MEMORY UPDATING
IN DEPRESSIVE RUMINATION—
THE ROLE OF VALENCE

Ee Pin Chang
Bachelor of Science (Psychology), Honours

This thesis is presented for the degree of
Doctor of Philosophy of the University of Western Australia
School of Psychological Science
2019
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Written patient consent has been received and archived for the research involving patient data reported in this thesis.

The work described in this thesis was funded by an Australian Government Research Training Program (RTP) Scholarship.

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Abstract

Previous research has found evidence for memory updating impairments in depression and rumination; however, the evidence is mixed, as some results have suggested a valence-specific updating impairment, whereas others have suggested a more general updating impairment. Furthermore, this research has largely relied on traditional working memory updating task, which may actually measure working memory capacity and general functions of working memory (WM) more so than the core processes involved in memory updating, such as the removal of outdated information from memory. Moreover, traditional WM updating tasks may lack ecological validity as they do not measure longer-term, more conceptual updating.

This thesis investigates the role of valence in memory updating impairments in depressive rumination. We used two separate paradigms: a novel task measuring removal efficiency, and the so-called continued influence paradigm, which measures conceptual updating that better reflects updating in real-world scenarios.

We first developed a list of self-referential valenced words, matched on factors that affect word processing. In Study 1, we obtained self-referentiality ratings from an unselected sample of participants. We then obtain self-referentiality ratings from pre-screened (high-depression, high-rumination) participants, in order to validate the ratings (Study 2). The resulting list was then used in Study 3.

The WM updating task used in Study 3 was designed to measure participants’ efficiency of removing outdated content from WM. Each trial of this task involves three stages: memorisation of three valenced words; an unpredictable sequence of updating steps, each involving the substitution of a word; and finally recall of the currently remembered set of words. During the updating phase, to-be-replaced words
are validly cued for a variable period of time before the new word is presented; this
time is either sufficient for active removal of the word representation from WM or it
is not. A contrast between those two conditions allows estimation of a participant’s
efficiency of removal. We hypothesized that depressive ruminators may be less
efficient at removing negative (vs. positive) words.

Results did not support this hypothesis. However, we found that depressive
ruminators were quicker to remove outdated words when updating towards a
negative word. We interpreted this as a negative attentional bias. We also found
impaired recall of negative words in depressive ruminators, which we interpreted as
an effect of interference from insufficiently removed outdated words. We thus
argued that while removal was particularly quick in the presence of new, negative
information, removal in this case was also incomplete and inadequate, allowing
interference from insufficiently removed outdated information. Study 3 therefore
provided evidence for a valence-generic updating deficit in depressive rumination.

To extend the investigation of memory updating impairments in depressive
rumination to more naturalistic information processing, we used a paradigm
involving presentation of an event narrative containing a piece of critical information
that is or is not subsequently identified as misinformation and thus retracted. The
tendency of people to continuously rely on corrected misinformation in their
reasoning is known as the continued influence effect (CIE). The CIE paradigm is
structurally similar to the removal task in that it involves updating in light of newly
presented information, but involves more conceptual updating of a complex mental
event model. Specifically, we used valenced misinformation to test whether
depressive ruminators would cling more strongly to corrected negative
misinformation compared to controls (Study 4) or positive misinformation (Study 5).
Contrary to expectations, we found that updating of negative misinformation in depressive ruminators was in fact enhanced compared to healthy controls and positive misinformation. We attributed this to a negative attentional bias that enhanced the salience of negative misinformation. It has been claimed that salience facilitates co-activation of misinformation and its retraction in memory, which in turn facilitates information integration and updating of the mental event model.

In sum, these findings suggest a negative attentional bias in depressive ruminators, which can have both detrimental and beneficial effects depending on the task used: impaired recall for negative words in the removal task but enhanced updating following a retraction in the CIE paradigm. This demonstrates that findings regarding micro-level cognitive processes may not always translate to higher-level cognition. Results contribute to evidence from a growing body of literature on the complex interactions of cognitive processes in depressive rumination, which has clinical implications.
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Acknowledgements

This research was supported by an Australian Government Research Training Program (RTP) Scholarship.

I would first like to thank my amazing supervisors, Ullrich Ecker and Andrew Page. I am extremely blessed and grateful for all the support during my PhD journey. Thanks to Ulli, for his consistently prompt and excellent feedback, recommendations on how to improve my writing, insights and advice on a career in academia, tutoring opportunities and finally the early opportunity for research experience. It has truly enriched my journey. To Andrew, thanks for his timely, brilliant and thought-provoking feedback and questions; I feel more intelligent just thinking about them. Thanks also for the research opportunities.

My research program was also enhanced by the insights and quality feedback from my panel members, Colin MacLeod and Simon Farrell; their insights are matched only by their passion for good research. Thanks also to Werner Stritzke, my honours supervisor who provided the opportunity and experience with subclinical participants; his guidance has been valuable and foundational in this journey. I am also grateful for all SPS academic staff whose passion and strive for excellence have inspired and sustained me in my humble pursuit. To my laboratory manager, Charles Hanich, members of the CogSci lab, past and present, and all the wonderful and diligent SPS administrative office staff, thank you!

This journey is made more memorable and will be treasured because of the friendships formed. To Diana who is ever so generous with encouragement, advice and practical help even in the midst of her busy schedule. To Angela, Annabelle, Blake, Briony, Dielle, Doug, Ellen, Fiona, Florence, Georgi, Jean, Joanna, Julie,
Kaitlyn, Kamari, Kris, Laura, Marton, Matt × 2, Sarah, Serena, Simone, Steph C. and T., and Yong for their assistance and/or sharing this journey.

I would also like to thank my parents for their sacrificial and unconditional love, and my siblings, nieces and nephews for the joys (and sometimes frustrations!) of growing up in a large family. Thanks also to my spiritual family, David, Ruth and Siew, and more recently, Henry and Shirley, Steven and Evelyn, members of Lighthouse 2 and 7, and Lighthouse Zone, for the edifying fellowships and for feeding my body and soul. I would also like to express my immense gratitude to Alvin, for going through thick and thin, making this journey less lonely and more memorable. A final thank you to the late Mr S. K. Quah, my high school coach, for imparting the values to excel in sports; they have been instrumental in bringing me thus far in life. Above all, praise and gratitude to God for fulfilling my childhood dream of studying psychology and for everything. This has been the most amazing journey and I believe there is more where all these came from.
Publications Included in the Thesis

This thesis contains work that has been published and/or prepared for publication.

Publication 1: Unsubmitted manuscript (Chapter 2)


Publication 2: Published manuscript (Chapter 3).


Publication 3: Published manuscript (Chapters 4 and 5)

Statement of Candidate Contribution

*Publication 1: 80% (Chapter 2)*

The candidate completed the literature review, designed the study, programmed the survey, analysed the data, and completed the manuscript preparation. Associate Professor Ullrich Ecker provided guidance and feedback on the design, analysis, and manuscript preparation and Professor Andrew Page provided feedback on the manuscript preparation.

*Publication 2: 80% (Chapter 3)*

The candidate completed the literature review, designed the study, created the stimuli, analysed the data, completed the manuscript preparation and completed the manuscript revisions. Associate Professor Ullrich Ecker and Professor Andrew Page provided guidance and feedback on the design, analysis, manuscript preparation and manuscript revision. In addition, Associate Professor Ullrich Ecker contributed to the data analysis.

*Publication 3: 80% (Chapters 4 and 5)*

The candidate completed the literature review, designed the study and stimuli, analysed the data, completed the manuscript preparation and completed the manuscript revisions. Associate Professor Ullrich Ecker and Professor Andrew Page provided guidance and feedback on the design, analysis, manuscript preparation and manuscript revision.
I, Associate Professor Ullrich Ecker certify that the student statements regarding their contribution to each of the works listed above are correct.
Preamble

This thesis is presented as a series of empirical papers that have been published or have been written in manuscript format. For consistency, “we” was used throughout, even in sections that were not submitted as co-authored works. Two empirical papers (Chapter 3, and Chapters 4 and 5) have been published in peer-reviewed journals. Chapter 2 has been published on the Open Science Framework’s repository PsyArXiv. To facilitate review, literature references for in-text citations can be found directly after each chapter. As the manuscripts were written as independent works, some definitions and themes are presented multiple times throughout the thesis. Based on reviewer/editor requests, various chapters used different labels but our preferred label is depressive rumination and this will be used consistently throughout the unpublished chapters.
Chapter 1: General Introduction
1.1 Introduction

Research on the nature of memory updating impairments in depressive rumination has largely relied on response-time and list-recall tasks, despite the complex interplay among cognitive processes and biases in depressive rumination (Everaert, Duyck, & Koster, 2014; Everaert, Grahek, Duyck, Buelens, Van den Bergh, & Koster, 2017; Everaert, Koster, & Derakshan, 2012; Everaert, Tierens, Uzieblo, & Koster, 2013). Moreover, it has been argued that traditional tasks used to measure working memory (WM) updating primarily measure WM capacity and general WM functions such as maintenance and retrieval (Ecker, Lewandowsky, Oberauer, & Chee, 2010; Schmiedek, Hildebrandt, Lövdén, Wilhelm, & Lindenberger, 2009; Singh, Gignac, Brydges, & Ecker, 2018), or do not actually require WM updating (Bunting, Cowan, & Saults, 2006). More specifically, these tasks do not measure the removal of outdated information, which has been identified as a core process of WM updating (Ecker, Lewandowsky, & Oberauer, 2014; Ecker, Oberauer & Lewandowsky, 2014; Ecker, Lewandowsky, Oberauer et al., 2010; Singh et al., 2018).

We used two separate paradigms to investigate the nature of memory updating in depressive rumination: a novel response-time removal task (Ecker, Lewandowsky, & Oberauer, 2014; Ecker, Oberauer, et al., 2014), and the continued influence effect (CIE; Johnson & Seifert, 1994; Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012; Wilkes & Leatherbarrow, 1988) paradigm, which is structurally similar to the removal task but temporally extended and involves conceptual updating that better reflects updating in real-world scenarios. Conceptual updating involves the revision of complex mental models and thus requires higher-level cognitive processes beyond basic attention and short-term memory processes.
We predicted that participants scoring high on measures of depression and rumination would show updating deficits for negative information (i.e., we predicted that depressive ruminators would “cling” to negative information during updating). However, in both paradigms, we found little evidence that depressive ruminators cling to negative information. Instead, the findings across both paradigms were generally consistent with an attentional bias towards negative information. Moreover, some more specific findings from the removal task did not map onto the findings from the CIE paradigm, which suggests that findings regarding micro-level cognitive processes may not always scale up to higher-level cognition. This provides an impetus for a more holistic research approach to understanding the nature of cognitive impairments in depressive rumination, using tasks with high ecological validity, if the motivation for psychopathology research is its clinical utility (Barlow, Bullis, Comer, & Ametaj, 2013; Hayes, Beevers, Feldman, Laurenceau, & Perlman, 2005).

1.2 Cognitive Biases and Working Memory Impairments in Depression

There is considerable evidence suggesting that depression is characterised not only by negative mood, but also by cognitive impairments (Rock, Roiser, Riedel, & Blackwell, 2014), such as deficits in attention, WM, and executive function. Of particular importance for the present thesis are potential WM impairments. WM is responsible for the temporary short-term storage and processing of information (Baddeley, 1992) and is necessary for daily cognitive tasks including logical reasoning (Carpenter, Just, & Shell, 1990), mental arithmetic (Deschuyteneer, Vandierendonck, & Muylleart, 2006), problem solving (Baddeley, 2000), and reading comprehension (Daneman and Carpenter, 1980; Palladino, Cornoldi, De Beni, & Pazzaglia, 2001). However, due to the limited capacity of WM, the ability to
update the contents of WM and keep them relevant is necessary for its efficient functioning (De Beni & Palladino, 2004; Oberauer, Lewandowsky, Farrell, Jarrold, & Greaves, 2012).¹

The relationship between WM impairment and depression extends beyond merely an association: a WM updating impairment has been implicated in the etiology and maintenance of depression (Joormann & Gotlib, 2008; Levens & Gotlib, 2010). More specifically, it has been suggested that an inability to update the contents of WM may impair the ability to regulate negative emotions, which may contribute to the development and/or maintenance of depression (Joormann & Gotlib, 2008; Levens & Gotlib, 2010; Onraedt & Koster, 2014). This is because an inability to update the contents of WM would mean that once negative information enters WM, it would tend to persist even when there is (potentially more positive) new information available. According to Beck’s cognitive theory of depression (Beck, 1976, 2005), the contents of WM in depressives are likely to be negative due to a negative self-schema. A negative self-schema enhances the salience of negative information in the environment (Segal, 1988). However, findings on the relationship between WM updating and depression have been mixed with regards to the role of valence in WM updating impairments. Some evidence suggests that depression is associated with a valence-specific updating deficit (i.e., impaired updating of negative information only; Joormann & Gotlib, 2008; Levens & Gotlib, 2009),

¹ This holds true only if one assumes that there is no relevance of temporal decay in WM. Temporal decay is the notion that forgetting is a passive process that occurs as a direct consequence of the passage of time (Baddeley, 2000; Barrouillet, Bernardin, Portrat, Vergauwe, & Camos, 2007; Barrouillet, De Paepe, & Langerock, 2012). There is strong evidence against this notion (Lewandowsky & Oberauer, 2009; Lewandowsky, Oberauer, & Brown, 2009).
whereas other evidence suggests a more general updating impairment in depression (Harvey et al., 2004; Meiran, Diamond, Toder, and Nemets, 2011).

Various studies have established a valence-specific updating impairment in depression using negatively-valenced materials (Joormann & Gotlib, 2008; Levens & Gotlib, 2009, 2010); that is, compared to healthy controls, currently depressed individuals are impaired in updating negatively-valenced materials. For example, using a modified Sternberg task (see Oberauer, 2001), Joormann and Gotlib had participants memorize a positive and a negative list of words; they were subsequently required to ignore one of the lists (deemed the irrelevant list). Participants were then presented with words from both lists, plus new words not presented before; participants were required to discriminate between words from the relevant and irrelevant lists (i.e., accepting the former and rejecting the latter, also rejecting new words). Participants took longer to reject words from the irrelevant list than new words, that is, they showed an intrusion effect—a difference in response latency between rejecting words from the irrelevant list versus new words of the same valence. Importantly, the intrusion effect for negative words was greater in individuals with depression than controls, and correlated positively with rumination scores. This valence-specific intrusion effect reflects a WM updating impairment for negative materials in depression.

A valence-specific updating impairment in depression, such that updating is impaired only with negative information, is consistent with Beck’s cognitive theory of depression (Beck, 1976) and Bower’s associative-network model (Bower, 1981). According to Beck, depressed individuals are characterized by negative schemata in information processing, such that negative information is preferentially attended to. That is, a negative schema promotes salience of negative information, which
contributes to a negative attentional bias (Joormann & Gotlib, 2007, 2008; Peckham, McHugh, & Otto, 2010). A negative attentional bias means that limited cognitive resources are preferentially directed towards negative information, at the expense of positive information. In conjunction with impaired attentional disengagement from negative information in depressive rumination (Bradley, Mogg, & Lee, 1997; Grafton, Southworth, Watkins, & MacLeod, 2016; Koster, De Lissnyder, Derakshan, & De Raedt, 2011), this may contribute to negative information receiving preferential cognitive processing even downstream of attentional processing (i.e., interpretation and memory processing; Everaert et al., 2017; Everaert et al., 2013). Similarly, according to Bower’s model, memory is represented by a network of interconnected nodes, and activation travels through this network. The activation of emotion nodes promotes activation of associated nodes with similar content, which increases the salience of negative information when a person is in a negative mood. Both Beck’s and Bower’s theory suggest that cognitive resources are involuntarily directed towards maintenance processing of negative information—that is, the encoding or maintaining of negative information in memory. This contributes to the robust mood-congruent memory (i.e., enhanced memory for negative materials only) for negative information in depression (Matt, Vázquez, & Campbell, 1992). However, in the context of WM updating, this might contribute to a valence-specific updating impairment in depression.

On the other hand, Yoon, LeMoult, and Joormann (2014) failed to replicate the valence-specific updating impairment of Joormann and Gotlib (2008), and instead demonstrated that memory updating impairments in depressed individuals may not be restricted to negative words, but found with any emotionally-valenced words, that is, both negative and positive words (also see Joormann, 2006). Yoon et
al. highlighted that the smaller number of trials in their study might have reduced sensitivity to replicate the findings of Joormann and Gotlib.

Consistent with a more general updating impairment in depression, in a study by Meiran et al. (2011), depressed participants exhibited difficulties recalling three numbers after a series of updating steps. As numbers are valence-neutral, this supports a general WM updating impairment in depression (also see Harvey et al., 2004). Further evidence for a generic updating deficit comes from a study using face stimuli (De Lissnyder, Koster, Everaert, Schacht, Van den Abeele, & De Raedt, 2012). Even though depressed participants seem to demonstrate an attentional bias towards angry compared to neutral faces (Leyman, De Raedt, Schacht, & Koster, 2007), De Lissnyder et al. found that emotional valence did not influence updating in depressed individuals in a cognitive control task involving updating that used angry and neutral faces as stimuli. The authors suggested that this could be due to a lack of distinction in emotional valence between angry and neutral faces, since depressed participants would have interpreted neutral faces as more negative than non-depressed individuals (Joormann & Gotlib, 2006). However, an alternative view is that the selection of angry faces versus neutral faces may lack sensitivity in discriminating valence-specific updating impairments in depression. This is because according to the content-specificity hypothesis (Derry & Kuiper, 1981, Kuiper & Derry, 1982) of Beck’s cognitive model of depression (Beck, 1976; Beck, Brown, Steer, Eidelson, & Riskind, 1987), depression is characterised by themes of loss and failure, rather than anger and fear (assuming fear as a default response to an angry face). Thus, using sad faces instead of angry faces might have allowed for a more sensitive test of valence effects on memory updating in depression (Duque & Vázquez, 2015; Gotlib, Kasch, Traill, Joormann, Arnow, & Johnson, 2004; Gotlib,
Krasnoperova, Yue, & Joormann, 2004). Indeed, depressed individuals require stimuli of a lower emotional intensity to identify sad as opposed to angry facial expressions, and stimuli of a greater emotional intensity than controls to correctly identify happy expressions (Joormann & Gotlib, 2006).

A general updating impairment in depression suggests that updating is generally impaired for any material in WM. In line with this, the attentional scope model (Whitmer & Gotlib, 2013; also see Grol, Hertel, Koster, & De Raedt, 2015) proposed that a negative mood leads to a narrowed attentional focus on the contents already in WM. This focused attention promotes deeper processing of the contents in WM, which are likely to be negative during a negative mood state. Of relevance to updating, a narrow attentional scope may contribute to a slower rate of conceptual change in WM: To the extent that cognitive resources are focused on information currently in WM at the expense of new information, resources available to attend to novel information in the environment will decrease, hindering updating of WM content with current and relevant information which may be conceptually different from the contents currently in WM. Given the salience of negative schemata associated with a negative mood state, such a mechanism could potentially perpetuate repetitive negative thoughts and act as a contributing factor for the etiology and maintenance of depression (Nolen-Hoeksema, 2000; Roberts, Gilboa, & Gotlib, 1998).

In sum, it is unclear whether depression is associated with a valence-specific and/or a general updating impairment. A valence-specific updating impairment in depression would suggest that only negative information will have a tendency to “stick” in WM, leading to a persistent focus on negative information and the potential consequence of perpetuating a negative mood. To the extent that WM
contents in depression tend to be negative anyway, however, a valence-generic updating deficit may have similar consequences. Specifically, both types of updating deficits could contribute to a tendency for rumination—a recurring, unintentional, and uncontrollable focus on (negative) thoughts revolving around the self, the world, and the future—the ‘cognitive triad’ conceptualized by Beck, Rush, Shaw, and Emery (1979).

1.3 The Role of Rumination

Rumination has been described as a hallmark characteristic of depression (Koster et al., 2011; Watkins, 2008). According to response style theory, rumination is defined as the repetitive, persistent, and uncontrollable focus on negative thoughts, such as thoughts of the causes, meaning, and consequences of one’s depressed mood (Nolen-Hoeksema, 1991; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). A ruminative response style is associated with a vulnerability for depression and the maintenance of negative affect (Lyubomirsky & Nolen-Hoeksema, 1993; Nolen-Hoeksema, 2000). While various studies have found a correlation between measures of depression and rumination (De Lissnyder, Koster, Derakshan, & De Raedt, 2010; Grafton et al., 2016; Knowles, Tai, Christensen, & Bentall, 2005; Lam, Smith, Checkley, Rijsdijk, & Sham, 2003; Marchetti, Loeys, Alloy, & Koster, 2016; Onraedt, & Koster, 2014; Yoon et al., 2014), others have failed to find this correlation, suggesting that rumination may be an independent individual-differences construct (Owens & Derakshan, 2013), even in depression (Nolen-Hoeksema et al., 2008). Hence, including rumination tendencies as a selection criteria when investigating the nature of potential cognitive impairments in depression would enhance task sensitivity, especially when using tasks that are novel to the research on depression.
Rumination has been found to be a relatively stable, trait-like response style (Davis & Nolen-Hoeksema, 2000; Nolen-Hoeksema, 1991), regardless of the presence of depressive episodes (Roberts et al., 1998) or the level of negative affect (Nolen-Hoeksema et al., 2008). As discussed earlier, rumination may be associated with either a valence-specific memory updating impairment (Joormann, Levens, & Gotlib, 2011; Koster et al., 2011) or generic memory updating impairment (Davis & Nolen-Hoeksema, 2000; Harvey et al., 2004; Meiran et al., 2011). De Lissnyder, Koster, and De Raedt (2012) found that selection of participants based on rumination scores provided more distinct valence-specific effects in a WM updating task (specifically, the so-called internal shift task using neutral and angry faces as stimuli) than sample selection based on depressive symptoms. De Lissnyder et al. interpreted their findings to suggest that rumination could be more proximally related to WM impairments than measures of depressive symptoms (Koster et al., 2011).

It has been suggested that rumination consumes WM resources (Levens, Muhtadie, & Gotlib, 2009; Meiran et al., 2011; Watkins & Brown, 2002); it may thus have a reciprocal relationship with WM performance by drawing cognitive resources away from task-relevant cognitive processes. That is, if, due to an underlying WM updating impairment, outdated information is not sufficiently removed, this can lead to increased interference in WM and thus impaired WM performance. This suggests that updating deficit is a consequence of rumination. On the other hand, rumination could also arise from a generic updating deficit, which contributes to depressive symptomatology (Vanderhasselt & De Raedt, 2012) suggesting that updating deficit is a cause of rumination. Alternatively, both updating deficit and rumination could be linked to a third factor. Accordingly, Meiran et al. demonstrated that rumination was negatively correlated with WM performance, and this correlation increased with
increasing memory load (also see Levens, Muhtadie, et al., 2009). This finding suggests that depressed individuals are only impaired in updating impairment when cognitive load is high, but not when it is low, supporting the notion that rumination consumes cognitive resources; this reduces available cognitive resources for other tasks, which may then contribute to the impairments often demonstrated in depression and rumination. In sum, depression and rumination are both characterised by impairments in WM performance although the nature of this impairment is not clear. This issue is further complicated by the high co-occurrence of depression and rumination (Davis & Nolen-Hoeksema, 2000; De Lissnyder et al., 2010; Grafton et al., 2016; Joormann, 2006; Joormann & Gotlib, 2008; Lam et al., 2003; Marchetti et al., 2016; Onraedt, & Koster, 2014; Yoon et al., 2014), which makes it difficult to tease apart the relative contributions of depression and rumination to WM impairment.

The correlation between measures of depression and rumination is a robust finding (De Lissnyder et al., 2010; Grafton et al., 2016; Lam et al., 2003; Marchetti et al., 2016; Onraedt, & Koster, 2014; Yoon et al., 2014), and non-depressed individuals may also become susceptible to depressed mood when they ruminate. LeMoult and colleagues distinguished between state and trait rumination and demonstrated the role of state rumination in the association between rumination and the persistence of depressed mood, after controlling for trait rumination and depressive symptoms (LeMoult, Arditte, D’Avanzato, & Joormann, 2013). Furthermore, in an unselected sample of undergraduates, induced rumination was associated with sustained processing of negative images (Lewis, Taubitz, Duke, Steuer, & Larson, 2015), a behaviour often exhibited in depression (Larson, Nitschke, & Davidson, 2007). State rumination in the absence of depressive
symptoms has also been found to promote deeper processing of negative information (LeMoult et al., 2013). Taken together, these findings support the notion that rumination may be a stronger predictor of WM impairments than depressive symptoms as assessed with Beck Depression Inventory-II (DBI-II; Beck, Steer, & Brown, 1996; Koster et al., 2011), and that rumination could be more proximally related to WM impairments than measures of depressive symptoms (De Lissnyder, Koster, and De Raedt, 2012; Koster et al., 2011). Moreover, there is evidence to suggest a positive correlation between rumination tendencies—but not depression severity—and a negative attentional bias in depression (Everaert et al., 2017) and in non-depressed individuals (Owens & Gibb, 2017).

1.4 Attentional Bias in Depression and Rumination

A basic lower-level cognitive process often researched in depressive rumination is attention, and in particular a negative bias that characterizes attentional processing. A negative attentional bias in depressive rumination is consistent with Beck’s cognitive theory of depression (Beck, 1976) and Bower’s associative-network model (Bower, 1981), as described earlier. Gotlib and Joormann (2010) proposed that a negative attentional bias can predict future depressive symptoms and is a risk factor for depression. As attention is an early cognitive process, an attentional bias may also underlie performance differences that arise in subsequent cognitive processing stages including interpretation and memory (Everaert et al., 2017; Everaert et al., 2013).

Attentional bias refers to the disproportionate and preferential attention directed towards a certain stimulus over others, such that cognitive resources are directed towards the encoding of the stimulus at the expense of other, potentially more relevant processes. Gotlib and Joormann (2010) proposed that a negative
attentional bias contributes to a valence-specific updating impairment so that negative information persists in memory (which may foster rumination and perpetuate a negative mood; Lyubomirsky & Nolen-Hoeksema, 1993; Nolen-Hoeksema, 2000). Consistent with that, various researchers have found that depression is associated with an attentional bias towards negative materials (Bradley et al., 1997; Donaldson, Lam, & Mathews, 2007; Gotlib & Cane, 1987; Gotlib, Krasnoperova, et al., 2004; Joormann & Gotlib, 2007, 2008; Koster, De Raedt, Goeleven, Franck, & Crombez, 2005; Koster, De Raedt, Leyman, & De Lissnyder, 2010; Mathews, Ridgeway, & Williamson, 1996; Mogg, & Bradley, 2005; for reviews see Dalgleish & Watts, 1990; Peckham et al., 2010). Furthermore, this negative attentional bias has been associated with enhanced recall for negative words, regardless of the intensity of depressive symptoms (Koster et al., 2010), providing preliminary evidence of coherence among cognitive biases, specifically negative attention and memory biases. More recently, eye-tracking experiments—offering a more direct measure of attentional bias with a continuous measure of visual attention—have also demonstrated a negative attentional bias in rumination (Owens and Gibb, 2017; for review see Armstrong & Olatunji, 2012) and subclinical depression, compared to non-depressed individuals (Duque & Vazquez, 2015).

