powerful tool is offered by Dynamic Systems Theory (DST), which explicitly aims at capturing individual and group-level trajectories (Kelso, 1995). DST is a metatheoretical framework that, originally derived from mathematics and physics, has successfully been applied in many domains where time is an importance variable, such as developmental and clinical psychology (Carver & Scheier, 1998; Granic & Hollentesin, 2003). Within the DST framework, it is possible to represent a certain phenomenon as a set of elements co-varying over time (i.e., system) and, in turn, capitalize on the enormous amount of information that dynamics provide. Concepts, like "state space", "attractor", and "repellor" are usually adopted to analyze temporal dynamics.

A *state space* is a schematic map where all the possible states of a system are included. For instance, by representing simultaneously both state mood (i.e. positive, neutral, or negative) on the *x*-axis and attention (i.e. internally-oriented vs. externally-oriented) on the *y*-axis, the two-dimension system would consist of six possible states (e.g., positive-internal, neutral-internal, etc.). Hence, a single subject (or group) trajectory could be shown transiting from one state to another across time and, by doing so, provide valuable information not only in terms of general intensity (i.e. mean), but also of temporal dynamics (i.e. variability and flexibility). For instance, two trajectories could show the same mean with regard to both mood and attention, but show very different temporal patterns when time is taken into account.

Furthermore, although it is theoretically possible that all the states of the state space are visited with the same frequency (i.e., equiprobability), it is much more likely that one state (or a subset of states) is visited more often than others. In other words, it is more probable for a trajectory to enter a specific state than to exit (Heylighen, 1992). Such a state is defined as *attractor*. On the other hand, by applying the same logic, it is also possible that some states are constantly avoided, as their probability to be visited is null or close to zero. Consequently, they are considered as *repellors.*

Research on rumination could clearly take great advantage from applying DST. Given a certain state space[1], it would be interesting to investigate whether high ruminators compared to low ruminators tend to preferentially select a specific state over time (i.e. *attractor*), such as being internally focused and experiencing negative mood at the same time. Adopting this perspective would provide many benefits. For instance, not only would it be possible to ascertain what state absorbs ruminators most, but also what state high ruminators stay far away from.

Despite these promising perspectives, no novelty is without costs. In fact, DST demands repeated measures and the availability of short but psychometrically sound measures of state rumination is pivotal. Unfortunately, so far most of the experience sampling studies, that potentially meet the DST requirements, have made use of a single item or very few items with unknown psychometric properties to measure rumination (e.g. Genet & Siemer, 2012). We here stress the necessity to adopt valid questionnaires that could be viable for repeated and reliable assessment of state rumination, such as the recently developed Momentary Ruminative Self-Focus Inventory (MRSI; Mor, Marchetti, & Koster, 2013).

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[1] This construct can be operationalized in different ways, such as by means of the state space grids (Hollenstein, 2007).

In sum, DST seems to be a very promising perspective both to propose new hypotheses and to re-interpret our current findings about rumination.

4.2 Resting state studies

Moments where individuals are not actively engaged in a task are contexts that may give rise to enhanced levels of ruminative thought. At the neural level, there is increasing research examining the relation between rumination and the DMN using resting state paradigms. However, given the very specific context and the loud background noise, at present it is unclear to what extent the fMRI research is representative of normal resting state (Gaab, Gabrieli, & Glover, 2008). Therefore, behavioral studies examining rumination during resting state are particularly promising.

A recent behavioral study investigated whether resting state indeed provides an important context for ruminative self-focus and negative affect. In this study, individuals were at rest, while being randomly probed about their attentional focus. This focus could either be internally or externally oriented (Marchetti, Koster, & De Raedt, 2013). Being internally focused predicted increased levels of state rumination and, in turn, a worsening in mood. This rest-related toxic effect held only in people at high risk of depression. Moreover, a questionnaire study recently showed that the trait tendency to engage in daydreaming (as a proxy of resting state) specifically predicted individual levels of depression, but only to the extent to which both trait self-focus and brooding were involved too (Marchetti, Van de Putte, & Koster, 2013).

In sum, given the absence of external stimulation and the proneness to become self-focused, resting state seems to be a promising field of inquiry for rumination. Nevertheless, new theoretical and empirical efforts are needed in order to account for and reconcile both neuropsychological and cognitive data.

4.3 Examining causal mechanisms of rumination

The current chapter underscores that there are many different possible factors contributing to rumination. In order to stringently test the causal involvement of certain mechanisms of rumination an increasing number of studies is using experimental manipulations. Especially in the domain of information-processing, novel methodologies have been developed to manipulate basic cognitive processes (e.g., working memory) or cognitive biases (e.g., attentional bias for negative material). Such training procedures can be used either to induce certain processing styles in healthy samples or to reduce certain impairments in high ruminators or depressed individuals (see Koster et al., 2009).

For instance, as discussed earlier, the link between cognitive impairments and rumination has been demonstrated in several correlational and prospective studies, but no clear inferences about the nature of this association can be made. It is possible that rumination depletes working memory resources (e.g. Philippot & Brutoux, 2008) or, alternatively, working memory impairments may lead to rumination (e.g., Gotlib & Joormann, 2010). To examine the functional role of cognitive impairments, the expected causal factor, being working memory functioning, has to be manipulated to subsequently monitor the effects on ruminations.

Currently, there is an extensive debate about the efficacy of working memory training and the transferability of training effects (Shipstead et al., 2012). A major challenge of working memory training procedures is to obtain transfer of training to new tasks and contexts. In recent years, several studies have shown promising results using a working memory training paradigm. For instance Jaeggi, Buschkuehl, Jonides, and Perrig (2008) used a dual n-back task to train working memory. This training involves monitoring and updating two streams of information which becomes gradually more difficult. They found, next to improvements on the training task, considerable gains in fluid intelligence scores compared to a control group. However, these

results have been challenged based on inappropriate designs (absence of an active control condition) and inappropriate transfer tasks that do not tap aspects of working memory (Shipstead et al., 2012).

Although the efficacy of working memory training in improving working memory performance in healthy individuals is still under debate, working memory training did show interesting effects in the context of psychopathology or traits that are characterized by reduced working memory performance (Owens et al, 2013; Siegle et al., 2007). The results of these studies suggest that the dual n-back training might be a valid tool to manipulate working memory within an experimental design when individuals have impaired cognitive control. Such training has interesting potential to examine the influence of cognitive processing on rumination. Moreover, if working memory training proves to cause sustainable beneficial effects, it could complement existing treatments or (relapse) prevention programs.

5. Conclusion

Rumination is a problematic self-regulation strategy that is associated with negative consequences on mood and cognition. We have discussed some of the key mechanisms explaining why individuals are susceptible to rumination. Major new developments in the study of rumination have been introduced which are likely to deepen our understanding of the dynamics of rumination and might also indicate new ways to reduce rumination.

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