However, some studies have failed to replicate a negative attentional bias in depression (Bradley, Mogg, Millar, & White, 1995; Lichtenstein-Vidne, Okon-Singer, Cohen, Toddor, Aue, Nemets, & Henik, 2017; MacLeod, Mathews, & Tata, 1986; Mogg, Bradley, Williams, & Mathews, 1993; Neshat-Doost, Moradi, Taghavi, Yule, & Dalgleish, 2000). Three reasons have been proposed for this discrepancy: specificity of stimuli used (Beck et al., 1987; Greenberg & Beck, 1989), stimulus presentation duration (Bradley et al., 1997; Gotlib, Krasnoperova, et al., 2004; Mogg,
& Bradley, 2005), and lack of self-referentiality (Koster et al., 2005; Leyman et al., 2007).

First, according to the content-specificity hypothesis (Beck et al., 1987; Greenberg & Beck, 1989) of Beck’s cognitive model, attentional bias is more pronounced when stimuli used are specifically depression-related. Studies that used threat stimuli such as angry faces failed to demonstrate a negative attentional bias in depression (De Lissnyder, Koster, Everaert, et al., 2012), while studies that used depression-related stimuli such as sad faces have more consistently demonstrated a negative attentional bias in depression (Gotlib, Kasch, et al., 2004; Gotlib, Krasnoperova, et al., 2004).

Second, studies that demonstrated negative attentional bias in depression have done so at longer stimulus presentation duration of approximately 1,000 ms or more (Bradley et al., 1997; Gotlib, Krasnoperova, et al., 2004; Koster et al., 2010; Mogg, & Bradley, 2005), which allow for elaborative, deeper levels of processing (Mogg & Bradley, 2005; Watkins, 2002). However, some studies presenting depression-related words to participants for up to 1,500 ms have failed to demonstrate a negative attentional bias in depression (McCabe, & Toman, 2000; Neshat-Doost et al., 2000). This discrepancy has partly been attributed to the lack of stimulus self-referentiality. Thus, both stimulus presentation duration and stimulus self-referentiality contribute to the negative attentional bias in depressive rumination. In line with this, Koster et al. (2005) demonstrated negative attentional bias for self-referential words in dysphoric participants with negative words presented for 1,500 ms but not with negative words presented for 250 ms.

Third, it has been suggested that the self-referentiality of stimuli may account for the inconsistent findings regarding a negative attentional bias in rumination
(Koster et al., 2005; Leyman et al., 2007). The self functions as the strongest schema and materials in relation to the self promote the deepest level of processing (Symons & Johnson, 1997); the self-reference effect is observed when preferential processing of self-referential materials produces enhanced memory (Matt et al., 1992). Self-referentiality has been manipulated through encoding instructions (Kuiper & Derry, 1982), or reflected in the stimuli used (Joormann, 2006; Koster et al., 2005).

Converging evidence highlights the role of self-referentiality in demonstrating a valence effect in memory updating impairments in depression and rumination (Joormann, 2006; Koster et al., 2005).

### 1.5 Task-Impurity Issues

The empirical situation regarding the nature of WM updating impairments in depressive rumination is further complicated by methodological issues. Notwithstanding the substantial variability in the tasks used to investigate the nature of WM updating impairments, the tasks may not always measure what they purport to measure (Bunting et al., 2006; Ecker, Lewandowsky, & Oberauer, 2014; Ecker, Oberauer, et al., 2014). In terms of WM updating, it has been argued that traditional tasks used to measure WM updating primarily measure WM capacity (Ecker, Lewandowsky, Oberauer, et al., 2010; Schmiedek et al., 2009; Singh et al., 2018) or do not even require WM updating (Bunting et al., 2006). Previous research arguing for an impairment of WM updating in depression (Harvey et al., 2004; Joormann, Levens, et al., 2011; Meiran et al., 2011; Watkins & Brown, 2002) has largely relied on tasks measuring WM updating abilities indirectly: the tasks used involved repeated updating of a memory set but only measured recall at the end of each trial.

To illustrate, such WM updating tasks typically require participants to encode a set of three items (e.g., B-F-M) followed by an unpredictable series of updating steps.
where one item is replaced by another (e.g., B→R→...K→R→...); this updating phase is then followed by the recall of the currently memorized set. Such traditionally used “updating tasks” are flawed in that they measure mainly general WM functions related to maintenance and retrieval, and do not specifically measure the removal of no-longer relevant information, which has been identified as the core process of WM updating (Ecker, Lewandowsky, & Oberauer, 2014; Ecker, Lewandowsky, Oberauer, et al., 2010; Ecker, Oberauer, et al., 2014; Singh et al., 2018).

Ecker and colleagues (Ecker, Lewandowsky, & Oberauer, 2014; Ecker, Oberauer et al., 2014) argued that the removal of no-longer relevant information from WM is central to WM updating so that new and relevant information can be encoded into the limited-capacity WM. To that end, Ecker and colleagues introduced a novel removal task that provides a more direct measure of WM updating ability and an estimate of the time taken for the removal of no-longer relevant information from WM. In their task, participants press a key once each updating step is completed; the associated updating response time provides a more direct measure of WM updating. Moreover, a cue is presented to participants before each updating step, indicating which item is about to be updated and can thus be removed from WM. This cue is presented for a short or long period of time (200 ms vs. 1,500 ms), with only the longer interval allowing removal of outdated information. Thus, the measured response time (from onset of the new item) either includes or excludes the time required for removal of the outdated item. Therefore, this procedure allows the separation of response time components associated with the removal of outdated information on the one hand, and the encoding of new information on the other. Ecker and colleagues were thus able to obtain a measure of the time taken for the
removal of no-longer relevant information, which they proposed to be the core process of WM updating, without confounding this process with general WM functions (also see Singh et al., 2018). This removal task provides the time taken to remove outdated information from working memory. In Study 3, we use this removal task to investigate the nature of potential impairment in the removal of valenced words in depressive ruminators.

1.6 Conceptual Updating—Continued Influence Effect

Up until recently, research on the nature of memory updating impairments and cognitive biases in depression and rumination has mainly investigated cognitive processes in isolation. Moreover, these studies are largely based on response-time or list-recall measures in short-term memory (but see Everaert, Bronstein, Cannon, & Joormann, 2018; Everaert et al., 2013, 2017). It is unclear if such updating effects would transfer to real-world information processing situations involving long-term memorization of news, facts, or event narratives. That is, studies investigating short-term processing of simple de-contextualized stimuli can provide important insights into the mechanisms underlying the impairments of specific cognitive processes in depressive rumination, but they may not elucidate the nature or impact of memory updating impairments when it comes to common materials that have more conceptual meaning and are processed on longer time-scales, and such studies may thus lack some ecological validity.

Of relevance, people often continue to rely on retracted misinformation—information initially believed to be true, but subsequently corrected—in their reasoning even after acknowledging a retraction (Ecker, Lewandowsky, E. P. Chang, & Pillai, 2014; Ecker, Lewandowsky, Swire, D. Chang, 2011; Thorson, 2016; Wilkes & Leatherbarrow, 1988). This reliance on retracted misinformation is known as the
continued-influence effect (CIE; Johnson & Seifert, 1994; Seifert, 2002; for a review see Lewandowsky et al., 2012). In traditional tasks using the CIE paradigm, participants are presented with a fictional report which contains a critical piece of information; this critical piece of information is subsequently either retracted, or not retracted. The difference in the frequency with which participants make reference to the retracted misinformation in their responses to open-ended inferential-reasoning questions provides a measure of their reliance on retracted misinformation and the CIE. The CIE paradigm (Johnson & Seifert, 1994; Lewandowsky et al., 2012; Wilkes & Leatherbarrow, 1988) allows for the investigation of the nature of conceptual updating in depressive ruminators, since it mimics real-world updating where misinformation is processed that subsequently requires correction. To keep up-to-date with a constantly changing world, we need to constantly update our mental models to avoid reliance on outdated information. Thus, memory updating and knowledge revision are required, yet they are error-prone processes (Ecker, Lewandowsky, Oberauer et al., 2010; Rich, van Loon, Dunlosky, & Zaragoza, 2017).

The CIE paradigm can be seen as structurally similar to the novel removal task presented in Chapter 3. In both tasks, outdated information needs to be updated in memory, either because it is being replaced by new information or because of a retraction. In the same vein, therapeutic interventions also involve updating of mental models. The findings from these studies would be informative for the development of intervention strategies designed to replace dysfunctional and maladaptive thoughts and beliefs with more adaptive ones.

The CIE is a robust finding across various domains, including politics (Ecker & Ang, 2019; Nyhan & Reifler, 2010; Travis, 2010), health (Nyhan & Reifler, 2015), and education (Ecker, Swire, & Lewandowsky, 2014; Trevors, Muis, Pekrun,
Sinatra, & Winne, 2016). In extreme cases, retractions of misinformation can even backfire—where false beliefs ironically increase after misinformation is retracted (Lewandowsky et al., 2012)—especially when the retracted misinformation is consistent with one’s worldviews, attitudes, and beliefs (Ecker & Ang, 2019; Nyhan & Reifler, 2010; Nyhan, Reifler, & Ubel, 2013; Prasad et al., 2009; Trevors et al., 2016).

1.7 Depressotypic Worldview Effects

To the best of our knowledge, no studies have looked at the effect of depressive rumination on the CIE. The CIE paradigm seems particularly suited to the understanding of memory updating impairments in depressive rumination for various reasons. The CIE is a robust finding, especially when misinformation is consistent with existing attitudes, worldviews, or schemata (Ecker & Ang, 2019; Lewandowsky et al., 2012). As depressive rumination is associated with dysfunctional worldviews, these negative and depressotypic worldviews may similarly contribute to the CIE when processing negative, and thus worldview-congruent, misinformation. It is assumed that when it comes to worldview-congruent misinformation, motivated dismissal of retractions may serve to uphold existing worldviews and beliefs, which could thus be interpreted in terms of a disconfirmation bias (Del Vicario et al., 2016; Everaert et al., 2018; Taber & Lodge, 2006). This raises the question if a similar mechanism might serve to uphold depressotypic attitudes and beliefs in clinical conditions such as depression. If general (e.g., political) worldviews can predict receptiveness for retractions of worldview-congruent misinformation, then this may also apply in case of depressotypic worldviews—that is, depressive ruminators may in a sense be motivated to resist retractions of negatively-valenced misinformation. If there is a worldview-driven negativity bias in depressive rumination, then one would
predict that retractions of negative misinformation in a CIE paradigm should be less effective in individuals with depressive rumination.

However, worldview effects on the CIE have not been found consistently. For example, participants’ level of racial prejudice has been found not to influence the effectiveness of a retraction of racial misinformation in the context of a crime scenario (Ecker, Lewandowsky, Fenton, & Martin, 2014). Ecker et al. suggested that worldview-incongruent retractions may be effective, but only when accepting the retraction did not require attitude change. They argued that this may only be the case when the misinformation relates to a specific event, but not when it relates to a general assertion: A retraction concerning a specific, one-off event can be accommodated as an exception to a rule, while maintaining a general pre-existing worldview (Kunda & Oleson, 1995; Richards & Hewstone, 2001). On the contrary, accepting a worldview-incongruent retraction of a general assertion would entail a certain degree of attitude change. For example, if a politician of Party X is first accused of misconduct but is subsequently cleared of wrongdoing, even people who do not support Party X may accept the retraction while maintaining their negative view of Party X politicians. By contrast, if a study finds politicians of Party X engage in more misconduct generally, and this is then retracted, a person with a negative view of Party X may dismiss the retraction, as it will require some attitudinal change (“politicians of Party X are not as untrustworthy as I thought”). In other words, accepting a correction of a specific event can be accommodated as an exception, whereas accepting a correction of a more general assertion will require some degree of attitude change. This argument was supported in a recent study using fictional scenarios involving misconduct of politicians: Ecker and Ang (2019) provided preliminary support for the hypothesis that worldview-incongruent
retractions were more effective with a specific scenario compared to a general scenario.

To ascertain if depressotypic worldviews would influence the effectiveness of a worldview-incongruent retraction using the CIE paradigm, we manipulated the specificity of the scenarios presented to depressive ruminators and healthy controls (Study 4). The specific scenario described the suicide death of a young celebrity, while the general scenario described an increasing trend in youth suicide rates. Both scenarios relate to suicide, which represents the ultimate “loss” and a common theme in the negative schema in depression (Beck et al., 1987). The aim of this study is to test whether depressive ruminators may be impaired in updating negative misinformation, both when compared to healthy controls, and when comparing the general to the specific scenario.

1.8 The Effects of Emotional Valence

In a second experiment using the CIE paradigm (Chapter 5), we used only general scenarios and manipulated the emotional valence of the scenarios to investigate the effects of depressive rumination on updating of negative misinformation when contrasted against positive misinformation. The valence-specific memory updating hypothesis (Joormann & Gotlib, 2008; Levens & Gotlib, 2009, 2010) would predict that depressive ruminators exhibit a greater post-retraction reliance on negative misinformation than positive misinformation. In other words, the CIE with negative misinformation would be larger than the CIE with positive misinformation in depressive ruminators. On the contrary, according to the attential scope model (Whitmer & Gotlib, 2013) which proposes a generic memory updating impairment in depressive rumination, we would expect a larger
CIE across both positive and negative scenarios in depressive ruminators relative to healthy controls.

As the CIE paradigm assesses memory and inferential reasoning, this paradigm can also serve to ascertain if the robust mood-congruent memory bias in depressive ruminators (Matt et al., 1992) is replicated; this would demonstrate convergent validity of the CIE paradigm in depressive ruminators.

1.9 Thesis Outline

The aim of this thesis was to investigate the nature of potential memory updating impairments in depressive ruminators. It aimed to address several limitations of prior research, by first creating a list of positive and negative words, matched on various variables, including self-referentiality ratings in a word-rating pilot study (presented in Chapter 2) and second, using this word list in a novel working memory updating task (Ecker, Lewandowsky, & Oberauer, 2014; Ecker, Oberauer, et al., 2014), which provides a more direct measure of updating processes than tasks used in previous studies (Chapter 3). We then extended our investigation into the nature of potential memory updating impairments in depressive rumination using a paradigm that is structurally similar to the working memory updating task but assesses conceptual updating of information held in long-term memory, which may have stronger ecological validity as it mimics real-world updating. We investigated updating of negative information in depressive ruminators relative to control participants (Chapter 4), and relative to the updating of positive misinformation (Chapter 5). The experiment presented in Chapter 4 additionally manipulated the specificity of the misinformation scenario, as previous research has suggested this factor to influence the occurrence of worldview effects in the CIE paradigm (Ecker & Ang, 2019; Ecker, Lewandowsky, Fenton, et al., 2014). Finally, Chapter 6
provides a summary of the empirical findings, the theoretical accounts underlying the unexpected findings, the practical and clinical implications of the findings, and the limitations and future directions.
1.10 References


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Chapter 2: Self-Referential Ratings for Valenced Words in Depressive Rumination
2.1 Abstract

People remember events and materials better when these are congruent with their mood at retrieval; this is known as the mood-congruent memory bias. This effect is largest when the materials are self-referential and this is known as the self-reference effect. We present two word rating studies, first to create a list of self-referential words for a memory updating task to investigate the influence of valence on memory updating in depressive ruminators. We used words selected from the Affective Norms for English Words pool. Given the self-referential effect, Study 2 validated the self-referential ratings as provided by depressive ruminators. As hypothesized, depressive ruminators rated negative words as more self-referential than an unselected sample. We thus created a list of self-referential positively and negatively valenced words, matched on factors known to influence word processing and self-referential ratings as provided by depressive ruminators.
2.2 Introduction

People remember events and materials better when these are congruent with their mood at retrieval. That is, the congruence between the affective valence of the materials and the current mood state enhances memory for the materials. For example, when in a negative mood state, memory for negatively valenced materials is better—this is known as the mood-congruent memory (MCM; Blaney, 1986; Bower, 1981) bias. The MCM is consistent with Beck’s cognitive theory of depression (Beck, 2005), which proposed that negative thoughts and beliefs consistent with a negative self-schemata contribute to depression. This mood congruency is generally largest when the materials are self-referential (Rogers, Kuiper and Kirker, 1977).

However, before it is possible to conduct research to examine the different effects that mood-congruent stimuli may have on the updating of working memory in people with depressive rumination, it is necessary to develop appropriate stimuli. Therefore, we begin with a rating study to create a suitable word list for the experiment presented in Study 3. The present chapter will first begin with a review of the literature on the MCM and the self-reference effect. We then present two rating studies. The aim of the first study is to identify words that are self-referential and matched on other factors known to influence word processing, by obtaining self-referential ratings on positively and negatively valenced words from an unselected sample. The aim of the second study is to validate the self-referential rating of the valenced words on a sample of participants pre-screened on measures of rumination and depression.
2.2.1 Mood-Congruent Memory in Depression

Various studies have found MCM where depressed individuals demonstrated enhanced memory for depression-related and negatively valenced materials, while healthy controls tended to demonstrate enhanced memory for positively valenced materials (Bradley, Mogg, & William, 1995; Denny & Hunt, 1992; Hammen, Miklowitz, & Dyck, 1986; Kuiper, Olinger, MacDonald, & Shaw, 1985; Matt, Vázquez, & Campbell, 1992; Ridout, Astell, Reid, Glen, & O’Carroll, 2003; Watkins, Mathews, Williamson, & Fuller, 1992). The MCM bias has been implicated in the aetiology and maintenance of depression (Teasdale, 1983), as well as its duration and severity (Ingram, 1984). Furthermore, MCM has been found to be a significant predictor of depression levels, even after controlling for the level of initial depression (Dent & Teasdale, 1988).

However, findings on MCM in depression have been mixed. Recent studies have failed to replicate the MCM effect (Ellwart, Rinck, & Becker, 2003; Moritz, Glascher, & Brassen, 2005; Wittekind, Terfehr, Otte, Jelinek, Hinkelmann, & Moritz, 2014), with one study even reporting enhanced recall for positively valenced materials in depressed individuals (Calev, 1996). Wittekind et al. proposed that memory in these studies might have been influenced by the self-referentiality of the materials, rather than just their valence alone (Davis, 1979; Derry & Kuiper, 1981; Kuiper & Derry, 1982). Consistent with this view, Moritz, Voigt, Arzola, and Otte (2008) suggested that the salience of the stimuli, instead of mood congruence per se, might be the primary driver of the effect. One key determinant of stimulus salience is its self-referentiality (Rogers, Kuiper, & Kirker, 1977).
2.2.2 Self-Reference Effect

There is overwhelming evidence that the “self” functions as a “superordinate schema” for cognitive processes (Rogers, Kuiper, & Kirker, 1977; Symons & Johnson, 1997) both in healthy controls and individuals with depression (Disner, Shumake, & Beevers, 2017; Phillips, Hine, & Thorsteinsson, 2010). The self serves as the strongest schema for various cognitive processes partly because the self is frequently used in information processing and promotes the deepest level of processing (Symons & Johnson, 1997). This is best illustrated in the robust finding that recall is superior for materials processed in relation to the self—compared to materials undergoing structural, phonemic, or even semantic processing; this effect is known as the self-reference effect (Rogers, Kuiper and Kirker, 1977; also see Bower & Gilligan, 1979; Kuiper & Rogers, 1979; Maki & McCaul, 1985). The self-reference effect has also been demonstrated in depression (Derry & Kuiper, 1981; LeMoult, Kircanski, Prasad, & Gotlib, 2016; for review see Wisco, 2009). The self-reference effect is consistent with the notion that the mechanism underlying the mood-congruent memory bias is the level of processing that materials receive (Craik & Lockhart, 1972), rather than the materials’ mood congruence (i.e., bias towards negative materials in depressed individuals). The salience of the self as a schema that guides information processing would promote the deepest level of processing.

In the literature on rumination and depression, self-referentiality has typically been manipulated by varying the encoding instructions (Bradley & Mathews, 1983; Davis, 1979; Derry & Kuiper, 1981; Gotlib, Kasch, Traill, Joormann, Arnow, & Johnson, 2004; Ji, Grafton, & MacLeod, 2017; Kuiper & Derry, 1982; Kuiper & Rogers, 1979; LeMoult, Kircanski, Prasad, Gotlib, 2016; Maki & McCaul, 1985; Murray, Whitehouse, & Alloy, 1999; Rogers, Kuiper and Kirker, 1977) or by relying
on extreme valence ratings of stimuli as a proxy for self-referentiality (Moritz, Voigt, Arzola, & Otte, 2008). For example, in a memory task, the encoding process can be manipulated by asking participants to rate to-be-recalled words in a self-referential manner (e.g., “does the word describe you?”), as opposed to, for example, a purely semantic manner (e.g., “does the word describe something negative?”; Rogers, Kuiper, & Kirker, 1977). Depressed individuals exhibit superior memory for negative words encoded in a self-referential manner, compared to negative words encoded semantically; in contrast, non-depressed controls exhibited superior memory only for self-referential, non-negative words (Derry & Kuiper, 1981; LeMoult, Kircanski, Prasad, & Gotlib, 2016; Wisco, 2009), presumably due to difficulty for controls to relate negative words to themselves, as negative information may not form part of their self-schema.

However, to induce self-reference effects by varying the encoding process is not ideal: we cannot rule out the effects of (a) decreased motivation in depressed individuals (Miller, 1975; Scheurich, Fellgiebel, Schermuly, Bauer, Wölfges, & Müller, 2008; Schmand, Kuipers, Van der Gaag, Bosveld, Bulthuis, & Jellema, 1994), and (b) impaired effortful processing in depressed individuals (Beevers, 2005) to encode as instructed. That is, systematic variability in the encoding process between depressed and non-depressed individuals may contaminate the observed effects, which may be erroneously interpreted as the self-reference effect. First, depressed individuals may lack the motivation to engage in self-referential encoding as instructed. The decreased motivation of depressed individuals can be explained by the learned helplessness model of depression (Seligman, 1975). This model proposes that motivational efforts are reduced by the perceived independence of reward or
reinforcement; this perceived independence interferes with future learning (Miller, 1975).

Second, depressed individuals are impaired in effortful processing (Hartlage, Alloy, Vázquez, & Dykman, 1993), which according to the dual-process model (Beevers, 2005), confers a vulnerability to depression, contributing to a vicious cycle. The dual-process model proposes that associative processing is effortless while reflective processing is effortful. A negative schema in depression promotes automatic associative processing, which is characterised by self-referential negative biases (Beevers, 2005). While an effortful reflective processing—or motivated processing aimed at attenuating a negative mood (Forgas, 2000)—can overcome the negative biases in automatic associative processing to regulate emotions, this is possible only when cognitive resources are available (Beevers, 2005). However, depressed individuals often lack the necessary cognitive resources (Hartlage, Alloy, Vázquez, & Dykman, 1993) required to engage in emotional regulation because cognitive resources are tied up in rumination (Meiran, Diamond, Toder, & Nemets, 2011), a hallmark characteristic of depression (Koster, De Lissnyder, Derakshan, & De Raedt, 2011; Watkins, 2008). Taken together, deliberate engagement in self-referential encoding would arguably be more effortful than processing stimuli that are inherently and intrinsically self-referential because the former involves building an additional association between the to-be-encoded information with aspects of the self which will require additional cognitive effort; therefore, manipulating the encoding process to induce self-reference effect in depression has its limitations.

Furthermore, the paradigm of inducing self-referential processing of stimuli restricts the type of task that can be used; for example, to investigate working memory updating, tasks will typically have to rely on the intrinsic self-referential
nature of the word stimuli used. To illustrate, in an updating task, participants should focus on updating to maintain the correct and most recent stimulus set active in memory; by contrast, in a simple recall task, the self-referential rating can be the main focus of the participant at encoding because encoding is usually incidental—in which case memorising the words is a secondary by-product of the self-referential rating task. Although studies using the emotional Stroop task (Gotlib, Kasch, Traill, Joormann, Arnow, & Johnson, 2004) and dot probe task (Ji, Grafton, & MacLeod, 2017) have manipulated self-referentiality by first asking participants to encode words in either a self-referential or semantic way before using those words in the respective tasks, this two-step approach creates a problem (Greenberg & Beck, 1989). First, Craik and Tulving (1975) found that “yes” responses to shallow encoding questions (e.g., is the word in capital letters?) or self-referential encoding questions (e.g., does the word describe you?) corresponded with better performance than “no” responses in a subsequent recognition task, meaning there may be an additional factor at play over and above self-referential processing (e.g., the recognition advantage may be due to context-dependent memory [Smith, 1994] where the encoding question serves as the contextual cue and facilitates retrieval of words that are congruent [i.e., attracted “yes” responses] with the encoding question). Second, inducing self-referential processing may have an impact on other cognitive processes (e.g., self-critical thinking) which may influence the findings (Everaert, Koster, & Derakshan, 2012). Taken together, inducing self-referential encoding with this two-step approach has its limitations.

Moreover, to induce self-referential encoding, participants typically respond “yes” or “no” to the question “describes you?” for each word (Derry & Kuiper, 1981), but a dichotomous self-referential rating may lack sensitivity. In Wittekind

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and colleagues’ (2014) study, depressed and non-depressed individuals rated nouns for self-referentiality. Although the authors found that depressed individuals rated negative and depression-relevant nouns as more self-referential than controls, the nouns were paired with valenced adjectives to manipulate the valence of the context, hence the ratings may not reflect the “pure” self-referential nature of the nouns. Moreover, Wittekind and colleagues failed to find the robust MCM bias for negative self-referential words in depressed individuals (Matt, Vázquez, & Campbell, 1992), which questions the validity and reliability of using these nouns to investigate the nature of specific memory biases, such as potential biases in memory updating. In sum, for the purposes of the memory updating study presented in Study 3, which required a list of 300 valenced words high in self-referentiality, existing word lists were deemed inadequate.

### 2.2.3 Self-Referential Valenced Words

Currently there are no valid and reliable norms available for intrinsically self-referential valenced words, other than the unpublished manuscripts of Myers (1980a, 1980b). Where self-referential ratings of depression-relevant and valenced words were obtained (Dobson & Shaw, 1987; Greenberg & Beck, 1989; Myers, 1980a, 1980b; Derry & Kuiper, 1981; Roth & Rehm, 1980; Watson, Dritschel, Jentzsch, & Obonsawin, 2008; Wittekind et al., 2014), the findings have been mixed. While depressed individuals have rated depression-relevant words, regardless of valence, as more self-referential, and positive words as less self-referential, compared to non-depressed individuals (Derry & Kuiper, 1981; Dobson & Shaw, 1987; Wittekind et al., 2014), Roth and Rehm (1980) found no difference in self-referential ratings for negative words between the two groups.
Moreover, while existing word lists matched valenced or depression-related words and control words on word length and word frequency, they were often not matched on arousal (Connolly, Abramson, & Alloy, 2016; Greenberg & Beck, 1989; Koster, De Raedt, Goeleven, Franck, & Crombez, 2005; Neshat-Doost, Moradi, Taghavi, Yule, & Dalgleish, 2000). Arousal may have thus been a confounding factor contributing to the mixed findings from previous studies. This is relevant because if negative materials were found to receive preferential processing due to arousal in an unselected sample (Recio, Conrad, Hansen, & Jacobs, 2014), we can expect depressed individuals to exhibit similar preferential processing due to arousal (or enhanced processing may be arousal-based rather than related to self-referential encoding, to the extent that depressed individuals might perceive negative materials as more arousing).

2.3 The Present Study

To investigate valence effects on WM updating in depressive rumination (Study 3), we required a list of 300 valenced words high in self-referentiality. Existing word lists were deemed inappropriate as self-referential ratings were either obtained from an unselected population or did not adequately control for confounding factors such as arousal. Self-referential ratings from an unselected population may not reflect the subjective self-referentiality of the words as perceived by depressed individuals; specifically, the self-referentiality of negative words may be higher for depressed individuals due to a negative self-schema (Beck, Rush, Shaw, and Emery, 1979). Thus, any observed valence effects in memory or memory updating tasks in depressed individuals may effectively represent a self-reference effect since depressed individuals would arguably perceive negative words as more self-referential than positive words. To develop a list of intrinsically—and
matched—self-referential valenced words, we obtained self-referential ratings from depressed and non-depressed individuals.

The purpose of the present pilot studies was to develop a list of self-referential valenced words, as rated by depressed and non-depressed individuals, matched on arousal and other psycholinguistic factors known to influence word processing, including word length, word frequency and number of syllables.

We used a sequential approach. In a first study, self-referential ratings were obtained from an unselected sample in order to develop a shorter list of positively and negatively valenced words, maximized and matched on the obtained self-referential ratings. The 150 positive and 150 negative words of the shortened list were then used as the stimuli for the updating task in Study 3 (see below for details on selection criteria to create this word list). In a second study, self-referential ratings were obtained from participants pre-screened on measures of rumination and depression to validate the self-referential ratings obtained in the first study. We hypothesized that individuals who score high on measures of rumination and depression would rate negative words as more self-referential than individuals who score low on these scores (Greenberg & Beck, 1989); this would allow us to create a list of positive and negative words matched on self-referential ratings of individuals scoring high on measures of rumination and depression.

2.4 Study 1

2.4.1 Method

Participants. Eighty-five participants (45 males, 40 females; age range 18-69; \( M = 35.56, SD = 11.95 \)) completed an online survey. Participants were recruited via the online crowdsourcing platform, Crowdflower, and were paid US$1.50 for their participation. Participation was restricted to residents of the United States, the
United Kingdom, Canada, New Zealand, and Australia. We excluded one participant who took only 8 min to complete the rating task, which was more than 1.5 $SD$ less than the mean time to complete the task ($M = 26$ min, $SD = 11$), as well as eight participants with a repetitive response pattern (e.g., the same rating for all words, or a block of 25 words presented on each page). The final sample size was thus $N = 76$.

**Stimuli.** We selected words from the Affective Norms for English Words pool (ANEW; Bradley & Lang, 2010). The ANEW comprises 2,476 nouns, verbs, and adjectives, with ratings for valence and arousal. From this list, we selected nouns with three to eight letters, and up to three syllables. We created word pools of positive and negative words from words with valence ratings $\geq 6.02$ and $\leq 4.37$ (on 1-9 scale, with higher ratings reflecting more positive valence), matched on word length and arousal (following Joormann & Gotlib, 2008), as well as word frequency (Brysbaert & New, 2009). We then excluded words that could be considered inappropriate or offensive ($n = 19$; e.g., “vibrator”), uncommon words ($n = 6$; e.g., “fawn”), words sharing the first three letters with another word ($n = 174$), or words that were too similar to other list words$^2$ ($n = 307$; e.g., “cruiseship” being similar to “cruise”). The final list contained 620 words (299 positive and 321 negative). Six words that were known to less than 5% of participants ($n = 4$) were excluded from analyses (e.g., “pang”, “gangrene”). Analyses were thus conducted on the final word list of 614 words (298 positive, 316 negative).

**Design and Procedure.** The word list was presented for a self-referential rating using a Qualtrics survey (Qualtrics, Provo, UT). Words were presented in

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$^2$ Where a word pair or group consisted of words with similar valence, words with the less extreme valence were removed; where a word pair or group consisted of words with different valence, positive words were removed, in order to match the number of positive and negative words in the final word list.
random order, and participants were instructed to rate how easily they could relate each word to themselves, on a 1-5 Likert scale with higher ratings indicating greater self-referentiality; that is, participants were asked to give a high rating when the word was one they would use to describe themselves, or when the word described a concept they could easily relate to. Participants could also select “6” if they did not know the meaning of the word.

2.4.2 Results

Descriptive statistics are provided in Table 1. There was obviously a significant difference between mean valences of positive and negative words. Positive and negative words were matched on mean word length, $t(612) = 0.20$, $p = .839$; number of syllables, $t(612) = 0.81$, $p = .418$; and arousal, $t(612) = 0.18$, $p = .856$. However, positive and negative words differed on mean word frequency, $t(328.11) = 3.14$, $p < 0.01$; and self-referential ratings, $t(566.86) = 28.93$, $p < 0.001$.

In Study 2, we will select positive and negative words such that they are matched on mean word frequency and also self-referential ratings in high-DR participants.
Table 1

Descriptive statistics of words in Study 1

<table>
<thead>
<tr>
<th></th>
<th>Positive words (N = 298)</th>
<th>Negative words (N = 316)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>Range</td>
</tr>
<tr>
<td>Valence***</td>
<td>7.24 (0.61)</td>
<td>6.03 – 8.72</td>
</tr>
<tr>
<td>Word length</td>
<td>5.38 (1.39)</td>
<td>3.00 – 8.00</td>
</tr>
<tr>
<td>Number of syllables</td>
<td>1.66 (0.66)</td>
<td>1.00 – 3.00</td>
</tr>
<tr>
<td>Word frequency**</td>
<td>108.90 (384.12)</td>
<td>0.57 – 4,008.39</td>
</tr>
<tr>
<td>Arousal</td>
<td>5.47 (0.93)</td>
<td>2.80 – 8.02</td>
</tr>
<tr>
<td>Self-referential rating***</td>
<td>3.10 (0.44)</td>
<td>2.05 – 4.16</td>
</tr>
</tbody>
</table>

Note. N = 76.

** p < .01 *** p < .001 (Significant difference between positive and negative words).

2.4.3 Discussion

The aim of this study was to obtain self-referential ratings for a list of positive and negative words selected from ANEW (Bradley & Lang, 2010). The mean valence and arousal values obtained for positive and negative words were comparable to those of Joormann and Gotlib (2008). The higher self-referential ratings for the positive compared to the negative words were expected, as the self-referential ratings were provided by an unselected sample. We expected higher self-referential ratings for negative words from a sample of individuals pre-screened on measures of rumination and depression, as compared to ratings for negative words from the unselected sample in Study 1; this was hypothesised to also reduce or eliminate the difference between the self-referential ratings from depressive ruminators for positive and negative words.
To reiterate for the sake of clarity: First, in Study 1, we obtained self-referential ratings from an unselected sample for 620 positive and negative words, matched on factors known to influence word processing. As expected, we found that self-referential ratings were higher for positive compared to negative words in this unselected sample. In Study 2, we selected 300 words that are high on self-referential ratings—while matched on factors that influence word processing—and obtained self-referential ratings from individuals pre-screened on rumination and depression measures.

2.5 Study 2

The aim of Study 2 was to validate the self-referentiality of valenced words used as word stimuli for the memory updating task (Study 3), from individuals pre-screened on rumination and depression measures. The objective was to maximise, as well as match, the self-referential ratings for positive and negative words, as rated by participants who score high on both rumination and depression measures. We hypothesized that individuals scoring high on rumination and depression scores would rate negative words as more self-referential than individuals who score low. This would reduce the difference in self-referential ratings between the positive and negative words (as observed in Study 1) in this pre-screened sample.

2.5.1 Method

**Participants.** A total of 185 students (57 males, 128 females, mean age \(M = 20.6\) years; \(SD = 6.91\); age range 18-71 years) from the University of Western Australia completed the word rating task as described in Study 1. We selected participants who scored high or low on the Rumination Response Scale (RRS; Nolen-Hoeksema & Morrow, 1991; details below) and the depression scale of the short version of the Depression Anxiety Stress Scales (DASS-21; Lovibond &
Lovibond, 1995; details below). As the DASS-21 is a time-sensitive measure, the DASS depression scale was readministered on test day, using the full DASS-42 version. The high depressive-rumination (DR) group \( (n = 90) \) comprised individuals with RRS scores \( \geq 40 \) (Onraedt & Koster, 2014; score range was 40-88; possible range is 22-88) and test-day DASS depression scores \( \geq 10 \) (Lovibond & Lovibond, 1995; score range was 10-42; possible range is 0-42). The low-DR group \( (n = 95) \) comprised individuals with RRS scores \( \leq 33 \) (score range was 22-33) and test-day DASS depression scores \( \leq 9 \) (score range was 0-9). Mean RRS and DASS depression scores were \( M_{\text{RRS}} = 60.94 \) (\( SD_{\text{RRS}} = 11.08 \)), \( M_{\text{DASS}} = 20.03 \) (\( SD_{\text{DASS}} = 7.95 \)) for the high-DR group, and \( M_{\text{RRS}} = 27.49 \) (\( SD_{\text{RRS}} = 3.05 \)), \( M_{\text{DASS}} = 2.46 \) (\( SD_{\text{DASS}} = 2.54 \)) for the low-DR group. The mean RRS score (Joormann & Gotlib, 2008; Watkins et al., 2007) and level of depression severity (Ronk, Korman, Hooke, & Page, 2013) in the high-DR group were comparable to high depression groups in these previous studies. All norms in Table 2 are taken from ANEW (Bradley & Lang, 2010), except for word frequency (taken from Brysbaert & New, 2009).

**Measures.**

**Ruminative Response Scale (RRS).** The RRS is a subscale of the Response Style Questionnaire (Nolen-Hoeksema & Morrow, 1991). It is a 22-item self-report questionnaire that assesses how often participants respond to symptoms of depression in a ruminative way (e.g., “I think about how sad I feel”) on a scale of 1 (almost never) to 4 (almost always). Scores below 40 suggest low rumination tendencies (Crane, Goddard, & Pring, 2013).

**Depression Anxiety Stress Scales (DASS).** The DASS (Lovibond & Lovibond, 1995) is a 42-item self-report questionnaire assessing current mood state—specifically levels of depression, anxiety, and stress experienced over the past
week. The DASS depression scale and the DASS-21 depression scale used in the initial screening of participants consist of 14 and seven items, respectively, with adequate reliability and validity (Henry & Crawford, 2005).

Materials and Procedure. As expected, self-referential ratings were lower for negative than positive words in Study 1. The aim was to create lists of positive and negative words matched on self-referential ratings in high-DR participants. In the selection of words from Study 1, we thus attempted to maximise the valence difference between positive and negative words, while matching positive and negative words on all other factors (i.e., word length, word frequency, number of syllables, arousal, and self-referential ratings). To that end, we (a) excluded high-frequency positive words (e.g., “god”, ‘love”) to match the lower mean word frequency of negative words; (b) selected negative words with the highest self-referential ratings; (c) excluded positive words with self-referential ratings above 3.57 (to match the maximum self-referential rating of a negative word, which was 3.56); and (d) selected the 150 positive words with the highest valence ratings (valence > 7). The final list of 150 positive and 150 negative words is provided in Appendix A. Therefore, in Study 1, an unselected sample provided self-referential ratings for 620 words; the ratings were then validated in Study 2 where high- and low-DR participants rated a subset of 300 words.

2.5.2 Results

Descriptive statistics are presented in Table 2. Positive and negative words were matched on mean word length, $t(298) = 1.80, p = .074$; and mean word frequency, $t(298) = 0.11, p = .910$. Despite our best efforts to match positive and negative words on all factors, there was a small but statistically significant difference
between positive and negative words in number of syllables, \( t(298) = 2.37, p = .019; \)
and arousal, \( t(298) = 3.09, p = .002. \)

Table 2

<table>
<thead>
<tr>
<th></th>
<th>Positive words ((N = 150))</th>
<th>Negative words ((N = 150))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( M (SD) )</td>
<td>( M (SD) )</td>
</tr>
<tr>
<td>Valence***</td>
<td>7.57 (0.43)</td>
<td>3.06 (0.73)</td>
</tr>
<tr>
<td>Word length</td>
<td>5.62 (1.43)</td>
<td>5.33 (1.40)</td>
</tr>
<tr>
<td>Number of syllables*</td>
<td>1.79 (0.68)</td>
<td>1.60 (0.69)</td>
</tr>
<tr>
<td>Word frequency</td>
<td>53.50 (93.84)</td>
<td>54.88 (116.67)</td>
</tr>
<tr>
<td>Arousal**</td>
<td>5.79 (0.86)</td>
<td>5.46 (0.95)</td>
</tr>
<tr>
<td>Self-referential rating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-DR group</td>
<td>3.10 (0.47)</td>
<td>3.00 (0.54)</td>
</tr>
<tr>
<td>Low-DR group***</td>
<td>3.22 (0.49)</td>
<td>2.21 (0.39)</td>
</tr>
</tbody>
</table>

Note. \( N = 185; \) DR = Depressive rumination.

* \( p < .05 \) ** \( p < .01 \) *** \( p < .001 \) (Significant difference between positive and negative words).

Consistent with the literature (Wittekind, Terfehr, Otte, Jelinek, Hinkelmann, & Moritz, 2014) and as hypothesized, the high-DR group rated negative words as more self-referential \((M = 3.00, SD = 0.54)\) than the low-DR group \((M = 2.21, SD = 0.39)\), \( F(1,596) = 209.18, p < .001. \) The difference between the high-DR group \((M = 3.10, SD = 0.47)\) and the low-DR group \((M = 3.22, SD = 0.49)\) for positive words was also statistically significant, \( F(1,596) = 4.45, p = .035. \) The difference in mean self-referential ratings between positive and negative words in the low-DR
group was significant, $F(1,596) = 335.29, p < .001$. Importantly, this difference in the high-DR group was not significant, $F(1,596) = 3.02, p = .083$.

### 2.5.3 Discussion

The aim of the present studies was to develop a list of valenced words that were intrinsically self-referential—as rated by participants pre-screened on rumination and depression measures—and matched on arousal and psycholinguistic factors known to influence word processing. To the best of our knowledge, there is no large word database with intrinsically self-referential valenced words, other than the unpublished manuscripts of Myers (1980a, 1980b). The list constructed in this study was thus not only useful for the memory updating task described in Study 3, but may also facilitate future investigations of verbal processing in depressive ruminators.

As expected, the word rating task revealed that compared to low-DR individuals, high-DR individuals rated negative words as more self-referential. This invariably also means that positive words need to have higher arousal ratings in order to match self-referential ratings between positive and negative words in high-DR individuals, which then results in a difference in self-referential ratings between positive and negative words in low-DR individuals. We created two word lists with equivalent self-referentiality rating in high-DR participants, with arguably negligible differences in mean arousal and number of syllables. However, this inevitably results in higher self-referentiality ratings for negative words in high- compared to low-DR group.

This is the first study to obtain self-referential ratings for positive and negative words, matched on factors known to affect word processing, including word length, word frequency, number of syllables, and arousal. The word list developed in these
studies provide a large database of positive and negative words matched on these factors, which will facilitate experiments designed to investigate the nature of valence in depressive rumination, controlling for the effects of self-reference.

2.6 Conclusion

The objective of Studies 1 and 2 was to create a list of positively and negatively valenced words, with maximized and matched self-referential ratings provided by participants screened on measures of rumination and depression (Study 2), and also matched on other psycholinguistic factors known to influence word processing. The created list contains 150 positive and 150 negative words that served as word stimuli for the memory updating task (Study 3). To investigate the nature of potential effects of valence on memory updating impairments in depressive ruminators, we were thus able to control for the confounding effects of the self-reference effect and other characteristics of the word stimuli.
2.7 References


Ji, J. L., Grafton, B., & MacLeod, C. (2017). Referential focus moderates depression-linked attentional avoidance of positive information. Behaviour Research and Therapy, 93, 47-54.


Chapter 3: Impaired Memory Updating Associated with Impaired Recall of Negative Words in Depressive Rumination—Evidence for a Removal Deficit
3.1 Abstract

We present evidence that depressive rumination involves a working memory (WM) updating deficit. Sixty-one undergraduates—pre-screened with rumination and depression scales—completed a novel task providing a specific measure of WM updating. This task involved the substitution of emotionally-valenced words, and provided a specific, response-time measure of the time taken to remove outdated items from WM. Results showed that depressive ruminators spent less time removing outdated words from WM when the new to-be-remembered word was negative. This effect was (1) associated with impaired subsequent recall of negative words, arguably caused by interference from the insufficiently removed outdated words; and (2) correlated with participants’ rumination scores. This is the first study to use the novel removal task to investigate the nature of WM-updating impairments in rumination. The findings are consistent with a negative attentional bias in rumination, and provide preliminary evidence that rumination is associated with a valence-generic removal deficit during WM updating. Reducing the attentional bias could thus be an intervention target in the treatment of depressive rumination.
3.2 Introduction

Working memory (WM) is a limited-capacity system responsible for the temporary short-term storage and processing of information (Baddeley, 1992). Due to its limited capacity, the ability to update the contents of WM and keep them relevant is necessary for its efficient functioning (Oberauer, Lewandowsky, Farrell, Jarrold, & Greaves, 2012). In the depression literature, it has been argued that a relative inability to update WM content may be related to an inability to regulate negative emotion, thus contributing to the development and/or maintenance of depression (Joormann & Gotlib, 2008). In line with this notion, a hallmark of depression is rumination: the repetitive and persistent focus on negative thoughts, including thoughts about depressive symptoms, their causes, and consequences (Nolen-Hoeksema & Morrow, 1991).

3.2.1 Working Memory Impairment in Rumination—The Role of Valence

As we have elaborated earlier, rumination can be both a trait and can have state effects (LeMoult, Arditte, D’Avanzato, & Joormann, 2013). There are two ways in which impaired WM updating could contribute to rumination. First, there could be a general WM-updating impairment such that updating is impaired for any material that is in WM, thus leading to an attentional focus on contents already in WM. These contents may be mainly negative if a person finds themselves in an ongoing negative life situation, or in a chronic negative mood (given the salience of negative schemas associated with a negative mood state). The persistent focus on negative information will then invoke deeper processing and integration of the negative information in WM. Such a mechanism would promote the maintenance of depression (Whitmer & Gotlib, 2013). Second, there could be a valence-specific WM-updating impairment, such that updating is impaired only with negative information. In this case, negative
information that happens to enter WM will be more difficult to update and may thus linger in WM, which in turn could lead to a persistent focus on negative information and its consequences, including the fostering of negative mood.

Consistent with a general WM-updating impairment in depressive ruminators, Meiran, Diamond, Toder, and Nemets (2011) suggested that depression is characterized by a general WM-updating impairment. This study used a variant of an operation-span task that involved updating. Participants encoded a set of digits and this was followed by a series of updating steps; at each step, a digit was replaced with the result of an arithmetic operation performed on the to-be-replaced digit. It was found that rumination in participants with depression correlated negatively with post-updating digit recall. As digits are valence-neutral, this is evidence for a relation between depressive rumination and a general WM-updating impairment.

In line with the second possibility that there is a valence-specific WM-updating impairment, it has been found that WM updating in depression is specifically impaired when it involves negatively-valenced materials (Joormann & Gotlib, 2008). Joormann and Gotlib used a modified Sternberg task; in this task, individuals memorized two lists of words—one negative and one positive—and were subsequently told to ignore one of the lists (i.e., the irrelevant list). This was followed by a recognition task, where participants had to reject words that were not from the relevant list. The effect of interest here was an intrusion effect: At test, when participants were presented with words from both the relevant to-be-remembered and the irrelevant to-be-ignored list, as well as new words, response times were longer for rejections of irrelevant words compared to new words of the same valence. For negative words, this intrusion effect was greater in individuals with depression than controls, and correlated positively with rumination scores. This
valence-specific intrusion effect was interpreted as a WM-updating impairment for negative information in participants with depression. Such a finding is also consistent with the impaired attentional disengagement hypothesis of depressive rumination (Koster, De Lissnyder, Derakshan, & De Raedt, 2011; Grafton, Southworth, Watkins, & MacLeod, 2016), where depressive ruminators are slower to disengage attention from negative, compared to positive, materials. However, Yoon, LeMoult, and Joormann (2014) failed to replicate this finding and instead found that depression was associated with a WM-updating impairment for any emotionally-valenced material—that is, both negative and positive words. Furthermore, Levens and Gotlib (2009) suggested an alternative explanation for the valence-specific WM-updating impairment in depression, namely that depression is associated with an impaired selection of positive information (i.e., a positive insensitivity). In sum, there seems to be some evidence for impaired WM updating in rumination/depression but the nature of this impairment remains unclear.

To the extent that a WM-updating impairment contributes to a focus on negative information in WM, it may thereby also contribute to the well-established finding that individuals with depression tend to better remember negative information. For example, Matt, Vazquez, and Campbell (1992) found a valence-specific memory enhancement for negative materials in individuals with depression across studies using different tasks. However, a valence-specific memory enhancement could also result from a basic attentional bias towards negative information that results in stronger encoding of negative items into memory (cf. Joormann & Gotlib, 2007). In sum, while a WM-updating impairment could contribute to rumination/depression, rumination/depression could also contribute to a WM-updating impairment (Levens, Muhtadie, & Gotlib, 2009), or both WM-
updating impairment and rumination/depression could be linked to a common third factor.

3.2.2 Methodological Issues

The empirical situation is further complicated by two methodological issues. First, in the literature, sample selection is typically based on depressive symptoms, despite the fact that rumination is considered a more stable trait than depression, and a stronger predictor of WM impairments (Koster, De Raedt, Leyman, & De Lissnyder, 2010). Second, there is considerable variability in the tasks employed, and the utilized tasks may not always measure precisely what they purport to measure. To illustrate, Gotlib and colleagues (2004) found that different measures of cognitive bias (e.g., emotional Stroop, dot probe, self-referential encoding) did not correlate in a sample of individuals with depression. This could indicate either that there are uncorrelated cognitive processes underlying performance on these tasks (Gotlib et al., 2004), such that the tasks all measure the same broad bias construct but different aspects of it (Dalgleish et al., 2003), or that some of the tasks do not actually measure cognitive bias.

Likewise, in the context of WM updating more specifically, it has been argued that tasks traditionally used to investigate WM updating measure primarily WM capacity (Ecker, Lewandowsky, Oberauer, & Chee, 2010; Schmiedek, Hildebrandt, Lövdén, Wilhelm, & Lindenberger, 2009), or do not even involve WM updating (Bunting, Cowan, & Saults, 2006). Ecker and colleagues (Ecker, Lewandowsky, & Oberauer, 2014; Ecker, Oberauer, & Lewandowsky, 2014) recently argued that an item-wise removal process lies at the core of WM updating, serving to actively remove no-longer relevant information from WM so it can be replaced with new information. They introduced a novel WM-updating task that
specifically measures the efficiency of this core updating process of removal. In a nutshell, this task provides a specific, response-time measure of the time taken for the removal of outdated information from WM.

A number of individual-differences studies have used variants of this task to investigate the relation between removal and various other constructs, including WM capacity. The most recent study demonstrated covariation between the removal subprocess and WM capacity at the latent-variable level (Singh, Gignac, Brydges, & Ecker, 2018). Singh et al. argued that efficient removal of outdated or irrelevant information from a limited-capacity WM system can facilitate maintenance of relevant information and thus effectively increase available WM capacity. However, the observed relation between removal efficiency and WM capacity was weak, and even non-significant in earlier studies (Ecker et al., 2010; Ecker, Lewandowsky, et al., 2014). This suggests that the removal task measures a process that is primarily devoted to WM updating per se.

### 3.2.3 The Self-Reference Effect

The present study used valenced word stimuli in a memory updating task. In addition to valence, an additional stimulus dimension of importance is self-referentiality. There is mounting evidence of the self-reference effect in depression (SRE; Derry & Kuiper, 1981; LeMoult, Kircanski, Prasad, & Gotlib, 2016; for review see Wisco, 2009)—the finding that encoding materials with reference to the “self” promotes a deeper level of processing, which contributes to better memory. Moreover, Wittekind, Terfehr, Otte, Jelinek, Hinkelmann, and Moritz (2014) proposed that self-referentiality of materials may account for the mixed findings regarding valence-specific memory updating in depression. Therefore, we used self-referential positive and negative words to investigate the effect of valence on
memory updating in depressive ruminators. We also attempted to control for the SRE by matching valenced words on self-referentiality; this would rule out the SRE confounding the observed findings. Furthermore, because we expected self-referentiality ratings to differ between the unselected sample and depressive ruminators, our primary objective was to select valenced words matched on self-referentiality as rated by depressive ruminators (Study 2). While the primary objective of matching positive and negative words on self-referential ratings by depressive ruminators was achieved, these valenced words were not matched on self-referential ratings as provided by individuals who score low on depression and rumination measures.

3.2.4 The Current Study

The main aim of the present study was to investigate the nature of potential WM-updating impairments in depressive ruminators. To address the two methodological issues mentioned earlier, we selected participants based on a combination of rumination and depression indicators, and we used the novel removal measure as the main dependent variable.

Following previous findings of a more pronounced WM-updating impairment in depression with self-referential materials (Kuiper & Derry, 1982), we used

3 Based on the notion that rumination is considered a stronger predictor of WM impairments than depression (Koster et al., 2010), we could have selected participants just based on rumination tendencies. Indeed, had we hypothesized that any potential updating deficit was generic, this would have been an obvious choice: In this scenario [see point (1) above], the updating deficit would contribute to rumination tendencies, and this could contribute to the onset of depression to the extent that a person finds themselves in an ongoing negative life situation or negative mood. In this case, rumination could be seen as a primary symptom. However, we also hypothesized [see point (2) above] that there might be a valence-specific updating deficit associated with dysphoria or depression, which could itself lead to rumination. In this case, rumination would be a secondary symptom, and discovering such a deficit would be possible only by screening on depression, and even more likely if screening on both depression and rumination concurrently. Moreover, the approach of previous
positive/negative self-referential words as stimuli. Drawing on research that found an
WM-updating impairment for (e.g., Joormann & Gotlib, 2008), and more
specifically, an attentional-disengagement impairment from (Koster, De Lissnyder,
Derakshan, & De Raedt, 2011; Grafton, Southworth, Watkins, & MacLeod, 2016),
negatively-valenced materials in depressive rumination, we hypothesized that there
would be a valence-specific impairment in WM updating in depressive ruminators
such that they would be slower to update negative (compared to positive) words.

3.3 Method

3.3.1 Participants

A-priori power analysis (G*Power 3; Faul, Erdfelder, Lang & Buchner,
2007) suggested a minimum sample size of 62 participants to detect a small-size
effect of $f = 0.15$ at $\alpha = 0.05$, $1-\beta = 0.8$, and a moderate correlation between repeated
measures of $r = 0.5$. Seventy-eight undergraduate students from the University of
Western Australia participated in this study for partial course credit, after reading an
ethically-approved information sheet and providing informed consent. Participants
were recruited based on their responses on the Ruminative Response Scale (RRS)—a
subscale of the Response Style Questionnaire (Nolen-Hoeksema & Morrow, 1991)—
and the Depression scale of the short-form version of the Depression Anxiety Stress
Scales (DASS-21; Lovibond & Lovibond, 1995) in a screening exercise ($N \approx 800$;
participants were selected from the outer quintiles of the respective distributions).
Given its temporal specificity, the DASS was re-administered on test day in its full

memory updating studies of selecting participants based solely on depression scores has
produced inconsistent findings, as reviewed earlier. For these reasons, we selected
participants who scored high and low on both constructs simultaneously. While this
approach prevents us from disentangling the relative contributions of rumination and
depression directly, it can nevertheless provide hints regarding how these conditions may
relate to potential generic or valence-specific memory updating deficits, which future
research can explore.
form (DASS-42; Lovibond & Lovibond, 1995), and participants from the pre-screened sample were removed if the test-day depression score did not confirm the classification based on the pre-screened score \( n = 10 \).

The high depressive rumination (DR) group comprised individuals with RRS scores \( \geq 41 \) (cf. Cook & Watkins, 2016; Onraedt & Koster, 2014; score range was 41-83; possible range is 22-88) and test-day DASS-Dep scores \( \geq 10 \) (cf. Lovibond & Lovibond, 1995; score range: 10-42; possible range: 0-42). The low-DR group comprised individuals with RRS scores \( \leq 32 \) (range 22-32) and test-day DASS-Dep scores \( \leq 9 \) (range 0-9). Three participants were removed due to outlying accuracy in the recall test of the memory updating task (see Results for details); another four participants were removed due to a program error. The final sample thus comprised \( N = 61 \) participants (25 in the high-DR group, 36 in the low-DR group; 20 males, 41 females) with a mean age of 19.4 years (age range 17-52 years; \( SD = 5.13 \)). High- and low-DR groups differed significantly in mean RRS scores, \( t (59) = 19.27, \) and DASS-Dep scores, \( t (59) = 11.12, \) \( ps < .001 \) (high-DR: \( M_{RRS} = 66.20, SD_{RRS} = 10.12; \) \( M_{DASS} = 21.28, SD_{DASS} = 8.49; \) low-DR: \( M_{RRS} = 26.24, SD_{RRS} = 2.71; \) \( M_{DASS} = 2.11, SD_{DASS} = 1.79 \)). There was no gender difference in RRS scores and the depression scale of DASS scores, \( ps > .244 \). The mean RRS scores are comparable to the samples in Joormann and Gotlib (2008) and Watkins et al. (2007). The level of depression severity in the high-DR group was above the clinical cut-off proposed by Ronk, Korman, Hooke, and Page (2013).

### 3.3.2 Measures

**Ruminative Response Scale (RRS).** The RRS (Nolen-Hoeksema & Morrow, 1991) is a 22-item self-report questionnaire that assesses how often participants respond to depressed mood in a ruminative manner (e.g., “I think about all my
shortcomings, failings, faults, mistakes”) on a scale of 1 (almost never) to 4 (almost always). Scores on the RRS suggest a level of rumination from low (< 40), to normal (40-50), above normal (50-60), to clinically significant (≥ 60; Crane, Goddard, & Pring, 2013). The RRS has good test-retest reliability and acceptable validity (Nolen-Hoeksema & Morrow, 1991; Nolen-Hoeksema, Parker, & Larson, 1994; Treynor, Gonzalez, & Nolen-Hoeksema, 2003) and the internal consistency (Cronbach’s alpha) in the present study was α = .95.

**Depression Anxiety Stress Scale (DASS).** The DASS (Lovibond & Lovibond, 1995) is a 42-item self-report questionnaire assessing current mood state—specifically levels of depression, anxiety, and stress experienced over the past week. Items (e.g., “I couldn’t seem to experience any positive feeling at all”) are rated on a scale from 0 (did not apply to me at all) to 3 (applied to me very much, or most of the time). The DASS depression scale (DASS-Dep) consists of 14 items with adequate reliability and validity (Henry & Crawford, 2005). In the present study, the internal consistency of the DASS-Dep was α = .98, and the correlation between DASS-Dep and RRS was r = .55, p < .001. The short version (DASS-21) was used in the initial screening of participants and has 21 items, seven of which form the depression scale (DASS-21-Dep). It also has adequate reliability and validity (Henry & Crawford, 2005). In the present study, the internal consistency of DASS-21-Dep was α = .91, and the correlation between DASS-Dep and DASS-21-Dep was r = .74, p < .001.

**3.3.3 Stimuli**

In the WM-updating task, we used nouns selected from the Affective Norms for English Words pool (ANEW; Bradley & Lang, 2010). From this list, nouns with three to eight letters and up to three syllables were selected; negative and positive
word pools were created from words with valence ratings $\leq 4.37$ and $\geq 6.02$ (on 1-9 scale, with higher ratings reflecting positive valence), matched for word frequency (Brysbaert & New, 2009; possible range 0.02-41,857), following Joormann and Gotlib (2008). Word lists are provided in Appendix A and descriptive statistics are provided in Table 3.

Table 3

**Descriptive statistics of word stimuli**

<table>
<thead>
<tr>
<th></th>
<th>Positive words ($N = 150$)</th>
<th>Negative words ($N = 150$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M (SD)$</td>
<td>Range</td>
</tr>
<tr>
<td>Valence***</td>
<td>7.57 (0.43)</td>
<td>7.00 – 8.72</td>
</tr>
<tr>
<td>Word length</td>
<td>5.62 (1.43)</td>
<td>3.00 – 8.00</td>
</tr>
<tr>
<td>Number of syllables*</td>
<td>1.79 (0.68)</td>
<td>1.00 – 3.00</td>
</tr>
<tr>
<td>Word frequency</td>
<td>53.50 (93.84)</td>
<td>1.00 – 640.76</td>
</tr>
<tr>
<td>Arousal**</td>
<td>5.79 (0.86)</td>
<td>2.97 – 7.72</td>
</tr>
<tr>
<td>Self-referential rating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High-DR group</td>
<td>3.10 (0.55)</td>
<td>1.74 – 4.42</td>
</tr>
<tr>
<td>Low-DR group***</td>
<td>3.16 (0.51)</td>
<td>1.91 – 4.16</td>
</tr>
</tbody>
</table>

*Note. $N = 61$; DR = Depressive Rumination.

*p < .05 **p < .01 ***p < .001 (Significant difference between positive and negative words).

To obtain general self-referentiality (SR) ratings, the resulting list of 620 words (321 negative, 299 positive) was presented to a separate sample of $N = 85$ participants (45 males, 40 females; age range 18-69; $M = 35.56$, $SD = 11.95$) in an online pilot rating survey. Words were presented in random order, and participants
were instructed to rate how easily they could relate each word to themselves (i.e., if they would use it to describe themselves or a concept they could easily relate to) on a 1-5 Likert scale, with higher ratings indicating greater SR.

Based on these SR ratings (i.e., selecting words with high SR), 150 negative and 150 positive words were selected, maximising the difference in valence while attempting to minimise differences on all other variables (SR, word frequency, word length, number of syllables, and arousal). This final list of 300 words was used for the WM-updating task in the main study; mean ANEW valence scores were $M = 3.06$ for the negative words and $M = 7.57$ for the positive words.$^4$

### 3.3.4 Design and Procedure

The WM-updating task was adapted from Ecker, Lewandowsky, et al. (2014), and used words randomly drawn from the list of 150 negative and 150 positive self-referential words. The task consisted of 90 trials, presented in three blocks of 30. Each trial in this task comprised three stages: encoding, updating, and recall.

Participants first encoded three words, presented simultaneously in individual frames for 3,000 ms. This was followed by a series of updating steps, which was of unpredictable length (i.e., there was a constant stopping probability of $p = .15$, and a maximum number of 9 updating steps, resulting in a mean of approximately 5.12 updating steps per trial). At each updating step, one word was replaced by a new

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$^4$ There were statistically significant but numerically negligible differences in the number of syllables and arousal ratings between negative and positive words. Also, in an additional manipulation-check experiment, we obtained SR ratings from $N = 61$ high- and low-DR participants (48 of whom also participated in the main study). We found that SR ratings of positive words were slightly higher than those of negative words, and not unexpectedly, this difference was larger for the low-DR group. The descriptive statistics provided in Table 3 are based on 61 participants, which is the data available at the time this manuscript was submitted for publication; descriptive statistics presented in Study 2 (Table 2) are based on 185 participants.
word. Before the new word was presented, a cue—one of the three frames turning bold and red—indicated which word was about to be updated. The duration of this cue (the cue-target interval, CTI) was either long (1,500 ms) or short (200 ms); this varied randomly on a step-by-step basis and was thus a within-subjects manipulation. The reason for this variation in CTI is that a short CTI would only allow participants to move their focus of attention to the to-be-updated frame, without any opportunity to remove the currently held item; by contrast, the long CTI should allow active removal of the outdated item (Ecker, Lewandowsky, et al., 2014). The task involved updating in four different valence-shift conditions: from a negative to a negative word (neg-neg), a negative to a positive (neg-pos), a positive to a negative (pos-neg), or a positive to a positive (pos-pos) word; again, this was a randomly varying within-subjects manipulation. The experiment thus had a 2 (DR group) × 2 (CTI) × 4 (valence-shift condition) mixed-factorial design with approximately 49 updating steps per cell.

At each updating step, participants pressed the space bar to indicate completion of memory updating, with a response deadline of 5 s; this provided a measure of updating response time (RT), measured from onset of the new word. The dependent variable of main interest was a removal-time index, which was derived from the difference in updating RT between the long- and short-CTI conditions for each valence-shift condition, calculated as a proportional-gain score following Ecker, Lewandowsky, et al., 2014) as follows:

\[
\text{Removal-time Index} = \frac{\text{mean}(\text{short CTI}) - \text{mean}(\text{long CTI})}{\text{mean}(\text{short CTI})}.
\]

The rationale for this measure is as follows: In the long-CTI condition, participants would have sufficient time to remove the outdated word before the new to-be-updated word is presented. Thus, when the new word is presented, the RT
would represent mainly the time taken to encode the new word. By contrast, in the short-CTI condition, participants would not have sufficient time to remove the outdated word, so that when the new to-be-updated word is presented, the RT would represent the time taken to remove the outdated word and encode the new word. Thus, it can be assumed that the time taken for removal is a constituent component of updating RT in the short-CTI condition but not the long-CTI condition (Ecker, Lewandowsky, et al., 2014). Hence, the RT difference between conditions can be considered an estimate of the time taken for removal of an outdated item. Expressing this measure as a proportional score controls for overall differences in processing speed.

At the end of each trial, there was a cued-recall test of the last word that was presented in each of the frames, with words cued in a random order. Participants typed the first three letters of the word they remembered for a particular frame, and this provided a measure of recall accuracy (following Fenton & Ecker, 2015). An example of a trial sequence is shown in Figure 1.

---

5 This was done to minimize inter-trial interval variance across trials and participants, and to reduce participant workload and overall testing time. In the vast majority of cases, the first three letters were unique; of the 300 words, only 21 pairs and 3 triplets shared the first three letters, and so it would only happen on less than 1% of all trials that two words sharing the first three letters would appear.
Figure 1. A trial sequence of the removal task. The example trial features 2 updating steps. Adapted from Ecker, Lewandowsky, and Oberauer (2014).
3.4 Results

3.4.1 Recall Accuracy Analyses

Word recall was scored as correct when at least two of the first three letters were correctly entered. To ensure adequate encoding and updating, three participants with recall accuracy more than 3 SDs from the grand mean were discarded for the RT analyses, as mentioned earlier. As expected, overall recall accuracy was high at 92% correct; mean recall accuracies by group and word valence are shown in Figure 2. A 2 (DR group: high vs. low) × 2 (word valence: negative vs. positive) repeated measures ANOVA revealed a significant interaction between DR group and word valence in mean recall accuracy, \( F(1,59) = 4.02, p = .05, \eta_p^2 = .06. \)

Contrary to expectations, recall accuracy in the high-DR group was lower for negative words than positive words, \( F(1,59) = 4.70, MSE = 0.004, p = .03. \)

---

6 Lenient scoring was applied to accommodate for certain types of occasionally occurring errors resulting from typos and non-registered key presses; thus, if the correct response was \( abc, \) responses \( abx, axc, xcb, \) and also \( acx \) were scored as correct. This was necessary because the program did not allow participants to correct an error once a letter on the keyboard was pressed. The following analyses were also run with strict correct-in-position scoring. This reduced the accuracy rate to 87%, but analysis outcomes were identical unless indicated otherwise.

7 Applying strict recall-accuracy scoring, the interaction between DR group and word valence was no longer statistically significant, \( p = .38; \) however, the valence effect in the high-DR group remained significant, \( p = .04. \)
Figure 2. Mean recall accuracy in updating task for negative and positive words by DR group. Error bars indicate within-subject standard errors of the mean.

Note. DR = Depressive Rumination.

### 3.4.2 Updating Response Time Analyses

Mean updating RTs excluded RTs below 300 ms and above the time limit of 5 s. The overall mean RT was $M = 1,096$ ms ($SD = 375$ ms). The mean updating RTs by DR group, CTI conditions, and valence-shift conditions are presented in Table 4.
Table 4

*Updating response times, in seconds, by DR groups, CTI conditions, and valence-shift conditions*

<table>
<thead>
<tr>
<th></th>
<th>High-DR group</th>
<th>Low-DR group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N = 25</td>
<td>N = 36</td>
</tr>
<tr>
<td>M (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long CTI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative-Negative</td>
<td>1.047 (0.43)</td>
<td>0.918 (0.32)</td>
</tr>
<tr>
<td>Negative-Positive</td>
<td>1.018 (0.42)</td>
<td>0.948 (0.32)</td>
</tr>
<tr>
<td>Positive-Negative</td>
<td>1.038 (0.39)</td>
<td>0.948 (0.32)</td>
</tr>
<tr>
<td>Positive-Positive</td>
<td>1.014 (0.40)</td>
<td>0.960 (0.33)</td>
</tr>
<tr>
<td>Short CTI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative-Negative</td>
<td>1.265 (0.43)</td>
<td>1.190 (0.38)</td>
</tr>
<tr>
<td>Negative-Positive</td>
<td>1.278 (0.44)</td>
<td>1.169 (0.38)</td>
</tr>
<tr>
<td>Positive-Negative</td>
<td>1.262 (0.45)</td>
<td>1.170 (0.38)</td>
</tr>
<tr>
<td>Positive-Positive</td>
<td>1.257 (0.42)</td>
<td>1.181 (0.39)</td>
</tr>
</tbody>
</table>

*Note*. DR = Depressive Rumination; CTI = cue-target interval.

### 3.4.3 Removal-Time Indices Analyses

Removal-time indices derived from the updating RTs across conditions are presented in Figure 3.
Figure 3. Removal-time index in updating task across valence-shift conditions by RRS group. Error bars indicate within-subject standard errors of the mean. 

Note. DR = Depressive Rumination.

A 2 (DR group: high vs. low) × 4 (valence-shift: neg-neg vs. neg-pos vs. pos-neg vs. pos-pos) mixed-design ANOVA on the removal-time index data revealed an DR group × valence-shift interaction, $F(3,177) = 3.51$, $p = .02$, $\eta^2_p = .06$. Participants in the low-DR group showed prolonged removal time when updating from a negative to another negative word, while otherwise showing relatively uniform removal times [i.e., the neg-neg condition differed from the other three pooled conditions, $F(1,59) = 19.70$, $MSE = .003$, $p < .001$]. When gender was included as an additional
factor, there was no main effect of gender, and gender did not interact with group or valence-shift condition.

Of main interest, however, participants in the high-DR group spent significantly less time removing words when updating towards a negative word (i.e., valence-shift conditions neg-neg and pos-neg) compared to updating towards a positive word (neg-pos and pos-pos), $F(1,59) = 4.05, MSE = .004, p = .05$. Moreover, this measure—the time taken for removal when updating towards a negative word—correlated significantly with high-DR participants’ rumination scores ($r = - .41, p = .04$).

As less time removing an outdated item when updating towards a to-be-remembered item might negatively impact on memory for the to-be-remembered item, particularly in the short-CTI condition (where removal and encoding are not artificially segregated as in the long-CTI condition), we applied a linear-regression analysis to predict recall accuracy for words last updated with a short CTI from the removal-time indices. Specifically, the regression analysis concurrently predicted recall accuracy for all four valence-shift conditions separately; that is, the removal-time index associated with each valence-shift condition was used to predict recall of words last updated in that given condition. This regression analysis revealed that removal time was a significant predictor of recall accuracy in the short-CTI condition, particularly in the high-DR group [$R^2 = .04, F(1,98) = 4.95, p = .03$; low-DR group, $R^2 = .01, F(1,142) = 2.97, p = .09$]. We also note that the encoding times of negative words cannot account for the lower recall accuracy of negative words in the high-DR group, as in fact high-DR participants took slightly longer to encode negative relative to positive words, as reflected in the long-CTI updating RTs, $F(1,59) = 6.15, MSE = 0.02, p = .02$. 


3.5 Discussion

The main aim of the present study was to investigate the nature of potential WM-updating impairments in depressive ruminators, specifically with regards to the removal subprocess of WM updating (Ecker, Lewandowsky, et al., 2014, Ecker, Oberauer, et al., 2014). WM updating has real-world relevance as there is a constant need to attend to new information in the environment and disengage from irrelevant or outdated WM contents. We hypothesized that there would be a valence-specific impairment in WM updating in the high-DR group, with slower removal of negative words from WM compared to positive words, in line with the notion of ruminators potentially “clinging” onto negative information in WM. This hypothesis was derived from previous studies that investigated WM updating in depression and rumination, which found that irrelevant negative material created substantial interference in WM (Joormann & Gotlib, 2008).

3.5.1 Negative Attentional Bias

However, contrary to expectations, the removal deficit found in the high-DR group depended on the valence of the new words—not the valence of the to-be-removed words. Of main interest, participants in the high-DR group spent less time on outdated-item removal when updating towards a negative word. This exploratory finding can be interpreted as the result of an attentional bias towards negative information (Joormann & Gotlib, 2007; Peckham, McHugh, & Otto, 2010), such that cognitive resources are prematurely directed towards the encoding of a new negative word at the expense of the removal process. This arguably resulted in incomplete or inadequate removal of outdated words, regardless of their valence, in the presence of new negative words in high-DR individuals.
There is an alternative explanation for the observed findings: it is plausible that high-DR group may find negative words less surprising and thus easier to process. This alternative explanation would predict that depressive ruminators would be quicker to process negative words and should have intact and comparable (or even enhanced) memory for negative words, compared to healthy controls and compared to positive words. However, this alternative explanation a) does not support our findings that depressive ruminators have poorer recall for negative words compared to both healthy controls and compared to recall for positive words, and b) is contrary to the numerous studies which found that depressed individuals are impaired in processing/updating negative stimuli. Thus, our interpretation of an incomplete or inadequate removal of outdated words due to a negative attentional bias in high-DR individuals is more consistent with our findings and the literature on memory updating in depression.

3.5.2 Impaired Recall of Negative Words—The Effect of Interference

We speculate that this diminished-removal effect had a direct effect on recall of to-be-remembered negative words. Overall, the high recall accuracy across groups demonstrated that both groups engaged in active WM updating and maintenance processing to a comparable degree. However, high-DR individuals exhibited worse recall for negative words compared to positive words. This is contrary to the often reported enhanced recall performance for negative information in dysphoria (i.e., the so-called negative memory bias; e.g., Matt, Vazquez, & Campbell, 1992; but see Koster et al., 2010, who reported the absence of a significantly enhanced recall for negative words in depression). However, in the context of an updating task, failure to adequately remove outdated words will subsequently create interference with memory for the new to-be-remembered words (e.g., Oberauer & Lewandowsky,
2008). Given the reduced removal time in the high-DR group when updating towards negative information, this account can explain the poorer recall accuracy of negative words in high-DR individuals: Incompletely removed outdated words may have selectively interfered with memory for the negative words. This notion is substantiated by the fact that in the high-DR group, the removal-time index was a significant predictor of recall accuracy for words updated in the short-CTI condition (where removal and encoding are not artificially segregated and thus potentially compete for resources). This account is also in line with Oberauer et al. (2012) and Singh et al. (2018), who argued that efficient removal can enhance performance in memory tasks by reducing interference from outdated or irrelevant information. It is thus plausible that a removal deficit for words being replaced by negative words in high-DR individuals would impair memory for those negative words due to interference from the outdated but not fully removed words.

### 3.5.3 Negative Bias and Positive Insensitivity

There is an alternative explanation for the present findings: Participants in the high-DR group may not be quicker to remove outdated items when updating towards a negative item, they instead may be generally slower to update towards a positive item; in other words, they may show positive insensitivity (Levens & Gotlib, 2009). Negative bias and positive insensitivity are not mutually exclusive, and thus both may contribute to the observed effects to some extent. Because of the absence of neutral words, the present study was not designed to differentiate between the two. However, seemingly speaking against the notion of positive insensitivity as the main explanans, RTs in the long-CTI condition, which reflect mainly encoding time, were lower for positive than negative items in high-DR participants, suggesting quicker encoding of positive compared to negative items. While this quicker encoding could
be attributable to less elaborative processing at encoding due to positive words not capturing the attention of high-DR participants as effectively (in line with positive insensitivity), this seems inconsistent with the notion of slower updating towards positive items and the higher recall accuracy for positive compared to negative words in high-DR participants. The overall pattern of findings would thus seem to favour an explanation in terms of negative attentional bias rather than positive insensitivity.

3.5.4 Valence-Generic Removal Deficit

Furthermore, the significant correlation between DR scores and the removal-time index when updating towards a negative word, in the high-DR group, may point to a cognitive explanation of rumination tendencies: If people with a strong attentional bias towards negative information neglect the removal of outdated information in the presence of new negative information, this could lead to outdated (and if a person is in a chronic negative mood, typically also negative) information lingering in WM. This explanation is admittedly speculative but compatible with significant correlations found between an intrusion index (reflecting interference from irrelevant material) and rumination in studies by Joormann and Gotlib (2008) as well as Yoon et al. (2014) in participants with depression. This is because irrelevant distractor information also needs to be actively removed to avoid interference in WM (cf. Oberauer et al., 2012). Specifically, our finding of a general removal deficit for both negative and positive words in the presence of new negative information is most consistent with the Yoon et al. finding that depression is associated with impairments updating both positively- and negatively-valenced materials in WM. However, the valence-generic removal deficit in high-DR individuals is contrary to the impaired attentional disengagement hypothesis of depression (Koster, De Lissnyder, Derakshan, & De Raedt, 2011; Grafton, Southworth, Watkins, & MacLeod, 2016); to
the extent that removal involves disengaging attention away from the removed item, high-DR individuals are no more impaired in disengaging attention away from negatively-valenced materials than positively-valenced materials.

3.5.5 Association between Attentional and Memory Biases

Taken together, the pattern of results in the present study provides support for the coherence between attentional and memory biases for negative words in dysphoria (cf. Koster et al., 2010). However, the nature of the coherence in the present study differs from that found in Koster et al. While Koster et al. found a significant positive association between attention and memory biases, for both positive and negative words, in dysphoria, the present study found a negative association between attentional and memory biases for negative words in depressive ruminators, presumably due to interference from the incomplete removal of outdated words.

3.5.6 Negative Insensitivity in Healthy Controls

Finally, regarding the selective delay in negative-to-negative removal time in low-DR participants, we can only speculate that the effect could reflect reluctance to go from one negative to another negative item in participants with low dysphoria/rumination scores, or in other words, a desire to not deal with sustained negative information. Indeed, it has been suggested that a habit or desire to not dwell on negative thoughts—so-called anti-rumination tendencies—may protect against depression (Mak, Hu, Zhang, Xiao, & Lee, 2009). Moreover, impaired WM updating of negative self-referential information in an unselected sample has been linked to fewer resources devoted to the processing of negative self-referential information (Sedikides & Green, 2000); this is in line with the “self-enhancement principle”, a
motivational bias towards the processing of positive instead of negative information with reference to the self (Baumeister, 1998).

**3.5.7 Limitations and Future Directions**

There are some limitations to the present study. First, we used only positive and negative self-referential words, due to time constraints. Future studies could include neutral words as a control condition to provide baseline updating response times for both CTI conditions. This would allow disentangling the potential contributions of negativity bias and positive insensitivity to the observed findings. However, it should not be dismissed that previous research studies using only positive and negative stimuli have advanced our understanding of cognitive biases in rumination and depression/dysphoria significantly, (De Lissnyder, Koster, Derakshan, & de Raedt, 2010; Joormann & Gotlib, 2008; Yoon, LeMoult, & Joormann, 2014).

Second, we selected participants on both depression and rumination measures. While this provides an understanding of the nature of impairments in memory updating in depressive rumination, it does not allow us to disentangle the unique and relative contributions of depression and rumination directly. Regardless of the correlation between depression and rumination, understanding the impact of each variable may have clinical implications: it could inform how interventions may be more effectively designed to target the underlying mechanisms that contribute to memory updating impairments in depression and rumination. Future research should aim to use more specific participant-selection criteria to disentangle the relative contributions of depression and rumination to the observed updating deficit.

Third, we attempted to use valenced words matched on factors known to potentially influence cognitive processing, including self-referential ratings obtained
from participants pre-screened on depression and rumination measures. The main aim was to maximise self-referential ratings, and achieve self-referential ratings in high-DR individuals that were equivalent for positively and negatively valenced words: this was achieved with only negligible differences in mean arousal and number of syllables. As expected, self-referential ratings for negative words were higher in the high- compared to the low-DR group. This could arguably also suggest that (1) negative words may have been perceived as more arousing, on average, by high- compared to low-DR individuals, and/or (2) positive words may have been perceived as less arousing by high- compared to low-DR individuals (Levens & Gotlib, 2009). Moreover, there was also a statistically significant difference in mean self-referential ratings between positive and negative words in the low-DR group. Some differences of this nature are probably unavoidable when using positive and negative stimuli in a study comparing participants with high and low depression scores. While we do not believe that these differences had a significant influence on the main findings of the present study, future studies may attempt to further optimize the selection of materials.

Fourth, our methodology of using normed valence ratings for positive and negative words is consistent with the approach of numerous studies that investigate the role of valence in cognitive performance, more generally, and in depression more specifically. Future research can explore the effect that perceived valence has on the removal subprocess, as opposed to objective valence, by obtaining valence ratings of positive and negative words as rated by high- and low-DR groups, and then controlling for this factor, similar to what we have done for self-reference ratings of valenced words by high- and low-DR groups in Chapter 2.
Finally, this is the first study to use this novel removal task to investigate the nature of WM updating in depressive rumination. Future replication is necessary to validate the findings in the present study.

3.5.8 Conclusion

To conclude, this is the first study to use a specific, response-time measure of WM-updating efficiency (Ecker, Lewandowsky, et al., 2014, Ecker, Oberauer, et al., 2014; Fenton & Ecker, 2015) to investigate the nature of WM-updating impairments in rumination and dysphoria. The findings provide preliminary evidence that depressive rumination is associated with a valence-generic deficit in the removal of outdated items in the presence of attention-attracting negative information. This reduced rate of removal in depressive ruminators predicted post-updating recall performance, presumably because it led to enhanced interference in WM. Future research should aim to use more specific participant selection criteria to disentangle the relative contributions of rumination and depression to the observed generic updating deficit. From a clinical perspective, a reduction of attentional bias (e.g., through attentional-bias modification; cf. LeMoult, Joormann, Kircanski, & Gotlib, 2016) may achieve an indirect reduction of depressive rumination by increasing the resources available for removal.
3.6 References


Chapter 4: Continued Influence Effect in Depressive Rumination—The Role of Scenario Specificity
4.1 Foreword

In Study 3, we investigated the nature of potential impairments in the removal subprocess of WM updating in depressive ruminators by using a novel WM updating task. Removal is a core micro-level subprocess of WM that serves to remove outdated information and prevents interference from outdated items. We found that depressive ruminators spent less time removing outdated words—both positive and negative—when updating towards a new negative word. We attributed this valence-generic removal deficit in the presence of a new to-be-updated negative word to a negative attentional bias in depressive ruminators; this attentional bias draws cognitive resources towards the new negative word at the expense of the process of removing the outdated words. We argued that this subsequently impaired recall of negative words due to interference from the insufficiently removed outdated words. The removal deficit had a positive correlation with participants’ rumination scores, but not depression scores. Taken together, depressive ruminators demonstrated a valence-generic removal deficit in the presence of negative information, and this deficit was correlated with rumination tendencies.

The finding of a valence-generic removal deficit in depressive ruminators is contrary to the literature on updating impairments in depressive rumination for negative information (Joormann & Gotlib, 2008; Levens & Gotlib, 2009). However, our understanding of the nature of memory updating impairments in rumination and depression is largely based on response-time or list-recall measures in short-term memory, which have mainly investigated cognitive processes in isolation (but see Everaert, Bronstein, Cannon, & Joormann, 2018; Everaert, Grahek, Duyck, Buelens, Van den Bergh, & Koster, 2017; Everaert, Tierens, Uzieblo, & Koster, 2013). While such studies provide insights into the potential mechanisms underlying impairments,
it is unclear how impairments would manifest in real-world information processing situations involving long-term memorization of news, facts, or event narratives, which arguably have greater ecological validity.

We next investigate the potential nature of memory updating impairments in depressive rumination using a paradigm that better represents real-world updating. Impaired memory updating in depressive rumination may suggest an inability to stay up-to-date in a constantly changing environment. In our information-driven society, this may imply a greater tendency to continue to be affected by misinformation—information initially believed to be true, but subsequently corrected or retracted (Ecker, Lewandowsky, & Tang, 2010) —despite having processed a correction or retraction. An impairment in memory updating could thus lead to continued reliance on retracted misinformation. In the literature, the observation that people often continue to rely on misinformation in their memory and reasoning despite being aware of a retraction is known as the continued influence effect (CIE; Johnson & Seifert, 1994; Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012).

The paradigm used in CIE studies is structurally similar to the removal task used in Study 3 in that it involves updating, specifically, conceptual updating on a longer time scale. Conceptual updating involves higher level cognitive processes beyond basic attention and memory processes—specifically, it requires the integration of corrective information with an existing mental model in long-term memory, and revision of this model (Ecker, Hogan, & Lewandowsky, 2017; Kendeou, Walsh, Smith, & O'Brien, 2014). It should be noted that such integration and knowledge revision processes are still a function of working memory because long-term memory representations need to be retrieved into working memory to be updated (Brydges, Gignac, & Ecker, 2018). Therefore, findings from working
memory processes and impairments in rumination and depression provide an important framework for investigating the nature of potential CIE modulation in rumination and depression.
4.2 Abstract

People often continue to rely on misinformation in their reasoning after they have acknowledged a retraction. This phenomenon is known as the continued influence effect. Retractions can be particularly ineffective when the retracted misinformation is consistent with a pre-existing worldview, especially when accepting the retraction requires an attitude change. We investigated this effect in the context of depressive rumination. Given the prevalence of depressotypic worldviews in depressive rumination, we hypothesized that depressive rumination may affect the processing of retractions of valenced misinformation; specifically, we predicted that the retraction of negative misinformation might be less effective in depressive ruminators compared to control participants. We found evidence against this hypothesis: In depressive ruminators, retractions of negative misinformation were as effective as they were in control participants. Findings are interpreted in terms of an attentional bias that may enhance the salience of negative misinformation and may thus facilitate its updating in depressive rumination.
4.3 Introduction

In our current information-driven society, unverified and potentially inaccurate information is often disseminated, which subsequently warrants retraction. Thus, in order to maintain efficient interaction with a dynamic state of affairs and avoid reliance on outdated information, people need to constantly amend their mental models of events and causal interrelations. Memory updating and knowledge revision are thus commonly required; yet, they are non-trivial, error-prone processes (e.g., Ecker, Lewandowsky, Oberauer, & Chee, 2010; Rich, van Loon, Dunlosky, & Zaragoza, 2017). Of particular relevance to the present paper, people often continue to rely on outdated or retracted misinformation in their reasoning even after they have received and acknowledged a retraction (Ecker, Lewandowsky, E. P. Chang, & Pillai, 2014; Ecker, Lewandowsky, Swire, & D. Chang, 2011; Thorson, 2016; Wilkes & Leatherbarrow, 1988). This post-retraction reliance on misinformation is known as the continued influence effect (CIE; Johnson & Seifert, 1994; Seifert, 2002; for a review see Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012).

This persistence of reliance on retracted and no-longer-relevant information has been demonstrated in a classic laboratory study by Wilkes and Leatherbarrow (1988). In this study, participants were presented with a series of reports describing a warehouse fire. The critical piece of information—that a closet in the warehouse contained carelessly stored volatile materials (oil paint and pressurised gas cylinders) that started the fire—was either subsequently retracted, or not retracted. Participants then answered fact recall and inference questions assessing their memory and inferential reasoning regarding the warehouse fire, and retraction awareness questions to ensure adequate encoding of the retraction in the retraction condition. The open-ended inference questions were designed to allow responding with or
without making reference to the critical piece of information. The difference in inference scores between the retraction and no-retraction conditions provides a measure of the effectiveness of the retraction in reducing the number of references made to the critical piece of information. The finding is that a retraction is effective in reducing the number of references made to the critical information, but does not eliminate the influence of the misinformation altogether. That is, typically participants continue to make references to the critical information despite receiving and acknowledging a retraction.

4.3.1 Worldview Effects on the Continued Influence Effect of Misinformation

There is some evidence that CIEs are particularly strong—or retractions particularly ineffective—when the retracted misinformation is consistent with a person’s worldview (i.e., the framework of attitudes and beliefs through which an individual interprets the world around them; Lewandowsky et al., 2012). For example, politically conservative participants have been found to show particularly strong CIEs if the misinformation was congruent with their worldview, such as when the misinformation was provided by conservative politicians (Nyhan & Reifler, 2010) or if it regarded misconduct in liberal politicians (Ecker & Ang, 2019). Thus, if relevant pre-existing worldviews exist, at least part of the observed ineffectiveness of retractions can be attributed to motivated cognition (Ecker, Swire, & Lewandowsky, 2014; Kunda, 1990). In extreme cases, there can even be worldview-based backfire effects, where a retraction ironically leads to stronger reliance on the retracted misinformation (Ecker & Ang, 2019; Nyhan & Reifler, 2010; Nyhan, Reifler, & Ubel, 2013; Trevors, Muis, Pekrun, Sinatra, & Winne, 2016). In other words, there is evidence that people tend to “cling” to misinformation that supports their worldviews.
4.3.2 Worldviews Effects—Specificity of Scenarios

However, it is important to note that worldview effects on the CIE have not been found consistently. To illustrate, Ecker, Lewandowsky, Fenton, and Martin (2014) found that the effectiveness of a retraction of racial misinformation in the context of a crime scenario was independent of participants’ level of racial prejudice. This led Ecker et al. to hypothesize that pre-existing attitudes may affect retraction processing only when accepting the retraction requires an attitude change. They argued that this is the case only when the misinformation relates to a general assertion but not if it relates to a specific episodic event: With a one-off event (e.g., a specific crime committed by a minority person), a worldview-incongruent retraction can be accommodated as an exception to a rule (e.g., one could still believe that most crimes are committed by minorities and that most minority people are criminal; see Kunda & Oleson, 1995; Richards & Hewstone, 2001). By contrast, with a general assertion (e.g., that minority people are particularly likely to commit crimes), for a racially prejudiced person to accept a worldview-incongruent retraction (i.e., accepting that minority people are not particularly likely to commit crimes) would require a certain degree of attitude change. Ecker and Ang (2019) recently tested this hypothesis using fictional scenarios involving misconduct of politicians and found preliminary support for this notion: Worldview-incongruent retractions were more effective in a specific scenario compared to a general scenario.

It is assumed that motivated dismissal of retractions serves to uphold existing worldviews, and it can thus be interpreted in terms of a disconfirmation bias (Del Vicario et al., 2016; Taber & Lodge, 2006). This raises the question if a similar mechanism might serve to uphold depressotypic worldviews in clinical conditions such as anxiety and depression. If general (e.g., political) attitudes can predict
receptiveness for retractions of worldview-congruent misinformation, then this may also apply in case of depressotypic worldviews—that is, depressive ruminators may in a sense be motivated to resist retractions of negatively-valenced misinformation. Moreover, Jonas, Graupmann, and Frey (2006) demonstrated that negative mood was positively associated with motivated reasoning tendencies. If there is a worldview-driven negativity bias in depressive rumination, then one would predict that retractions of negative misinformation in a CIE paradigm should be less effective in depressive ruminators compared to healthy controls.

4.3.3 Depressotypic Worldviews on the Continued Influence Effect

The present study extends the study of worldview effects on the CIE into the area of depression, because it has been argued that in depression, similar cognitive biases—ranging from basic attentional/interpretative/memory biases to higher-level distortions (e.g., impaired inferential reasoning)—exist that serve to uphold the depressotypic worldviews associated with depressive cognition (Bisson & Sears, 2007; Blanchette, & Richards, 2010; Everaert, Duyck, & Koster, 2014; Lam, Smith, Checkley, Rijsdijk, & Sham, 2003). For example, a mood-congruent memory bias—enhanced memory for depression-related and negatively valenced materials—is a robust finding in depression (Bradley, Mogg, & William, 1995; Denny & Hunt, 1992; Ridout, Astell, Reid, Glen, & O’Carroll, 2003, for review see Matt, Vázquez, & Campbell, 1992). In other words, depressed individuals (defined here as people with high scores on a measure of depression, selected from a non-clinical population) may tend to “cling” to misinformation that supports their negative worldviews. Such a finding would be consistent with the impaired attentional disengagement hypothesis of depressive rumination (Grafton, Southworth, Watkins, & MacLeod, 2016; Koster, De Lissnyder, Derakshan, & De Raedt, 2011), which proposed an
impairment in disengaging attention from negative materials. Such an effect would be in line with the fact that rumination—a repetitive and persistent focus on one’s thoughts and worries as well as their causes, meanings, and consequences (Nolen-Hoeksema, 1991)—is considered a hallmark symptom of (Koster, De Lissnyder, Derakshan, & De Raedt, 2011; Watkins, 2008), as well as a vulnerability factor for (Roberts, Gilboa, & Gotlib, 1998; Nolen-Hoeksema, 2000; Nolen-Hoeksema & Morrow, 1991), depression.

There seems to be a clear link between rumination and the development and persistence of depressotypic worldviews in depression (Beck, Rush, Shaw, & Emery, 1979; Lam et al., 2003); to illustrate, Lam et al. found that rumination predicted depressotypic worldviews in individuals with depression, after controlling for depression scores. Rumination can predispose a person to depression as it can enhance the focus on negative thoughts and thus cement the cognitive distortions and dysfunctional worldviews that feature prominently in theories of depression (Beck, 2005; Lyubomirsky & Nolen-Hoeksema, 1995; Roberts, Gilboa, & Gotlib, 1998). Once triggered, rumination can easily become self-perpetuating and involuntary, resulting in maladaptive consequences such as worsened mood (Moberly & Watkins, 2008). Depression can thus be characterized by a set of negative, depressotypic worldviews that are associated with distorted, false beliefs and recurring, unintentional, and uncontrollable negative thoughts (Lam, Smith, Checkley, Rijsdijk, & Sham, 2003; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008).

4.3.4 Rumination and Depression

It is currently unclear whether rumination predisposes people to depression, or whether depression promotes rumination. That is, the precise cognitive mechanisms underpinning depressive rumination, and the generality of any
associated processing biases remains unclear. On the one hand, rumination could lead to an enhanced focus on negative thoughts and could thus contribute to the maintenance of negative affect and cement cognitive distortions and depressotypic worldviews (Beck et al., 1979; Lam et al., 2003; Vanderhasselt & De Raedt, 2012). These depressotypic worldviews feature prominently in cognitive theories of depression (e.g., Beck, 2005) and are often evaluated by scales such as the Dysfunctional Attitude Scale (DAS-A; Weissman & Beck, 1978; see also de Graaf, Roelofs, & Huibers, 2009).

On the other hand, there may be cognitive factors associated with depression that promote rumination. One proposal has been that depression is associated with valence-specific memory updating deficits that promote the persistence of negative information (Levens & Gotlib, 2010) through impairments in the suppression of negative information (Goeleven, De Raedt, Baert, & Koster, 2006; Joormann & Gotlib, 2008, 2010). Such valence-specific updating deficits could potentially contribute to depressive rumination and the associated difficulties with the regulation of negative emotion (Levens & Gotlib, 2009). However, as these studies are largely based on response-time or list-recall measures in short-term memory (but see Everaert, Bronstein, Cannon, & Joormann, 2018; Everaert, Grahek, Duyck, Buelens, Van den Bergh, & Koster, 2017), it is unclear if such valence-specific updating effects would transfer to real-world information processing situations involving long-term memorization of news or event narratives, as is assessed in the CIE paradigm. We note that, while the CIE paradigm involves long-term memorization of narratives, the integration of a retraction and the associated updating of retrieved long-term memory representations—also known as knowledge revision (Kendeou, Walsh, Smith, & O'Brien, 2014) and similar to memory reconsolidation (Elsey &
Kindt, 2017; for review, see Agren, 2014; Elsey, Van Ast, & Kindt, 2018)—is effectively a function of working memory. Therefore, the literature on working memory processes and impairments in depression provides an important framework for investigating potential CIE modulations in depressive rumination.

We selected participants on both rumination and depression measures simultaneously because we have argued that rumination could be either (1) a primary symptom arising from a generic updating deficit, which contributes to depressive symptomatology (Vanderhasselt & De Raedt, 2012), or (2) a secondary symptom arising from a valence-specific updating deficit associated with depression (Joormann & Gotlib, 2008, 2010). If the latter is true, a depression screening measure would be sufficient, if the former is true, then a rumination screening measure may be sufficient. Given this uncertainty, it was decided to screen on both constructs simultaneously. Furthermore, previous studies which selected participants based solely on either rumination or depression measures have produced inconsistent findings. This approach provides a preliminary understanding of how these constructs may relate to potential updating impairments in depressive rumination in the CIE paradigm; disentangling the relative contributions of rumination and depression directly to the CIE remains a direction for future research (E. P. Chang, Ecker, & Page, 2017).

4.3.5 Continued Influence Effect of Misinformation in Depressive Rumination

Thus, the aim of the present study was to investigate updating of valenced information using the continued-influence paradigm which involves long-term memorization of narratives, akin to real-world information processing in participants with depressive symptoms and rumination tendencies. If motivated dismissal of correction attempts contributes to rumination and the maintenance of depressotypic
worldviews in depression, then one would predict that retractions of negative misinformation should be less effective in individuals with depressive rumination, especially if the negative misinformation is general (vs. specific) in nature.

While this was our working hypothesis, results from a separate experiment (E. P. Chang, Ecker, & Page, 2017) suggested a potentially different outcome. In that study, we investigated working memory updating in depressive rumination using valenced words. Contrary to expectations, we found that depressive ruminators did not have any difficulties updating negative information—that is, updating from a negative word to a positive word (cf. Joormann & Gotlib, 2008). However, we found that the updating process was generally accelerated in depressive ruminators when they were updating towards negative words. We interpreted this as an effect of salience driven by an attentional bias towards negative information. Thus, if there is a facilitative influence of salience on memory updating, then it is conceivable that a retraction of negative misinformation may be more effective in depressive ruminators, as various authors have argued that the salience of retracted misinformation can facilitate rather than hinder corrective updating—that is, there is evidence that enhancing the salience of misinformation can make it easier to correct (Ecker, Hogan, & Lewandowsky, 2017; Kendeou, Butterfuss, van Boekel, & O’Brien, 2017; Kendeou, Walsh, Smith, & O’Brien, 2014; Stadtler, Scharrer, Brummernhenrich, & Bromme, 2013). In other words, to the extent that a negative attentional bias in depressive ruminators would render negative misinformation more salient, retracting the misinformation may be more, not less, effective.

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8 The task involved participants encoding a set of three valenced (positive or negative) words; individual words were then repeatedly replaced with other valenced words before a final recall test.
4.3.6 The Present Study

The present study examined the impact of depressive rumination on the processing of misinformation retractions in a CIE paradigm (Ecker, Lewandowsky, Swire, & D. Chang, 2011; Johnson & Seifert, 1994). We tested participants scoring low or high on measures of rumination and depression. Participants were presented with a report including a piece of critical information that was or was not subsequently retracted. The critical information was negative in nature and presented in either a specific scenario (a young singer’s suicide) or a general scenario (a general increase in youth suicide rates). Participants’ understanding of the report and their inferential reasoning concerning the information presented in the report were assessed via questionnaire. In addition, participants’ awareness of the retraction (in the condition that involved a retraction) was assessed with retraction-awareness questions.

We expected the retraction of negative misinformation to be less effective in depressive ruminators compared to control participants with low depression/rumination scores, in particular in the general scenario. In other words, we expected depressive ruminators to exhibit a larger CIE of negative misinformation in the general as compared to the specific scenario; we expected retractions in control participants to be equally effective across general/specific scenarios.

To foreshadow, while this was our working hypothesis, we found evidence against this hypothesis. Retractions of worldview-congruent, negative
misinformation were as effective⁹ as retractions of worldview-incongruent misinformation. That is, retractions of negative misinformation were at least as effective in depressive ruminators as they were in control participants. We will thus interpret these results not in terms of motivated cognition, but in terms of attentional biases and salience effects.

### 4.4 Method

Experiment 1 used a standard continued-influence paradigm in a 2 (retraction: no vs. yes) × 2 (scenario: specific vs. general) × 2 (group: depressive rumination low vs. high) between-subjects design.

#### 4.4.1 Participants

A-priori power analysis (G*Power 3; Faul, Erdfelder, Lang, & Buchner, 2007) suggested a sample size of 199 participants to detect a small-medium effect size of $f = 0.2$ at $\alpha = 0.05$, $1-\beta = 0.8$. Two hundred and fifty-five first-year psychology undergraduates from the University of Western Australia participated in this study for partial course credit, after reading an ethically approved information sheet and providing informed consent. Following the selection criteria of E. P. Chang et al. (2017), participants were recruited based on their responses on the Ruminative Response Scale (RRS)—a subscale of the Response Style Questionnaire (Nolen-Hoeksema & Morrow, 1991)—and the depression scale of the short-form version of the Depression Anxiety Stress Scales (DASS-21; Lovibond & Lovibond, 1995) across multiple screening exercises (total $N \approx 1,900$). We also administered the Dysfunctional Attitude Scale (DAS-A; Weissman & Beck, 1978) on the day of

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⁹ We use the term “effective” here purely as a means of comparison, that is, in terms of relative (as opposed to absolute) effectiveness of a retraction to reduce mean inference scores.
testing for potential use as a continuous predictor in lieu of the DASS-Dep/RRS grouping.

Given its temporal specificity (the measure assess *current* mood state, see below for details), the full form of the DASS (DASS-42; Lovibond & Lovibond, 1995) was re-administered on test day and 58 participants were removed as the test-day depression score did not meet the pre-specified criteria provided below. The final sample for analysis thus comprised $N = 197$ participants (62 males, 135 females; mean age $M = 20.4$ years; $SD = 7.11$; age range 16-71 years). Participants were pseudo-randomly assigned to conditions ($n = 23-26$ per cell). The high depressive rumination (DR) group comprised individuals with RRS scores $\geq 40$ (following E. P. Chang et al., 2017; also see Cook & Watkins, 2016; Onraedt & Koster, 2014; score range was 40-88; possible range is 22-88), and test-day DASS depression scores $\geq 10$ (following Lovibond & Lovibond, 1995; score range was 10-42; possible range is 0-42). The low-DR group comprised individuals with RRS scores $\leq 33$ (score range was 22-33) and test-day DASS depression scores $\leq 9$ (score range was 0-9). Mean RRS and DASS depression scores were $M_{RRS} = 60.76$ ($SD = 11.18$) and $M_{DASS} = 20.16$ ($SD = 7.94$) for the high-DR group, and $M_{RRS} = 27.44$ ($SD = 3.03$) and $M_{DASS} = 2.37$ ($SD = 2.42$) for the low-DR group, respectively. There was no gender difference in RRS and DASS depression scores, $p_s > .286$. The mean high-DR RRS scores are comparable to the samples of Joormann and Gotlib (2008) and Watkins et al. (2007). The level of depression severity in the high-DR group was above the clinical cut-off proposed by Ronk, Korman, Hoke, and Page (2013).
4.4.2 Measures

**Ruminative Response Scale (RRS).** The RRS is a subscale of the Response Style Questionnaire (Nolen-Hoeksema & Morrow, 1991). It is a 22-item self-report questionnaire that assesses how often participants respond to symptoms of depression in a ruminative manner (e.g., “I think about how sad I feel”) on a scale of 1 (almost never) to 4 (almost always). Scores below 40 indicate low rumination tendencies (Crane, Goddard, & Pring, 2013). The RRS has good test-retest reliability (Nolen-Hoeksema, Parker, & Larson, 1994); the internal consistency (Cronbach’s alpha) in the present study was $\alpha = .97$ and coefficient omega = .97, 95% CI [.97, .98].

**Depression Anxiety Stress Scale (DASS).** The DASS (Lovibond & Lovibond, 1995) is a 42-item self-report questionnaire assessing current mood state—specifically levels of depression, anxiety, and stress experienced over the past week. Items (e.g., “I felt down-hearted and blue”) are rated on a scale from 0 (did not apply to me at all) to 3 (applied to me very much, or most of the time). The DASS depression scale (DASS-Dep) consists of 14 items with adequate reliability and validity (Henry & Crawford, 2005). In the present study, the internal consistency of the DASS-Dep was $\alpha = .96$ and coefficient omega = .96, 95% CI [.95, .97], and the correlation between DASS-Dep and RRS was $r = .86, p < .001^{10}$. The short DASS-21 used in the initial screening of participants has 21 items, seven of which are depression-specific. It also has adequate reliability and validity (Henry & Crawford, 2005). In the present study, the correlation between long and short-version depression scores was $r = .84, p < .001$.

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10 See Table 6 in Appendix B for correlation matrix of RRS and DASS subscales for depression, anxiety and stress.
**Dysfunctional Attitude Scale (DAS-A).** The DAS-A (Weissman & Beck, 1978) is a 40-item self-report questionnaire that assesses the intensity of depressotypic worldviews with items such as “I cannot be happy unless most people I know admire me”, which are rated on a scale of 1 (totally agree) to 7 (totally disagree). A lower score indicates more depressotypic worldviews. The mean DAS-A scores were \( M_{\text{DAS-A}} = 116.07 \) (\( SD = 26.40 \); score range was 40-178; possible range is 30-210) for the high-DR group, and \( M_{\text{DAS-A}} = 155.60 \) (\( SD = 18.75 \); score range was 98-198) for the low-DR group. The DAS-A scores differed between the low- and high-DR participants, \( t(195) = 12.15, p < .001 \). In the present study, the internal consistency was \( \alpha = .94^{11} \) and coefficient omega = .95, 95% CI [.93, .96]; the DAS-A correlations were \( r = -.71 \) with RRS, and \( r = -.75 \) with DASS-Dep, \( ps < .001 \).

**4.4.3 Scenarios**

The utilized news reports were fictitious, and consisted of a series of 11 messages. The reports both dealt with suicide, and detailed either a specific event or a general assertion: The specific scenario depicted the suicide death of a 27-year-old celebrity singer; the general scenario depicted an increase in young-adult suicide rates (see Appendix B for both scenarios). Reports were matched in terms of structure and length (word counts were 304 and 310). We also endeavoured to keep the trustworthiness of the retraction source comparable, as this has been found to influence the effectiveness of a retraction (Guillory & Geraci, 2013). While the scenarios are not self-referent per se, suicide represents the ultimate loss and a common theme in depressive thoughts (Beck, Brown, Steer, Eidelson, & Riskind, 2011).

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11 The observed internal consistency was improved from \( \alpha = .85 \) by excluding 10 reverse-scored items that have been found to be problematic (de Graaf, Roelofs, & Huibers, 2009). Therefore, DAS-A scores excluding the 10 reverse-scored items were used in analyses.
1987). Joormann and Gotlib (2008) demonstrated that non-self-referent negative—compared to positive—words were differentially processed in depression, and this effect correlated with rumination.

Across reports, message 2 contained the critical piece of information; message 10 contained its retraction (or some additional arbitrary information in the no-retraction condition). Specifically, message 2 in the specific scenario stated that a famous “singer had taken pills and that her death is being treated as a suicide.” Message 10 then stated in the retraction condition that “there had been a misrepresentation; according to medical reports [...] death did not result from suicide” and in the no-retraction condition, that “fans have congregated [...] to lay down flowers, soft toys, and letters.” In the general scenario, message 2 stated that “suicide rates in young adults [...] have risen in recent years.” Message 10 then either stated that “there had been a misrepresentation; according to the scientists involved, suicide rates in young adults were not, in fact, on the rise.” or that “researchers were preparing a summary of findings for public release.”

4.4.4 Test questionnaire

Following ample precedent (Ecker, Lewandowsky, Fenton, & Martin, 2014; Johnson & Seifert, 1994; Wilkes & Leatherbarrow, 1988), we assessed participants’ memory for the report and their inferential reasoning with a questionnaire. The questionnaire consisted of 11 inference questions, 10 fact-recall questions, and two retraction-awareness questions. All questions were open-ended apart from two inference questions that used rating scales. The open-ended inference questions were designed to allow responding with or without reference to the critical information. An example is the question “What should health authorities do now and why?” The two rating scales assessed participants’ critical-information beliefs more directly; for
example, participants rated their belief that suicide was the singer’s cause of death on a 0-10 scale, or provided their trend estimate of youth suicide rates on a -20% to +20% scale.

The fact-recall questions targeted arbitrary details provided in the reports, such as “Which university did the report come out of?” They were included not only to compare report memory across conditions, but also to ensure sufficient encoding of the report, that is, to allow potential exclusion of participants failing to recall any details, in order to eliminate insufficient encoding as an alternative explanation for a low number of references made to the critical information for any given participant. The two retraction-awareness questions assessed participants’ awareness of the retraction (in the conditions that involved a retraction). These questions were administered to potentially exclude participants who may have not encoded the retraction, in order to rule out insufficient retraction encoding as an alternative explanation for a high number of references made to the critical information for any given participant. All questions across both scenarios were made as similar as possible except for differences specific to each scenario; both questionnaires are provided in Appendix B.

4.4.5 Procedure

Participants provided informed consent both before the initial screening exercise and at the beginning of the laboratory test session. Participants then read the report corresponding to their assigned condition, and were informed that they would be asked to complete a questionnaire relating to the report. The report was presented on a computer screen, using Microsoft PowerPoint. Each message was presented individually and displayed for a fixed amount of time (350 ms per word; following Rayner & Clifton, 2009) to ensure sufficient but not excessive encoding time. The
pen and paper test questionnaire was administered after a 20-minute distractor task filled with an unrelated word rating task (Study 2). Participants were instructed to complete all questions in the sequence they were presented. Participants then completed the DASS and DAS-A before they were fully debriefed. The experiment took approximately 45 minutes.

4.5 Results

4.5.1 Coding of responses

Responses were coded by a scorer who was blind to experimental conditions (i.e., retraction condition and group), following a scoring guide. A second, independent scorer coded 40 randomly selected questionnaires (5 per condition); inter-rater reliability was high, \( r = .91 \). Following ample precedent (e.g., Ecker & Ang, 2019; Ecker, Hogan, & Lewandowsky, 2017; Guillory & Geraci, 2016), scoring of inference questions was based on references made to the critical piece of information. Responses to open-ended inference questions were scored 1 if there was any uncontroverted reference made to the critical information, and 0 otherwise (i.e., responses such as “first they thought it was suicide but it was not” were scored 0). Responses to the two rating scales were transformed onto continuous 0-1 scales. A mean inference score was calculated, equally weighting all open-ended inference questions and rating scales.\(^{12}\) This was the main dependent variable. Likewise, mean fact-recall scores and retraction-awareness scores (in retraction conditions) were also calculated and transformed onto continuous 0-1 scales.

\(^{12}\) The mean inference score is based on the combination of open-ended and rating scale questions, which was the a-priori analysis plan. There was no difference in the results between using the combined inference scores compared to using only the open-ended questions. Furthermore, there were 11 open-ended questions but only two rating scale questions, so it is not ideal to base any analysis on rating scale questions only.
4.5.2 Recall accuracy

Mean recall accuracy was sufficiently high—and comparable to previous CIE research (e.g., Ecker & Ang, 2019)—across conditions to generally ascertain adequate encoding of the news reports, \( M = 0.47 \) (\( SD = 0.18 \)). Nine participants recalled fewer than two details; following precedent (e.g., Ecker, Lewandowsky, Fenton, et al., 2014), we did not exclude these participants altogether, but re-ran all analyses with them excluded to corroborate results (discrepant outcomes will be reported in footnotes below). Condition-specific descriptive statistics are presented in Table 5.

Table 5

*Recall accuracy descriptive statistics by group, scenario, and retraction condition*

<table>
<thead>
<tr>
<th>Scenario/Retraction</th>
<th>Low-DR group ( M (SD) )</th>
<th>High-DR group ( M (SD) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific/No-Retraction</td>
<td>0.49 (0.20)</td>
<td>0.55 (0.19)</td>
</tr>
<tr>
<td>Specific/Retraction</td>
<td>0.43 (0.22)</td>
<td>0.56 (0.17)</td>
</tr>
<tr>
<td>General/No-Retraction</td>
<td>0.43 (0.15)</td>
<td>0.39 (0.14)</td>
</tr>
<tr>
<td>General/Retraction</td>
<td>0.42 (0.15)</td>
<td>0.46 (0.15)</td>
</tr>
</tbody>
</table>

*Note.* DR = Depressive rumination

A three-way analysis of variance (ANOVA) of recall scores with factors retraction, scenario, and group revealed a significant main effect of scenario, \( F(1,189) = 11.94, p < .001, \eta_p^2 = .06 \), as well as a marginal effect of group, \( F(1,189) = 3.89, p = .050, \eta_p^2 = .02 \). These were qualified by a significant group by scenario interaction, \( F(1,189) = 4.03, p = .046, \eta_p^2 = .02 \), indicating that recall
accuracy tended to be higher in the specific-scenario condition, in particular in the high-DR group\textsuperscript{13}. All other effects were non-significant, $F < 1.9$.

### 4.5.3 References to critical (mis)information (inference scores)

There were 15 participants in the retraction condition who did not indicate awareness of a retraction. These participants were retained but analyses were repeated with them excluded. Exclusion did not change any of the findings, except where specified. One-sample $t$-tests confirmed that all scores in the retraction conditions differed significantly from zero, all $t$s(23-25) > 7.41, $ps < .001$. This demonstrates a significant CIE in all retraction conditions.

A three-way ANOVA on mean inference scores (see Figure 4) with factors retraction, scenario, and group revealed main effects of retraction, $F(1,189) = 20.42$, $p < .001$, $\eta_p^2 = .10$, scenario, $F(1,189) = 12.42$, $p < .001$, $\eta_p^2 = .06$, and group, $F(1,189) = 3.91$, $p = .050$, $\eta_p^2 = .02$.\textsuperscript{14} These main effects were qualified by a group by scenario interaction, $F(1,189) = 5.64$, $p = .019$, $\eta_p^2 = .03$, indicating greater inference scores in the high-DR group in the specific scenario condition. All other interaction effects were non-significant, $Fs < 1$. Importantly, there were no significant interactions involving the retraction factor, indicating that neither DR group nor type of scenario influenced the effectiveness of a retraction. In other words, a retraction was similarly effective across all conditions, reducing the mean number of references to the critical information by a similar amount in each case. In particular, the retraction was effective even in the general-scenario condition in the high-DR group, $F(1,189) = 4.80$, $p = .030$, $MSE = .02$, where we had hypothesized it

\textsuperscript{13} The effects of group and group $\times$ scenario were non-significant after exclusion of participants with recall accuracy $< 2$; $ps > .10$.

\textsuperscript{14} Excluding the 15 participants with retraction-awareness scores of zero, the main effect of group only approached significance, $F(1,174) = 3.29$, $p = 0.071$, $\eta_p^2 = .02$. 
may be ineffective. When gender was included as an additional factor, there was no main effect of gender, and gender did not interact with retraction condition or group. However, there was a significant gender by scenario interaction, $F(1,181) = 5.06$, $p = .026$, $\eta^2_p = .03$, such that there was a significant difference in mean inference scores between specific and general scenarios for males, but not for females.

Figure 4. Mean inference score by retraction condition, scenario, and DR group. Error bars indicate standard errors of the mean.

Note. DR = Depressive rumination.

### 4.5.4 Continued Influence Effect and Depressotypic Worldview

There was a negative correlation between DAS-A scores and post-retraction inference scores, $r = -.26$, $p = .009$. The correlation was mainly attributed to a correlation in the high-DR group, $r = -.27$, $p = .060$, that was approaching significance (all other conditions: $-.12 < r < .10$; $p > .410$). This indicates a tendency for more reliance on corrected misinformation in participants with stronger
depressotypic worldviews. Consequently, in an alternative analysis, we included mean-centred DAS-A scores as a continuous predictor in an analysis of covariance (ANCOVA) with retraction and scenario as factors. This analysis closely replicated the main effects of retraction and scenario from the original ANOVA, and there was also a main effect of DAS-A scores, $F(1,189) = 4.46, p = .036, \eta^2_p = .02$, as well as a marginal interaction of DAS-A and scenario, $F(1,189) = 3.79, p = .053, \eta^2_p = .02$, mirroring the main effect of group and the group by scenario interaction in the original ANOVA. The interaction of DAS-A and retraction, which would constitute evidence that the effectiveness of a retraction may depend on the level of depressotypic worldviews, was trending towards significance, $F(1,189) = 3.08, p = .080$.

4.5.5 Disentangling Rumination and Depression

In a preliminary attempt to disentangle the relative contributions of rumination and depression to mean inference scores, DASS-Dep and RRS scores were entered into an exploratory linear regression. This model was significant, $F(2,196) = 4.43, p = .013$, adjusted $R^2 = .03$, and accounted for 4% of the variance in mean inference scores. Furthermore, DASS-Dep scores ($\beta = .35, p = .011$) were found to be a significant and stronger predictor of mean inference scores than rumination ($\beta = -.20, p = .153$), which was not a significant predictor in this model. A commonality analysis confirmed this, suggesting that depression scores accounted for more explained variance than rumination scores (0.03, or 75% vs. 0.01, or 23%; common variance was 0.001, or 2%).
4.6 Discussion

4.6.1 Continued Influence Effect in Depressive Rumination

The aim of the present study was to investigate if the specificity of a negative scenario would affect the effectiveness of a retraction in depressive rumination (DR). We hypothesized that the high-DR group would exhibit greater post-retraction reliance on negative misinformation—that is, a larger continued influence effect (CIE)—in the general scenario compared to both the specific scenario and the low-DR group.

Consistent with previous research (Ecker & Ang, 2019; Ecker, Lewandowsky, E. P. Chang, et al., 2014; Ecker et al., 2011; Thorson, 2016; Wilkes & Leatherbarrow, 1988), retractions generally reduced but did not eliminate reliance on misinformation. This demonstrates the presence of a significant CIE across conditions; that is, there was a CIE even in low-DR individuals who have no motivational reason to continue to rely on negative misinformation following a retraction. Although this may be partially due to the lower rate of retraction awareness in low-DR individuals, this seems unlikely as slightly reduced awareness arose only in the general-scenario condition, and the result pattern was not affected much by the exclusion of participants providing no evidence for retraction awareness.

Contrary to expectations, the effectiveness of a retraction was not influenced by depressive rumination in interaction with the nature of the scenario. That is, retractions of negative misinformation were equally effective across both low- and high-DR groups, and retractions were comparatively effective across both specific and general scenarios. This result pattern stands in opposition to the findings of Nyhan and Reifler (2010) and in particular Ecker and Ang (2019), who found that
pre-existing political attitudes impacted on retraction effectiveness especially with a
general scenario. This discrepancy could arise for two reasons, which we will discuss
in turn. First, general (e.g., political) worldviews could differ fundamentally from the
depressotypic worldviews that characterize depressive rumination in the way they
affect information processing. Second, salience effects may have dominated any
potential worldview effects in the present study.

4.6.2 Depressotypic Worldviews

Regarding the first point, the depressotypic worldviews present in depressive
rumination clearly differ qualitatively from generic (e.g., political) worldviews.
Depression is listed as a mental disorder in the DSM-5 (Diagnostic and Statistical
Manual of Mental Disorders, 5th Edition). As such, depression and the depressotypic
worldviews that are associated with it do not occur by choice and often cause
significant distress. By contrast, the political, racial, or religious worldviews that are
often the element of interest in studies using the CIE paradigm reflect individual
differences that can carry significance for a person’s identity in a manner that is self-
congruent (Festinger, 1957; Higgins, 1987; Rogers, 1957). As far as processing of
misinformation retractions is concerned, it might thus be that disconfirmation biases
are less potent in depression: People with strong political worldviews may be
strongly motivated to defend their beliefs (Ecker, Swire, & Lewandowsky, 2014;
Taber & Lodge, 2006; also see Kahan, 2010, 2013), and this may simply not apply to
the depressotypic worldviews found in rumination and depression. This is consistent
with the central tenet of Kahan’s “cultural cognition” theory, which argues that
motivated reasoning when dismissing worldview-dissonant evidence is driven by
one’s desire to defend one’s personal and social identity. In other words, while
depressotypic worldviews are a characteristic of depressive rumination (Lam, Smith,
Checkley, Rijsdijk, & Sham, 2003; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008), the depressotypic worldviews may not have a hindering impact on belief updating because depression is perceived as a stigma and often intentionally concealed (Quinn & Chaudoir, 2009; for review, see Schmitt, Branscombe, Postmes, & Garcia, 2014); in other words, a depressotypic worldview is not an identity aspect one is motivated to defend.

In the present study scores on the DAS-A correlate with the mean number of post-retraction references made to the critical information in the high-DR group. This provides evidence that a more depressotypic worldview in the high-DR group was associated with a larger CIE, that is, there was a tendency for more reliance on corrected misinformation in participants with stronger depressotypic worldviews. However, contrary to expectations, the worldview effects in the high-DR group did not differ across scenarios. That is, retractions were comparably effective in the high-DR group for both the specific and general scenarios, significantly reducing the mean number of references made to the critical information.

Furthermore, given the high correlations among the three measures (RRS, DASS-Dep and DAS-A), the findings that DAS-A scores closely mirror the effects of group and the group by scenario interaction in the original ANOVA is not surprising; RRS and DASS-Dep scores were the criteria for group assignment. In the alternative analysis using DAS-A scores, the evidence that the effectiveness of a retraction may depend on the level of depressotypic worldviews was weak. Thus, while there may be a weak worldview effect on the effectiveness of the retractions, it was dominated by another factor, viz. salience.
The second reason why results disconfirmed our original hypothesis may lie in the salience of the misinformation. Various authors have advocated that the salience of the misinformation is an important prerequisite for corrections to be effective. Stadtler, Scharrer, Brummernhenrich, & Bromme (2013) argued that salience of both misinformation and correction enhances conflict detection which facilitates memory updating (also see Putnam, Wahlheim, & Jacoby, 2014). Kendeou et al. (2014) asserted that salience enhances the co-activation of the misinformation and its retraction, allowing for greater integration and thus more efficient correction. Furthermore, Ecker, Hogan, and Lewandowsky (2017) recently demonstrated that repeating the misinformation within a correction improves the effectiveness of a correction, thus proposing that the misinformation’s salience during processing of the correction facilitates discounting of the misinformation. Our finding may suggest that misinformation’s salience during initial encoding might likewise facilitate corrective processing. This is in line with the theoretical proposals by Stadtler et al. and Kendeou et al. because stronger encoding and activation of the misinformation could arguably enhance co-activation and facilitate conflict detection, which is necessary for knowledge revision and memory updating.

In this vein, the data suggest that the celebrity suicide scenario was particularly salient in the high-DR group, as both fact-recall and (pre- and post-retraction) inference scores were elevated in this condition. Celebrity news in general have great appeal to young adults (Dubied & Hanitzsch, 2014; Turner, 2010), and the celebrity suicide may have been particularly salient to high-DR participants given that the negative thoughts in depression often involve themes of loss, death, and suicide (Beck, Brown, Steer, Eidelson, & Riskind, 1987; Nordentoft & Mortensen, 2010).
2011; Rihmer 2001). In general, in the current sample of young adults, the comparably high salience of both themes—celebrity suicide and an increase in young-adult suicide rates—may account for the similarity in results across both groups.

4.6.4 Rumination versus Depression

Although the present study was not designed to disentangle the relative contributions of rumination and depression to the CIE, the exploratory regression and commonality analyses suggest that depression might be a stronger predictor of the CIE than rumination, which was not a significant predictor. These results suggest that future research using the continued-influence paradigm (Johnson & Seifert, 1994; Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012) may benefit from recruiting participants solely on depression scores, although we cannot know whether those who are high on depression but low on rumination measures might attenuate this effect, since this group is currently not included in our sample.

4.6.5 Clinical Implications, Limitations and Future Directions

The CIE is a robust finding across various domains including politics (Ecker & Ang, 2019) and health (Nyhan & Reifler, 2015); the findings in the present study extends the CIE into the domain of mental disorder, more specifically, depressive rumination. A better understanding of the processing of negative misinformation in depressive rumination will be informative for cognitive therapy, which often involves the revision of negative event interpretations or thoughts (Beck, 1993; Beck, Rush, Shaw, & Emery, 1979). For example, the objective of cognitive therapy is for new information to replace the existing maladaptive cognition, that is, to minimise the continued influence of maladaptive cognition on ongoing cognitive processing. If some beliefs are differentially susceptible to the CIE, then clinicians
need to understand these processes and the implications for treatment, to improve the efficacy of treatment.

We will discuss other clinical implications, limitations and future directions after presenting a second experiment using the CIE paradigm. Study 5 investigated the influence of emotional valence on memory updating impairments in depressive ruminators using the CIE paradigm.

4.6.6 Conclusion

To conclude, this is the first study to use the CIE paradigm to investigate the nature of memory updating deficits in depressive rumination. The findings provide preliminary evidence that discounting of negative misinformation is not impaired in depressive ruminators in the CIE paradigm; depressive ruminators were as effective as healthy controls in updating negative misinformation following a retraction, potentially due to a negative attentional bias that enhanced the salience of negative (mis)information.
4.7 References


Processing inaccurate information: Applied and theoretical perspectives from cognitive science and the educational sciences, 13-38.


Chapter 5: Continued Influence Effect in Depressive Rumination—The Role of Valence
5.1 Foreword

Contrary to expectations, Study 4 demonstrated that depressive ruminators are not impaired in updating negative misinformation following a retraction. That is, depressive ruminators do not ‘cling’ to negative (mis)information and are as effective as healthy controls in updating negative misinformation following a retraction. This is contrary to the literature that demonstrated that depressive ruminators are impaired in updating negative information (Joormann & Gotlib, 2008; Levens & Gotlib, 2009, 2010), and impaired in disengaging from negative information (Grafton, Southworth, Watkins, & MacLeod, 2016; Koster, De Raedt, Goeleven, Franck, & Crombez, 2005), especially when it is self-referential (Koster, De Lissnyder, Derakshan, & De Raedt, 2011).

Furthermore, it was unexpected that the effectiveness of a retraction was not influenced by depressive rumination in interaction with the nature of the scenario: Depressive ruminators were equally effective in updating negative misinformation across both specific and general scenarios, which both relates to suicide and are themes common in depressotypic worldviews. We interpreted this unexpected finding as the effect of salience of the negative (mis)information which facilitated updating (Ecker, Hogan, & Lewandowsky, 2017; Kendeou, Walsh, Smith, & O’Brien, 2014; Stadtler, Scharrer, Brummernhenrich, & Bromme, 2013), as opposed to depressotypic worldviews effect that prevents discounting of worldview-congruent misinformation.

In the context of depressive rumination, salience may depend on the emotional valence of the misinformation, due to negative cognitive biases often exhibited in depression (Everaert, Duyck, & Koster, 2014). There is evidence that retractions are more effective if the misinformation is salient during processing of the
retraction (Ecker, Hogan, & Lewandowsky, 2017). Our findings (Study 4) suggest that discounting of the misinformation is also a function of the salience of the misinformation during *encoding*. Thus, we manipulated the emotional valence of the misinformation in the present study, in order to test if depressive ruminators might exhibit enhanced discounting of negative (i.e., presumably salient) misinformation when compared to discounting of positive misinformation.
5.2 Abstract

People persist in their reliance on retracted misinformation in their reasoning despite acknowledging a retraction and this is known as the continued influence effect. There is evidence that salience of the misinformation facilitates retraction processing by enhancing conflict detection. In depressive rumination, emotional valence may determine salience. We manipulated the valence of the misinformation to test if (1) based on cognitive theories of depression, depressive ruminators might be impaired in retraction processing for negative misinformation, or (2) based on salience-facilitated updating, retraction processing may be enhanced in depressive ruminators for negative, compared to both positive misinformation and control participants. We found support for the salience account: Processing was enhanced in depressive ruminators (control participants) for negative (positive) misinformation. We discuss the clinical implications of the findings and suggest future directions for research on cognitive impairments in depressive rumination.
5.3 Introduction

To maintain an up-to-date representation of a constantly changing world, memory updating and knowledge revision are necessary. However, these processes are error-prone (Ecker, Lewandowsky, Oberauer, & Chee, 2010; Rich, van Loon, Dunlosky, & Zaragoza, 2017); people often continue to rely on retracted misinformation in their memory and inferential reasoning despite acknowledging a retraction (Ecker, Lewandowsky, Swire, & D. Chang, 2011; Thorson, 2016; Wilkes & Leatherbarrow, 1988). This post-retraction persistence of misinformation is known as the continued-influence effect (CIE; Johnson & Seifert, 1994; for reviews, see Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012; Seifert, 2002; Swire & Ecker, 2018).

5.3.1 The Continued Influence Effect—The Role of Valence

The findings in Study 4 conform to theoretical accounts proposing that the salience of the misinformation during its retraction enhances updating by facilitating the detection of conflict and co-activation of the incorrect and correct information in memory (Ecker, Hogan, & Lewandowsky, 2017; Kendeou, Walsh, Smith, & O’Brien, 2014; Stadtler, Scharrer, Brummernhenrich, & Bromme, 2013). As in Study 4, misinformation salience was not specifically enhanced at the time of retraction, the findings suggest that the salience of the misinformation may more generally facilitate updating—that is, misinformation that is salient to a person may be easier to retract. In the context of depressive rumination, salience may depend on the emotional valence of the misinformation.

There is overwhelming evidence that depressive rumination is characterized by a negative schema (Beck, 1976, Beck, Brown, Steer, Eidelson, & Riskind, 1987; Nolen-Hoeksema, 1991; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008) that
contributes to negative cognitive biases (Everaert, Duyck, & Koster, 2014; Everaert, Tierens, Uzieblo, & Koster, 2013; Joormann & Gotlib, 2008; Levens & Gotlib, 2009, 2010). A negative self-schema would thus render negative information generally more salient, which may facilitate its updating following a retraction.

Thus, we manipulated the misinformation’s valence in the present study, in order to test if depressive ruminators might exhibit enhanced discounting of negative (i.e., presumably salient) misinformation when compared to discounting of positive misinformation. The comparison of positive and negative scenarios allows for a test of the salience account: retractions of negative misinformation should be particularly effective in depressive ruminators, compared to both the positive scenario, and compared to healthy controls. Alternatively, if salience does not carry the hypothesized weight, the present study allowed an additional test of our original hypothesis, namely that depressive rumination may be associated with impaired discounting of negative misinformation when contrasted against positive misinformation.

Regarding the low-DR group, we did not expect any difference in retraction effectiveness across positive and negative reports: One may argue that a positive scenario may be more salient to low-DR participants (Grafton, C. Ang, & MacLeod, 2012; Levens & Gotlib, 2010). It follows that retraction effectiveness should be enhanced in the low-DR group. However, there is also evidence to suggest that negative information is in general somewhat more attention-demanding (e.g., Rozin & Royzman, 2001). For example, in a CIE study, Guillory and Geraci (2016) presented participants with three stories (positive, negative, or neutral) regarding politicians seeking re-election, and found that participants demonstrated a negativity bias, preferentially referring to negative information regardless of a retraction.
However, the inference questions in Guillory and Geraci’s study differed across stories in their potential to elicit references to the critical information, and thus methodological artifacts might have contributed to this finding. Given these inconsistent results, we made no strong predictions regarding the low-DR group.

5.3.2 The Present Study

The aim of the present study was to ascertain if high-DR individuals might exhibit enhanced (or reduced) discounting of negative misinformation when compared to discounting of positive misinformation. Based on the literature demonstrating stronger worldview effects on the CIE with general scenarios (Ecker & L. C. Ang, 2019), the present study used only general scenarios contrasting negative with positive misinformation, and was thus similar to the general scenario condition in Study 4. Furthermore, based on the content-specificity hypothesis (Derry & Kuiper, 1981, Kuiper & Derry, 1982) of Beck’s cognitive model of depression (Beck, 1976; Beck, Brown, Steer, Eidelson, & Riskind, 1987)—which proposes that the content of depressive thoughts relates to specific themes—the negative scenarios related to themes of suicide and abandonment, which are themes common in depressive rumination. As the valence manipulation (unlike the specificity manipulation in Study 4) required conceptually different scenarios, it was applied within-subjects. Apart from those changes, the procedure was very similar to Study 4, with minor changes specified below.

5.4 Method

Valence and retraction factors were fully crossed and varied within-subjects. The present study thus had a 2 (retraction: no vs. yes; within-subjects) × 2 (valence: positive vs. negative; within-subjects) × 2 (group: depressive rumination low vs. high; between-subjects) mixed design.
5.4.1 Participants

Sample size was based on previous CIE research using a repeated-measures design (e.g., Ecker, Hogan, & Lewandowsky, 2017). Eighty-six participants\(^{15}\) were selected from multiple screening exercises \((N \approx 1,500);\) none of them had participated in the experiment presented in Study 4. Twenty-one participants were removed as the test-day depression score did not confirm their classification based on the pre-screened score. An additional participant was excluded due to illegible responses. The final sample comprised \(N = 64\) participants (32 per DR group; 24 males, 40 females) with a mean age of \(M = 19.3\) years \((SD = 2.91;\) age range 17-31 years). Mean RRS, DASS-Dep, and DAS-A scores were \(M_{\text{RRS}} = 61.06\) \((SD = 9.02),\) \(M_{\text{DASS}} = 20.03\) \((SD = 7.00),\) and \(M_{\text{DAS-A}} = 119.28\) \((SD = 18.66)\) for the high-DR group, and \(M_{\text{RRS}} = 27.41\) \((SD = 3.75),\) \(M_{\text{DASS}} = 2.37\) \((SD = 2.83),\) and \(M_{\text{DAS-A}} = 155.63\) \((SD = 15.35)\) for the low-DR group, respectively. The internal consistencies of the RRS, DASS-Dep, and DAS-A scores were \(\alpha > .91,\)\(^{16}\) and coefficient omegas > .95, 95% CI [.93, .97], and the correlations among RRS, DASS-Dep, DAS-A, and DASS-21 depression scores were \(r_s > |.68|, ps < .001\)\(^{17}\). There was a significant difference in DAS-A scores between the low- and high-DR participants, \(t(62) = 8.51, p < .001.\) There was no gender difference in RRS, DASS-Dep, and DAS-A scores, \(ps > .282.\)

\(^{15}\) We applied the same selection criteria as the experiment presented in Study 4. However, in the present study, two participants, one with a test-day DASS-Dep score of 11 and one with an RRS score of 36, were inadvertently included in the low-DR group. Exclusion of these two participants did not change any of the results, hence they were retained for the analyses.

\(^{16}\) The Cronbach’s alpha for DAS-A improved from .77 when the 10 reverse-scored items were excluded.

\(^{17}\) See Table 7 in Appendix C for correlation matrix of RRS and DASS subscales for depression, anxiety and stress.
5.4.2 Scenarios

There were four fictitious news reports; each consisted of a series of seven messages (word count ranged from 157 to 176). Each report detailed the findings of a study which portrayed either a positive or negative theme. The positive reports described an increasing trend in either charity giving or the happiness index of Australians; the negative reports described an increasing trend in either youth suicide rates or abandoned babies. The structure of the reports and trustworthiness of the retraction source was kept comparable (positive: The Guardian newspaper and a university professor; negative: a UNICEF speaker and a university professor; Guillory & Geraci, 2013).

Across reports, message 2 contained the critical piece of information and message 6 contained its retraction (or some arbitrary information in the no-retraction condition). Specifically, message 2 in the charity scenario stated that a study suggested that “donations to charities have increased steadily over the past 5 years”. Message 6 in the retraction condition then stated that “the lead author of the study [...] explained [...] that donations to charities in Australia have actually not increased in the past 5 years”, and in the no-retraction condition, that “the lead author of the study [...] explained [...] that the work done by charities in Australia deserved support and recognition”. In the happiness scenario, message 2 stated that “Australians are ranked the happiest people in the world”. Message 6 then either stated that “Australia did not actually top the list” or that “there had been a surge in comments [...] in response to this report”.

In the suicide-rate scenario, message 2 stated that “suicide rates in young Australian adults [...] have risen substantially in recent years”. Message 6 then either stated that “according to the researcher involved [...] suicide rates in young..."
adults were actually not on the rise in Australia.” or that “because of the number of media requests, the researcher involved […] was preparing a summary of findings for public release”. In the abandoned-babies scenario, message 2 stated that “the number of abandoned babies in Australia has increased manifold”. Message 6 then either stated that it was “clarified […] that the number of abandoned children in Australia in fact has not increased” or that it was “explained […] that a report was forthcoming regarding the impact of the establishment of baby hatches”. All reports are available in Appendix C.

5.4.3 Test questionnaire

The questionnaire booklet (see Appendix C) consisted of five inference questions (three open-ended questions and two rating scales), and two retraction-awareness questions per scenario. The three open-ended inference questions were identical across scenarios and designed to allow responding with or without reference to the critical information. An example is the question “What conclusions can be drawn from this report? (Please elaborate)”. The two rating scales used 9-point scales and were similar across scenarios; participants provided past or future trend estimates (e.g., regarding charity giving or suicide rates). As results from Study 4 suggested adequate encoding, and for pragmatic reasons, recall accuracy questions were excluded from the present study.

5.4.4 Procedure

Participants read the four news reports, with each message presented individually, similar to Study 4; at the end of each news report, participants pressed the space bar to continue with the next report. After encoding, participants engaged in an unrelated 3-minute distractor task before completing the questionnaire. The order of the questions in the test questionnaire corresponded to the presentation order
of the news reports. Presentation order was counterbalanced across participants, taking into account the reports’ specific topic, valence, and retraction condition. Specifically, within the $2 \times 2$ design, the four different reports could be assigned to retraction and no-retraction conditions in four possible combinations, and these four combinations could be presented in 24 different orders. Of the resulting 96 possible orders, we selected only orders with different valence and retraction conditions in the first two presented reports, to prevent participants from noticing any regularities regarding valence or the presence of a retraction. This resulted in the selection of 32 different presentation orders.

5.5 Results

5.5.1 Coding of responses

The coding procedure was identical to Study 4. Inter-rater reliability, based on 20 questionnaires across conditions and groups (2 to 3 per condition), was high, $r = .91$.

5.5.2 References to critical (mis)information (inference scores)

There were seven participants who did not indicate awareness of any retractions. These participants were retained but analyses were repeated with them excluded. Exclusion did not change any of the findings, except where specified. Mean inference scores across conditions are shown in Figure 5. One-sample $t$-tests confirmed that all scores in the retraction conditions differed significantly from zero, all $t$s(31) > 11.13, $ps < .001$. This demonstrates a significant CIE in all retraction conditions.
A three-way repeated measures ANOVA on mean inference scores with factors retraction, valence, and group revealed a main effect of retraction, $F(1,62) = 4.78, p = .033, \eta^2_p = .07$\textsuperscript{18}, which was qualified by a significant three-way interaction, $F(1,62) = 5.50, p = .022, \eta^2_p = .08$. All other effects were non-significant, all $F$s < 1 (except $F[1,62] = 2.58, p = .113$, for the valence by group interaction).

When gender was included as an additional factor, there was no main effect of gender, and gender did not interact with retraction condition or valence. However, there was a significant group by gender interaction, $F(1,60) = 8.27, p = .006$.

\textsuperscript{18} Excluding the seven participants with no retraction-awareness, this effect only approached significance, $F(1,55) = 3.30, p = .075$. 

\textit{Figure 5.} Mean inference score by retraction condition, valence, and DR group. Error bars indicate within-subject standard errors of the mean.

\textit{Note.} DR = Depressive Rumination.
\( \eta^2 = .12 \), such that high-DR males had numerically greater mean inference scores than low-DR males, whereas this pattern was reversed in females, that is, low-DR females had numerically greater mean inference scores than high-DR females. However, this should be interpreted with caution given no such effect was found in Study 4.

Planned contrasts showed that in the high-DR group, the retraction of negative misinformation was effective, \( F(1,62) = 8.15, p = .006, MSE = 0.04 \), and that it was more effective than the (entirely ineffective) retraction of positive misinformation, \( F(1,62) = 4.33, p = .042, MSE = 0.05 \), for the interaction of retraction and valence. Conversely, the low-DR group demonstrated the opposite trend: Here, the retraction of negative misinformation was obviously entirely ineffective, whereas the retraction of positive misinformation showed an effect at least approaching significance, \( F(1,62) = 3.22, p = .077, MSE = 0.05 \) (here, the interaction contrast was not significant, \( F[1,62] = 1.53, p = .221, MSE = 0.05 \)).

### 5.5.3 Continued Influence Effect and Depressotypic Worldview

We also ran a two-way repeated measures ANOVA with factors valence and group on data from the no-retraction baseline condition only. There was a significant interaction, \( F(1,62) = 6.57, p = .013, MSE = 0.05 \), showing that inference scores tended to be greater for the negative reports in the high-DR group, and greater for the positive reports in the low-DR group.

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19 We use the term “effective” here purely as a means of comparison, that is, in terms of relative (as opposed to absolute) effectiveness of a retraction to reduce mean inference scores.

20 Excluding the seven participants with no retraction-awareness, this effect only approached significance, \( F(1,55) = 2.37, p = .129 \).
In contrast to Study 4, the correlation between DAS-A scores and post-retraction inference scores was clearly non-significant, $r = -.08, p = .558$. Nevertheless, following the analysis procedure of Study 4, an ANCOVA was run including DAS-A scores as a continuous predictor, and retraction and valence as factors. Again, the main effect of retraction, $F(1,62) = 4.81, p = .032, \eta_p^2 = .07$, from the original three-way ANOVA was closely replicated. Moreover, the three-way interaction of retraction, valence, and DAS-A mirrored the three-way interaction effect from the ANOVA involving the DR group factor, $F(1,62) = 5.41, p = .023, \eta_p^2 = .08$.

### 5.5.4 Disentangling Rumination and Depression

In a preliminary attempt to disentangle the relative contributions of rumination and depression to mean inference scores, DASS-Dep and RRS scores were entered into an exploratory linear regression. This model was approaching significance, $F(2,63) = 3.03, p = .056$, adjusted $R^2 = .06$, and accounted for 9% of the variance in mean inference scores. Furthermore, DASS-Dep scores ($\beta = -.27, p = .036$) were found to be a significant and stronger predictor of mean inference scores than rumination ($\beta = -.09, p = .498$), which was not a significant predictor in this model. A commonality analysis confirmed this, suggesting that depression scores accounted for more explained variance than rumination scores (0.07, or 76% vs. 0.01, or 8%; common variance was 0.01, or 16%).

### 5.6 Discussion

The aim of the present study was to investigate if the valence of a general scenario would affect the effectiveness of a retraction in people with depressive rumination (DR). Our original hypothesis was that depressive ruminators would exhibit a larger continued influence effect (CIE) with negative compared to positive
reports, in line with studies investigating the impact of worldviews on the CIE.

Alternatively, in light of the finding of Study 4 that high-DR participants showed intact updating of negative misinformation, we speculated that high-DR participants might demonstrate enhanced discounting of negative (relative to positive) misinformation based on its greater salience in this population.

### 5.6.1 Continued Influence Effect in Depressive Rumination

Replicating the findings in Study 4 and consistent with previous research (Ecker, Lewandowsky, E. P. Chang, et al., 2014; Ecker et al., 2011; Thorson, 2016; Wilkes & Leatherbarrow, 1988), retractions generally reduced but did not eliminate reliance on misinformation. Of particular interest, we found a significant three-way interaction suggesting that the effectiveness of a retraction varied systematically across DR groups and valence. Consistent with the findings in Study 4, a retraction was effective in the high-DR group for negative misinformation only. This finding may be attributed to the salience of the negative misinformation, based on an attentional bias towards negative information in depressive ruminators (E. P. Chang, Ecker, & Page, 2017; Koster, De Raedt, Leyman, & De Lissnyder, 2010; Owens & Gibb, 2017). This is in line with the notion that misinformation that is more salient at the time of its correction is more easily retracted (Ecker et al., 2017), potentially due to enhanced co-activation (Kendeou, Butterfuss, Van Boekel, & O’Brien, 2017; Kendeou et al., 2014) and/or conflict detection (Stadtler et al., 2013; also see Ecker et al., 2011). In this vein, assuming that positive information was more salient to the low-DR participants could also explain why a retraction tended to be more effective in the low-DR group for positive misinformation. However, this effect in itself was non-significant, and thus the interpretation of the outcome in the low-DR group remains speculative. Taken together, both groups demonstrated worldview-congruent
attentional biases which was associated with enhanced post-retraction memory updating for worldview-congruent materials.

### 5.6.2 The Effect of Valence (Salience)

The novel and consistent finding across both experiments (Study 4 and the present study) was that retractions of negative misinformation were effective in depressive ruminators. We suggest this could be attributed to a negative attentional bias in depressive ruminators that enhanced the salience of the negative misinformation, thus facilitating subsequent updating following a retraction. Notably, our finding favors an attentional bias and information salience account of memory updating in depressive rumination (Ecker et al., 2017) as opposed to a motivated reasoning account (Ecker & L. C. Ang, 2019; Nyhan & Reifler, 2010), which would predict impaired updating for worldview-congruent negative misinformation in depressive ruminators, which is not what we found.

Naturally, our data offer no strong evidence that the observed effects are driven only by an attentional bias. It is also possible negative interpretative or memory biases, or any combination of attentional, interpretative, and memory biases, may be responsible for the observed findings. Indeed, emerging research on the combined cognitive bias hypothesis in depression (Everaert, Koster, & Derakshan, 2012) demonstrates the coherence and interactive relations of these cognitive biases in depression (Everaert, Duyck, & Koster, 2014; Everaert, Grahek, Duyck, Buelens, Van den Bergh, & Koster, 2017). However, the pattern of findings in the retraction conditions suggests that our high-DR participants did not exhibit interpretative bias (Bisson & Sears, 2007; Blanchette, & Richards, 2010), as they were able to integrate retractions that contradicted their negative schemata.
It is important to reiterate that the CIE occurs reliably even with no involvement of specific worldviews or cognitive biases, because of generic integration or retrieval failures (see Lewandowsky et al., 2012). Our results suggest that with emotionally valent information, the effect may be modulated by an attentional bias towards information that is worldview-congruent, which may boost references to this information if it is non-retracted but facilitate its updating and revision following retraction. We speculate that this modulation is salience-driven; that is, in our sample of depressive ruminators, we argue that the updating facilitation arose for negative information because this information was high in salience based on its valence-related worldview congruence. Arguably, this modulation was associated with a person’s level of depression but not their rumination tendencies—based on our exploratory regression analysis and the notion that it would seem paradoxical if rumination tendencies were to be associated with the successful updating of negative information. However, this conclusion must remain speculative given the available data—we did not measure attentional bias directly and the regression analysis was exploratory—and the potentially complex interplay between depressotypic worldviews, cognitive biases, and rumination tendencies, which requires further exploration in the context of memory updating and the processing of misinformation corrections. More specifically, future studies using the CIE paradigm could measure attentional bias and use a more stringent criterion for sample selection to better disentangle the unique and relative effects of rumination and depression measures on the CIE.

The contradictory finding that depressive ruminators are not impaired in memory updating following a retraction stands in contrast to studies demonstrating that depressed individuals were impaired in disengaging from negative information
(Grafton, Southworth, Watkins, & MacLeod, 2016; Koster, De Raedt, Goeleven, Franck, & Crombez, 2005), especially when the information is self-referential (Koster, De Lissnyder, Derakshan, & De Raedt, 2011). However, most studies demonstrating memory updating impairments for negative information in rumination or depression have relied on response-time or list-recall measures in short-term working memory (Joormann & Gotlib, 2008; Levens & Gotlib, 2010; cf. Everaert, Bronstein, Cannon, & Joormann, 2018). It is possible that such deficits in micro-level cognitive processing do not easily translate into the processing of realistic news reports, which requires the cooperation of working memory and long-term memory stores. The CIE paradigm may have stronger ecological validity as it more closely mimics real-world situations that require conceptual updating.

Moreover, the effectiveness of a retraction of negative misinformation in high-DR individuals across both experiments (Study 4 and the present study) suggests that (a) political worldviews associated with conservatism and depressotypic worldviews associated with depressive rumination cannot be equated in terms of their effects on information processing, and (b) while valence may impact on retraction effectiveness in depressive rumination, it seems that this occurs through a salience effect that promotes memory updating of negative information in depressive rumination instead of a worldview-incongruence effect that prevents it. Indeed, generic (e.g., political, racial) worldviews differ qualitatively from the depressotypic worldviews characterising depressive rumination, especially with regards to self-congruence and the associated motivation to defend the worldview against incongruence threats (Ecker & L. C. Ang, 2019; Higgins, 1987; Taber & Lodge, 2006).
It was unexpected that retractions of positive (negative) misinformation were entirely ineffective in high- (low-) DR participants. Our interpretation in terms of weaker encoding of worldview-incongruent misinformation and a potential lack of co-activation and conflict detection (Kendeou et al., 2014, 2017; Stadtler et al., 2013) is broadly consistent with the literature on positive insensitivity in depression and/or rumination (Levens & Gotlib, 2009, 2010; Rottenberg, Gross, & Gotlib, 2005) and negative material promoting withdrawal responses in an unselected sample (Recio, Conrad, Hansen, & Jacobs, 2014).

The no-retraction control condition yielded additional evidence for a valence-related attentional bias: Both groups of participants made more references to unretracted information that was worldview-congruent—that is, positive for low-DR and negative for high-DR participants, respectively. This is consistent with a general tendency to refer preferentially to worldview-congruent information (see Ecker, Lewandowsky, Fenton et al., 2014). In light of this, another way to frame the main finding is to argue that high-DR participants were biased towards referencing negative information and low-DR participants were biased towards referencing positive information, with retractions reducing these salience-driven biases.

The finding that a retraction of negative misinformation was not effective in the low-DR group in the present study stands in contrast to the findings in Study 4. The reasons for this discrepancy are unclear, but it could be attributed to a positive attentional bias in the low-DR group that is only activated in the presence of stimuli competing for representation, such that the bias draws cognitive resources towards positive information at the expense of negative information (Grafton et al., 2012; also see Kendeou et al., 2014).
5.6.3 Rumination versus Depression

The results from the exploratory linear regression and commonality analyses suggested that in the high-DR group, depression but not rumination scores predicted reliance on negative (mis)information. This suggests that future research using the continued-influence paradigm (Johnson & Seifert, 1994; Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012) may benefit from recruiting participants solely on depression scores. However, we cannot know whether those who are high on depression but low on rumination measures might attenuate the observed effect, since this group was not included in our sample.

5.6.4 Clinical Implications

Together with the findings reported in Study 4, the findings in the present study provide preliminary evidence that, contrary to expectations, depressive ruminators do not ‘cling’ to negative (mis)information. In the context of cognitive therapy designed to replace maladaptive thoughts, the findings may suggest that increasing the salience of maladaptive negative thoughts before implementing strategies to replace them with more adaptive and positive thoughts may achieve better treatment outcomes by facilitating updating (Elsey & Kindt, 2017; Hayes, Yasinski, Barnes, & Bockting, 2015; Köhler, Carvalho, Alves, McIntyre, Hyphantis, & Cammarota, 2015). This is important because the success of cognitive behavior therapy hinges on the ability to update and replace maladaptive and depressotypic worldviews and beliefs with more adaptive ones (Dobson & Dozois, 2001). However, we note that none of the experiments have tested the retractions of self-referential positive and negative thoughts, and given that the hypersalience of incorrect information in schizophrenia has been found to reduce belief revision (Balzan, Delfabbro, Galletly, & Woodward, 2013), further research is necessary, also
to ascertain if there is an optimal level of salience beyond which memory updating in depressive rumination may instead be impaired.

Another implication of the findings regards the stigma of depression (Griffiths, Christensen, & Jorm, 2008). A common belief and common stigma reported by depressed individuals is being blamed for their depression, or self-blaming (Barney, Griffiths, Christensen, & Jorm, 2009). The present study demonstrates that depressive rumination is not associated with the tendency to ‘cling’ to negative information; on the contrary, depressive ruminators are able to discount outdated negative information and update their memory representations, which translates to more accurate (and positive) memory and inferential reasoning. This finding may thus serve to reduce stigma, which could encourage people to seek treatment (Griffiths, Carron-Arthur, Parsons, & Reid, 2014).

5.6.5 Limitations and Future Directions

As both CIE experiments in Studies 4 and 5 are the first studies to investigate the potential nature of memory updating impairments in depressive rumination using the CIE paradigm, we selected participants based on rumination and depression measures concurrently. This prohibits disentangling the relative contributions of rumination and depression to the observed findings. However, the results from the exploratory regression analyses—confirmed by the respective commonality analyses—suggest that future studies could select participants based solely on depression measures in order to better disentangle the relative contributions of rumination and depression to the CIE.

In addition, we compared negative scenarios with positive scenarios to increase test sensitivity. Future studies could include a neutral scenario to better ascertain the role of cognitive biases towards negative information (Everaert, Duyck,
& Koster, 2014; Everaert, Tierens, Uzieblo, & Koster, 2013), cognitive biases away from positive information (Ji, Grafton, & MacLeod, 2017; Levens & Gotlib, 2009), or a combination of both cognitive biases (Everaert, Bronstein, Cannon, & Joormann, 2018) contributing to the observed findings.

Finally, given the significance of the self-referential effect on the nature of memory updating impairments in depressive rumination (as discussed in Studies 2 and 3), and the heterogeneity of depressive symptoms (Fried & Nesse, 2015), future studies could improve and refine the scenarios used. More specifically, future studies could benefit from (1) using scenarios that are more self-referential and map more specifically onto relevant depressotypic worldviews, instead of scenarios containing themes that are broadly relevant to depression in general (Study 4), or implementing a valence differentiation (the present study), (2) including more scenarios across the varied themes common in depression (e.g., worthlessness, hopelessness, and self-depreciation; Beck, Brown, Steer, Eidelson, & Riskind, 1987), to better capture the heterogeneity of depressive symptoms.

5.6.6 Conclusion

To conclude, this is the first study to use the CIE paradigm to investigate the role of valence in memory updating impairments in depressive rumination. The findings provide preliminary evidence that depressive rumination is associated with an updating enhancement for negative misinformation following a retraction, potentially due to a negative attentional bias that enhances the salience of negative information. Moreover, future research could aim to replicate the observed effects by (1) utilizing scenarios map more specifically onto relevant depressotypic worldviews, and (2) adopting more specific participant selection criteria to
adequately disentangle the relative contributions of rumination and depression to the observed effects.
5.7 References


Chapter 6: General Discussion
6.1 Discussion

The present thesis focused on a highly researched area of cognitive processing that is associated with efficient daily functioning (Björkdahl, Åkerlund, Svensson, & Esbjörnsson, 2013; Kane, Brown, McVay, Silvia, Myin-Germeys, & Kwapił, 2007): memory updating in depressive rumination. We examined memory updating both in working memory (WM), using a task involving memorisation and updating of words and a response-time measure, and in long-term memory (LTM), using a more naturalistic paradigm involving updating of news narratives following a retraction. The findings of these studies contribute to our understanding of the nature of memory updating impairments in depressive rumination, as the findings vary across a response-time task and a task involving conceptual updating. The mixed findings on the nature of memory updating impairments in depressive rumination across two paradigms have practical and clinical implications.

The nature of WM updating impairments in depressive rumination is not clear. As covered in previous chapters, there is evidence for both a generic (i.e., general impairment, Harvey et al., 2004; Meiran, Diamond, Toder, & Nemets, 2011) and a valence-specific (i.e., for negative materials; Joormann & Gotlib, 2007, 2008; Levens & Gotlib, 2010) updating impairment in depressive rumination. Thus, the present thesis investigated the nature of potential valence-specific memory updating impairments in depressive rumination, using positive and negative valenced materials, across two paradigms. We first used a novel WM updating task that provided a measure of removal, a core subprocess of WM (Ecker, Lewandowsky, & Oberauer, 2014; Ecker, Oberauer & Lewandowsky, 2014; Singh, Gignac, Brydges, & Ecker, 2018). We then used the continued influence effect (CIE) paradigm which investigated memory updating of news narratives, on a longer time-scale, better
reflecting real-world updating (Johnson & Seifert, 1994; Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012; Wilkes & Leatherbarrow, 1988). Based on the notion of a valence-specific updating impairment for negative materials in depressive rumination, we hypothesized that depressive ruminators would take longer or be less effective when updating negative information in memory.

By contrast, the novel and consistent finding across Studies 3, 4, and 5 was that depressive rumination was not characterised by a valence-specific updating impairment, neither in the WM updating task nor the CIE paradigm. Instead, in the WM updating task, depressive ruminators demonstrated a generic removal deficit (fast but incomplete removal of outdated information) when updating towards a new to-be-remembered negative word; in the CIE paradigm, they showed intact or even enhanced updating of worldview-congruent, negative misinformation. We interpreted these findings in terms of a negative attentional bias that enhanced the salience of negative materials (Joormann & Gotlib, 2007; Peckham, McHugh, & Otto, 2010).

In the WM updating task, we argue that this bias contributed to the valence-generic removal deficit, as opposed to valence-specific updating impairments reported in previous research (Joormann & Gotlib, 2007, 2008). This suggests that depressive ruminators do not cling to negative information in WM and do not exhibit a valence-specific deficit in removing outdated information from WM. Rather; they seemed to be impaired in adequately removing both positive and negative outdated information when presented with new, to-be-updated negative materials. We attributed this to a negative attentional bias in depressive ruminators, which prematurely draws cognitive resources towards new, negative materials, at the expense of sufficiently removing outdated information. This valence-generic
removal deficit was positively associated with impaired recall for negative words, suggesting that interference from inadequately removed outdated words impaired recall for negative compared to positive words in depressive ruminators (Oberauer & Lewandowsky, 2008; Oberauer, Lewandowsky, Farrell, Jarrold, & Greaves, 2012; Singh et al., 2018). The finding of a valence-generic deficit also speaks against the notion of impaired attentional disengagement from negative materials (Grafton, Southworth, Watkins, & MacLeod, 2016; Koster, De Lissnyder, Derakshan, & De Raedt, 2011), as depressive ruminators were able to disengage equally quickly from positive and negative materials.

In the CIE paradigm, we argue that a negative attentional bias enhanced the salience of negative materials, which in turn contributed to enhanced updating of negative misinformation (Ecker, Hogan, & Lewandowsky, 2017; Kendeou, Butterfuss, van Boekel, & O’Brien, 2017; Kendeou, Walsh, Smith, & O’Brien, 2014), as opposed to impaired updating of worldview-congruent negative misinformation driven by motivated dismissal of corrections (Ecker & L. C. Ang, 2019; Nyhan & Reifler, 2010). Again this supports the notion that depressive ruminators do not cling to negative (mis)information and are not impaired in dismissing outdated negative misinformation across both Studies 4 and 5; they instead demonstrated enhanced memory updating of negative misinformation compared to positive misinformation (Study 5), which we interpreted as arising from a negative attentional bias.

Across both studies using the CIE paradigm (Studies 4 and 5), we found evidence that depressive ruminators are not impaired in updating negative (mis)information. While this is generally consistent with the absence of a valence-specific updating deficit in Study 3, it seemingly stands in contrast to the literature
on updating impairments in depressive rumination (Joormann & Gotlib, 2007, 2008; Levens & Gotlib, 2010). In considering this, it needs to be borne in mind that most studies demonstrating impaired memory updating for negative information in depressive rumination have relied on response-time or list-recall measures in short-term WM (e.g., Joormann & Gotlib, 2007, 2008; Levens & Gotlib, 2010; cf. Everaert, Duyck, & Koster, 2014). The CIE paradigm, in comparison, involves cooperation of WM and LTM stores (Brydges, Gignac, & Ecker, 2018) and assesses the complex interaction among lower-level cognitive processes including attention and basic memory processes and higher-level processes such as information integration and inferential reasoning. It may thus have stronger ecological validity as it is more akin to real-world situations that require conceptual updating.

One proposal for updating in depressive rumination is that it may be generally impaired because updating is an effortful process and depressive ruminators are impaired in effortful processing because rumination consumes cognitive resources (Levens, Muhtadie, & Gotlib, 2009; Meiran et al., 2011; Watkins & Brown, 2002). However, this was clearly not the case here, as general recall and thus updating performance (in terms of accuracy) of depressive ruminators in Study 3 was comparable to controls, and in Studies 4 and 5 there were no general updating, recall, or reasoning impairments.

The finding of an impaired recall for negative words in depressive ruminators in Study 3 is also contrary to a mood-congruent memory bias for negative materials in depressed individuals (Matt, Vázquez, & Campbell, 1992; Ridout, Astell, Reid, Glen, & O’Carroll, 2003; Watkins, Mathews, Williamson, & Fuller, 1992). A speculative interpretation is that the absence of a memory bias arose because participants in Study 3 expected that most of the words in the updating task would
become irrelevant and would thus need to be removed (i.e., task instructions specified that there will be an unpredictable number of updating steps where a word will be replaced with a new, to-be-remembered word), such that encoding strength may have generally been reduced; this may be explained by expectancy theory which proposes that the expectancy that effort will change performance must precede the motivation to expend that effort (Vroom, 1964). However, expectancy theory cannot adequately account for the intact recall in healthy controls, and intact recall for positive words in depressive ruminators in Study 3. By contrast, participants do not expect to have to update in the CIE paradigm; this is a fundamental difference between the WM updating and CIE paradigms. Given the lack of updating expectations in the CIE paradigm, expectancy theory (Vroom, 1964) would suggest sufficient encoding of non-retracted information, which may account for the observed memory bias in Studies 4 and 5—participants used non-retracted worldview-congruent information more in recall and reasoning due to adequate encoding strength. We next discuss some theoretical frameworks that may be used to explain our findings, before turning to the practical and clinical implications, and finally the limitations and future directions.

6.2 Dual-Process Models of Cognitive Processing

We first discuss a theoretical framework of information processing that has its roots as far back as Greek philosophers and early psychologists: a dual-processing framework (Croskerry, 2009; James, 1890; Piaget, 1926). A dual-process model of reasoning has been extensively and widely applied across social and cognitive psychology (Evans, 2008; Smith & DeCoster, 2000). More recently, this model has been applied to depression in the dual-process model of cognitive vulnerability to depression (Beeters, 2005; Haeffel, Abramson, Brazy, Shah, Teachman, & Nosek,
We first discuss the dual-process model and illustrate how this model is unable to account for the findings across the three studies in the present thesis. We therefore point to alternative theoretical frameworks that better account for our findings, including a knowledge revision model and reconsolidation theory—which relate to mechanisms underlying cognitive processes more generally—and theories of attentional and cognitive biases in depressive rumination, which relate to mechanisms underlying cognitive processes in depressive rumination more specifically.

The dual-process model posits two modes of information processing: an automatic, effortless processing mode based on associations (e.g., in depression, associative processing based on negative schemata; Beevers, 2005), and an effortful, strategic and rule-based reflective processing mode based on inference (Evans, 2008; Sloman, 1996; Smith & DeCoster, 2000). It has been argued that failure of strategic processing to correct automatic and potentially (negatively) biased associative processing can confer a vulnerability to depression (Beevers, 2005). To the extent that in depressive rumination, a negative schema will lead to deeper processing of schema-relevant information, this negative information would thus require strategic processing to offset the associative bias, and the negative information should thus be relatively difficult to update. However, this model cannot account for the findings of Studies 3, 4, and 5 as depressive ruminators were not specifically impaired in updating negative materials. As one factor differentiating between associative and strategic processes is the need for WM resources (Evans & Stanovich, 2013), failures of strategic processing may arise from a lack of available WM resources. A plausible explanation for the observed findings may thus be that the undergraduate sample of depressive ruminators possessed the necessary WM resources required for strategic
processing to override negatively biased associative processing (Evans & Stanovich, 2013). This may in turn suggest that a more heterogeneous sample with greater variability in WM resources may demonstrate a valence-specific deficit in memory updating because relatively lower WM resources may allow less overriding of negative associative processing; we discuss this as a limitation and future direction in a later section.

Relatedly, but more relevant to Studies 4 and 5, the dominant account of the CIE has been a dual-processing account based on dual-process memory models (Ecker, Lewandowsky, Swire, & Chang, 2011; Ecker, Lewandowsky, & Tang, 2010; Swire, Ecker, & Lewandowsky, 2017; Wilson & Brekke, 1994). According to this account, continued influence occurs based on automatic retrieval of misinformation when strategic memory processes such as retraction recollection fail. As strategic memory processes are effortful and error-prone (e.g., Herron & Rugg, 2003), their failure can be assumed to be relatively common. Together, these dual-processing accounts would suggest that negative misinformation should be easily activated in memory in depressive ruminators, and hence the CIE should be pronounced in depressive rumination for negative misinformation. This is especially true if one additionally assumes that information that is worldview-incongruent—such as retractions of worldview-congruent misinformation—may in fact be strategically dismissed (or not recollected); that is, depressive ruminators may be motivated to reject retractions of worldview-congruent misinformation to uphold pre-existing depressotypic worldviews (Del Vicario et al., 2016; Taber & Lodge, 2006).

Again, the dual-process account of the CIE cannot adequately explain the observed results in Studies 4 and 5 for both depressive ruminators and healthy controls. According to the dual-process account, failure of strategic memory
processes would predict a general CIE that should, if anything, be pronounced for mood-congruent, negative misinformation in depressive ruminators and for positive misinformation in healthy controls. That is, the dual-process model would suggest a mood-congruent updating impairment following a retraction. Instead, depressive ruminators (and to some extent healthy controls) demonstrated a valence-specific, mood-congruent updating enhancement and mood-incongruent updating impairment, following a retraction (Study 5). That is, depressive ruminators were able to update negative misinformation but not positive misinformation following a retraction. On the contrary, healthy controls were able to update positive misinformation (although this effect was only approaching significance) but not negative misinformation following a retraction. These findings thus favour an alternative interpretation: a negative attentional bias in depressive rumination (Joormann & Gotlib, 2007; Peckham, McHugh, & Otto, 2010) that enhanced the salience of negative misinformation, which in turn facilitated knowledge revision (Ecker et al., 2017; Kendeou et al., 2014, 2017) for negative misinformation in depressive ruminators, and negative material promoting withdrawal responses in healthy controls (Recio, Conrad, Hansen, & Jacobs, 2014) which impaired knowledge revision.

6.3 Knowledge Revision

The knowledge revision framework (Stadtler, Scharrer, Brummernhenrich, & Bromme, 2013; van den Broek & Kendeou, 2008) postulates that during updating, outdated or superseded information and new information are co-represented in memory (Ayers & Reder, 1998), and that co-activation of both outdated information (e.g., misinformation found to be false) and new information (e.g., the correction of the misinformation) is necessary for successful knowledge revision. Co-activation is thought to facilitate updating and revision because it allows for conflict detection—
awareness of a discrepancy between prior knowledge and new information—and information integration. That is, the misinformation and its retraction need to be activated together in WM to facilitate integration of the retraction, so that the corresponding mental model can be updated and revised, thereby reducing subsequent reliance on retracted misinformation. Support for the knowledge revision framework comes from neuroimaging data, suggesting that integration failure when encoding the retraction may be more important than retrieval failure during test for the occurrence of the CIE (Gordon, Brooks, Quadflieg, Ecker, & Lewandowsky, 2017). Also, a larger WM capacity has been found to be associated with reduced susceptibility to the CIE (Brydges et al., 2018), which is in line with the knowledge revision account because greater WM capacity allows for more efficient information integration.

With regards to the present proposal that salience of (negative) misinformation facilitated knowledge revision, Kendeou et al. (2014) as well as Ecker et al. (2017) asserted that information salience enhances co-activation; that is, when the misinformation is salient in memory when the correction is processed, misinformation and corrective information are more likely to be co-activated, allowing for better information integration, mental-model updating, and thus facilitated knowledge revision and reduced continued influence (also see Putnam, Wahlheim, & Jacoby, 2014). The findings of enhanced updating for negative misinformation in depressive rumination in Studies 4 and 5 are therefore in line with this theoretical account, to the extent that negative information is more salient in depressive ruminators.

A theoretically different but conceptually similar account is offered by reconsolidation theory: According to this theory, already consolidated memories
become labile when they are reactivated (i.e., retrieved); this labilization makes them malleable for a short period of time, thus allowing for updating and revision. Subsequently, the memories need to undergo a process of re-consolidation to re-stabilize them (Elsey & Kindt, 2017; for review, see Agren, 2014; Elsey, Van Ast, & Kindt, 2018). In the context of the CIE paradigm, updating of a mental event model following a retraction requires retrieval of the event narrative from LTM; the ease of retrieval from LTM is partially dependent on accessibility of the memory trace (Cowan, 1999). To the extent that negative information is more salient in memory in depressive rumination (either due to an attentional bias at encoding or a memory bias), it may be more readily retrieved and labilized when a retraction is encountered, and thus more readily revised. The observed findings in Studies 4 and 5 suggest that both knowledge revision and reconsolidation theories can be extended to explain the memory updating performance in depressive ruminators using the CIE paradigm. In sum, the influence of emotional valence on the effectiveness of retractions favours an interpretation in terms of a negative attentional bias and the salience of negative misinformation facilitating integration and updating.

6.4 Cognitive Biases in Depressive Rumination

6.4.1 Negative Attentional Bias

The findings across Studies 3, 4, and 5 can be explained by the negative attentional bias in depressive rumination often reported in the literature (Bradley, Mogg, & Lee, 1997; Donaldson, Lam, & Mathews, 2007; Gotlib & Cane, 1987; Gotlib, Krasnoperova, Yue, & Joormann, 2004; Joormann & Gotlib, 2007, 2008; Koster, De Raedt, Goeleven, Franck, & Crombez, 2005; Koster, De Raedt, Leyman, & De Lissnyder, 2010; Mathews, Ridgeway, & Williamson, 1996; Mogg & Bradley, 2005; for reviews see Dalgleish & Watts, 1990; Peckham et al., 2010). If this
interpretation holds any weight, it adds to the large literature on negative attentional bias in depressive rumination and suggests that a negative attentional bias in depressive rumination generalizes to two new paradigms using self-referential and loss-related negative information (Bower & Gilligan, 1979; Derry & Kuiper, 1981; Joormann, 2006; LeMoult, Kircanski, Prasad, & Gotlib, 2016; Maki & McCaul, 1985; Mogg & Bradley, 2005; Peckham et al., 2010; Rogers, Kuiper and Kirker, 1977; Wisco, 2009). Furthermore, the findings demonstrate the utility of these two paradigms in investigating cognitive processes in depressive rumination.

Although we proposed that a negative attentional bias operated in a similar fashion across the three studies, the observable outcomes were varied and suggest that a negative attentional bias in depressive rumination can have surprising consequences, depending on the task used. In the removal task (Study 3), the consequence was an impaired recall for negative words, arguably due to interference from inadequately removed outdated words (Oberauer & Lewandowsky, 2008; Oberauer et al., 2012; Singh et al., 2018). However, in the CIE paradigm (Studies 4 and 5), memory updating following a retraction was facilitated, which we interpreted as the salience of the negative misinformation enhancing conflict detection, in turn facilitating updating following a retraction (Ecker et al., 2017; Kendeou et al., 2014, 2017; Stadtler et al., 2013). If our interpretation of a negative attentional bias is correct, these findings highlight an important observation: A negative attentional bias in depressive rumination may contribute to both detrimental and beneficial cognitive effects (for a similar argument on the detrimental and beneficial effects of ruminative tendencies, see Altamirano, Miyake, & Whitmer, 2010), depending on the paradigm used and the cognitive process under investigation. This may have clinical implications, which we address in a later section. The findings also highlight that the
tasks used may partially contribute to the mixed findings in the literature on memory updating in depressive rumination.

In the context of memory updating, a negative attentional bias means that cognitive resources are preferentially directed towards negative materials, sometimes at the expense of other more important and task-relevant cognitive process (Beevers, 2005; Levens, Muhtadie, et al., 2009), such as the removal of outdated words in the removal task (Study 3). We argued that in depressive ruminators, the inadequately removed but no-longer-relevant words interfered with subsequent recall: Depressive ruminators exhibited worse recall for negative words compared to positive words. The impaired recall for negative words is contrary to the negative memory bias often reported in depression (Blaney, 1986; Bower, 1981; Matt et al., 1992). However, our interpretation of a negative attentional bias is supported by the fact that the removal-time index significantly predicted recall accuracy of negative words in depressive ruminators, and is consistent with the notion that efficient removal can enhance memory performance by reducing interference from outdated information (Oberauer et al., 2012; Singh et al., 2018). This proposed valence-generic removal deficit (i.e., a deficit affecting the removal of both positive and negative words) due to a negative attentional bias, is consistent with the finding that depression is generally associated with impairments in updating emotional information in WM (Yoon, LeMoult, & Joormann, 2014).

However, a valence-generic removal deficit stands in contrast to findings of specifically impaired updating of negative materials in depressive rumination (Joormann & Gotlib, 2007, 2008; Levens & Gotlib, 2010) and the notion of impaired attentional disengagement in depression (Grafton et al., 2016; Koster et al., 2011). The conflicting findings between the literature and Study 3 provide preliminary
support that removal may be a unique subprocess of WM updating (Ecker, Lewandowsky, & Oberauer, 2014; Ecker, Oberauer et al., 2014; Singh et al., 2018), distinct from the WM functions assessed in previous studies using traditional updating tasks. In other words, the conflicting findings support our argument of a task-impurity issue in previous research investigating memory updating in depressive rumination and hints at the possibility that some commonly used memory updating tasks measure generic WM functions or WM capacity rather than updating (Ecker, Lewandowsky, Oberauer, & Chee, 2010; Schmiedek, Hildebrandt, Lövdén, Wilhelm, & Lindenberger, 2009; Singh et al., 2018) or do not even require WM updating (Bunting, Cowan, & Saults, 2006). However, as our use of the removal task in depressive rumination is novel, further research is necessary to support our argument and potentially reconcile the findings.

In the context of the CIE paradigm, we argue that a negative attentional bias facilitated memory updating. This is consistent with the notion that salient misinformation is more easily retracted (Ecker et al., 2017), potentially due to enhanced co-activation of the misinformation and its retraction, allowing for greater conflict detection and/or information integration (Kendeou et al., 2014, 2017; Stadtler et al., 2013; also see Ecker et al., 2011) and thus more efficient correction. This interpretation would also explain the finding that retraction of positive misinformation was marginally more effective in healthy controls (Study 5), potentially due to a positive attentional bias (Levens & Gotlib, 2010; Pool, Brosch, Delplanque, & Sander, 2016; also see the finding of higher self-referentiality ratings for positive compared to negative words in healthy controls in Study 2). However, we note that a pure salience account of the CIE would have suggested enhanced effectiveness of retractions of negative misinformation in depressive ruminators in
Study 4, compared to healthy controls, which was not observed. We also note that our interpretation of a negative attentional bias accounting for the findings across the studies remains speculative since attentional bias was not directly measured, although our interpretation is consistent with recent studies that used eye-tracking as a direct measure of negative attentional bias in rumination and depression (Duque, Sanchez, & Vázquez, 2014; Duque & Vázquez, 2015; Everaert et al., 2014; Owens & Gibb, 2017). To the extent that updating following a retraction requires disengagement from the misinformation, the findings in Studies 4 and 5 are contrary to the notion of impaired disengagement from negative information in depressive rumination (Grafton, et al., 2016; Koster et al., 2005; for review, see Koster et al., 2011), although we should note that these studies demonstrated impaired attentional disengagement (i.e., disengagement from stimuli in the environment, rather than disengagement from WM contents).

An alternative way to interpret our findings is in terms of positive insensitivity in depressive rumination as opposed to a negativity bias. We next discuss this alternative interpretation, which could potentially account for the observed findings especially of Study 3.

6.4.2 Negative Bias versus Positive Insensitivity

Admittedly, the findings of Study 3 and Study 5 offer no strong evidence to rule out the effects of positive insensitivity in depressive rumination (Levens & Gotlib, 2009; Mineka, Watson, & Clark, 1998; Watson, 2005) since negative bias and positive insensitivity are not mutually exclusive (Duque & Vázquez, 2015). Indeed, compared to never-depressed individuals, it was found in an eye-tracking task using sad and happy faces as stimuli that depressed individuals exhibit a double attentional bias (i.e., both an attentional bias towards negative and away from
positive materials, which would imply enhanced processing of negative materials and reduced processing of positive materials; Duque & Vázquez, 2015). However, seemingly speaking against this notion and as discussed in Study 3, quicker encoding and higher recall accuracy of positive, compared to negative, words in depressive ruminators would favour an explanation in terms of a negative attentional bias rather than positive insensitivity (because enhanced processing and retrieval of positive information is contrary to positive insensitivity).

In support of the double attentional bias in depression, the findings in Study 5 suggest both a negative attentional bias (Dalgleish & Watts, 1990; Peckham et al., 2010) and positive insensitivity (Levens & Gotlib, 2009, 2010; Rottenberg, Gross, & Gotlib, 2005) in depressive rumination: at baseline, in the pre-retraction condition, depressive ruminators referred preferentially to negative misinformation and significantly less to positive misinformation compared to healthy controls, and this valence-specific preferential referencing was associated with a valence-specific updating enhancement for negative information in depressive ruminators following a retraction. However, it was unexpected that retractions of positive misinformation were entirely ineffective in depressive ruminators, and that retractions of negative misinformation were ineffective in healthy controls (which stands in contrast to Study 4). We can only speculate that this discrepancy could be attributed to a positive attentional bias in healthy controls that is only activated when stimuli compete for representation, such that the bias draws cognitive resources towards positive information at the expense of negative information (Grafton, C. Ang, & MacLeod, 2012; also see Kendeou et al., 2017).
6.4.3 Combined Cognitive Bias Hypothesis

We note that our data offer no strong evidence that the observed effects are attributed solely to an attentional bias; we cannot rule out a combined cognitive bias effect, that is, effects of negative interpretative or memory biases, or any combination of attentional, interpretative, and memory biases contributing to the observed findings in Studies 4 and 5. In an emerging line of research on the combined cognitive bias hypothesis (Hirsch, Clark, & Mathews, 2006) in depression (Everaert et al., 2014; Everaert, Grahek, Duyck, Buelens, Van den Bergh, & Koster, 2017; Everaert, Koster, & Derakshan, 2012; Everaert, Tierens, Uzieblo, & Koster, 2013; Marchetti, Everaert, Dainer-Best, Loeys, Beevers, & Koster, 2018), Everaert and colleagues highlight that cognitive processes do not function in isolation, and demonstrate the coherence and interactive relations of these cognitive (attentional, interpretative, and memory) biases (Everaert et al., 2012, 2013, 2014, 2017; Marchetti et al., 2018). In line with the combined cognitive bias argument, the pattern of findings across Studies 4 and 5 provides evidence for the coherence between attentional and memory biases in depressive rumination, with a negative attentional bias presumably leading to better mnemonic availability and integration. However, there was no evidence for an interpretative bias (Bisson & Sears, 2007; Blanchette, & Richards, 2010, but see Mogg, Bradbury, & Bradley, 2006), as depressive ruminators were able to integrate retractions that contradicted their negative worldviews. Our findings thus suggest coherence between attentional and memory biases, and depressotypic worldviews in depressive rumination.

6.5 Depressotypic Worldviews

One of the strengths of the current thesis is the high external validity of the CIE paradigm across various domains including politics (Ecker & L. C. Ang, 2019)
and health (Nyhan & Reifler, 2015). The CIE paradigm does not measure a single cognitive process, but assesses the multidimensional and interactive cognitive processes of updating in everyday experiences. The findings of Studies 4 and 5 provide converging evidence for the robustness of the CIE and extend the application of the CIE paradigm into the domain of mental disorder, more specifically, depressive rumination.

We hypothesized that depressotypic worldviews may act like more general (e.g., political) worldviews in modulating the CIE via motivated protection of worldview-congruent misinformation from correction (e.g., Ecker & L. C. Ang, 2019), in line with the literature on motivated reasoning (Kunda, 1990). However, this is not what we found. The findings suggest that depressotypic worldviews differ qualitatively from generic worldviews. Unlike general worldviews such as political worldviews—which people are free to choose and hence motivated to defend (Kunda, 1990)—depression is beyond one’s choice, often causes significant distress, and is perceived as a stigma and often concealed (Quinn & Chaudoir, 2009; for review, see Schmitt, Branscombe, Postmes, & Garcia, 2014). Depressotypic worldviews therefore do not carry the same significance for a person’s identity in terms of promoting self-congruence (i.e., depressive worldviews may not be a part of one’s social identity that one desires to defend (Festinger, 1957; Higgins, 1987; Rogers, 1957). Hence, with regards to processing misinformation retractions, depressive ruminators may not be motivated to reject corrections of negative misinformation to defend their depressotypic worldviews. This conforms to the central tenet of Kahan’s “cultural cognition” theory, which proposes that people’s information processing is strongly influenced by their worldviews but that people defend primarily those worldviews that are crucial to their social identity (Kahan,
2013). Hence, while depression is characterized by depressotypic worldviews, unlike other general worldviews, depressotypic worldviews may not have a hindering impact on dismissing worldview-dissonant misinformation.

Despite a lack of worldview effects on the CIE in depressive ruminators, the positive association between depressotypic worldviews and the CIE in depressive ruminators in Study 4, but not in Study 5, suggests that under some circumstances, a more depressotypic worldview may be associated with a greater tendency for continued reliance on retracted negative misinformation. The reasons for the discrepancy between these two studies are not entirely clear. Overall, worldview effects in Study 4 were weak and we interpreted this as worldview effects being dominated by a salience effect; this interpretation was validated by the findings in Study 5. That is, Study 5 provided further support for our interpretation in terms of a salience effect—depressive ruminators (healthy controls) referred preferentially to non-retracted negative (positive) misinformation, and the salience of the misinformation arguably contributed to the enhanced updating following a retraction in both groups.

Taken together, the effectiveness of a retraction of negative misinformation in depressive ruminators in the CIE paradigm suggests that (1) political worldviews and depressotypic worldviews cannot be equated with respect to their effects on processing of retractions of misinformation, and (2) while valence influenced retraction effectiveness in depressive ruminators, this may have occurred through a salience effect that promotes processing of retractions of negative misinformation in depressive ruminators instead of a worldview-incongruence effect that prevents it.
6.6 **Rumination versus Depression**

We highlight that the findings in the present thesis are based on participants who have been selected on rumination and depression measures simultaneously, and we have discussed the rationale for this. Regarding the unique, relative, and interactive contributions of rumination and depression to the observed findings across the three studies, we can only speculate. In Study 3, the correlation between removal-time index and rumination scores—but not depression scores—in depressive ruminators suggests that rumination scores may be a stronger predictor of memory updating abilities than depression scores. However, in Studies 4 and 5, exploratory regression and commonality analyses suggested that rumination scores did not predict reliance on negative misinformation in depressive ruminators. Taken together, one could thus speculate that rumination tendencies may underlie impairments in individual cognitive processes (i.e., removal of outdated information) assessed with response-time tasks, but not cognitive impairments relating to higher-level cognitive functions, such as inferential reasoning as assessed in the CIE paradigm.

In support of this speculation, one could argue that rumination consumes cognitive resources (Levens, Muhtadie, et al., 2009; Meiran et al., 2011; Watkins & Brown, 2002) while depression per se, without rumination tendencies, may not; response-time tasks may therefore possess the sensitivity to capture impairments in cognitive processes that are resource demanding (and thus affected by rumination), which the CIE paradigm—without a response-time constraint—may lack. Consistent with this argument, rumination but not depression scores have been found to correlate with impairments in individual cognitive processes in depressed individuals as assessed by response-time tasks (De Lissnyder, Koster, and De Raedt, 2012;
Joormann, Dkane, & Gotlib, 2006; Joormann & Gotlib, 2008, 2010). If our speculation holds true, future studies investigating the effects of rumination or depression should be strategic in the choice of tasks to more appropriately capture variability in task performances in (non-depressed) ruminators or depressed individuals (without rumination tendencies). We note, however, that our speculative interpretation is contrary to the negative association reported between rumination measures and performance on the Wisconsin Card Sorting Test (WCST; Berg, 1948; Davis & Nolen-Hoeksema, 2000), which is also not a response-time task.

In general, given the high co-occurrence of rumination and depression even in non-clinical samples (Altamirano et al., 2010; Davis & Nolen-Hoeksema, 2000; De Lissnyder, Koster, Derakshan, & De Raedt, 2010; Grafton et al., 2016; Joormann, 2006; Joormann & Gotlib, 2008; Lam, Smith, Checkley, Rijsdijk, & Sham, 2003; Marchetti, Loeys, Alloy, & Koster, 2016; Onraedt, & Koster, 2014; Yoon et al., 2014), future studies may also benefit from more stringent sample selection criteria to better disentangle the unique, relative, and interactive contributions of rumination and depression to task performances.

6.7 Practical and Clinical Implications

An over-arching implication of the findings in the present thesis is that research on individual cognitive processes in psychopathology should aim to employ more holistic studies (Barlow, Bullis, Comer, & Ametaj, 2013; Hayes, Beevers, Feldman, Laurenceau, & Perlman, 2005), given the complex interplay among cognitive processes and biases (Everaert et al., 2012, 2013, 2014, 2017). While research on individual cognitive processes in isolation has advanced our understanding of the mechanisms underlying impairments in cognitive processes in
rumination and depression, a more holistic approach to research on psychopathology would arguably better inform practical applications.

There are three clinical implications arising from the converging evidence across three studies that depressive ruminators were not found to “cling” to negative materials. First, the present findings relate directly to the stigma of depression (Griffiths, Christensen, & Jorm, 2008): A perceived reluctance to relinquish negative information may be seen as an active contribution to the maintenance of depressive symptoms (Barney, Griffiths, Christensen, & Jorm, 2009). Hence, depressed individuals are often confronted with blame, both being blamed for their depression and also self-blaming (Barney et al., 2009). Our findings demonstrate that depressive ruminators are not impaired in their updating of negative information. When negative misinformation is retracted, if anything, they seem better able to correct their mental representations, resulting in a more accurate (and positive) representation of the world around them. This insight may serve to reduce stigma, which could in turn encourage people to seek treatment (Griffiths, Carron-Arthur, Parsons, & Reid, 2014).

Second, we interpreted our findings in terms of a negative attentional bias and salience facilitating knowledge revision. This is consistent with the mechanisms underlying interventions designed to replace maladaptive thoughts, such as emotion-focused therapy (Greenberg, 2004), which involves therapists guiding people to embrace their emotions by ascribing meaning to those emotions. In this context, increasing the salience of maladaptive negative thoughts and emotions before updating, changing, or replacing them with more positive and constructive thoughts and emotions may achieve better treatment efficacy (Elsey & Kindt, 2017; Hayes, Yasinski, Barnes, & Bockting, 2015; Köhler, Carvalho, Alves, McIntyre, Hyphantis,
& Cammarota, 2015; Nader & Hardt, 2009). However, future replication of the current findings is necessary to ascertain if there may be an optimal level of salience beyond which memory updating in depressive rumination may be impaired, as it has been found that in other domains such as schizophrenia, hypersalience of incorrect information can impair belief revision (Balzan, Delfabbro, Galletly, & Woodward, 2013).

Third, the mixed findings of a negative attentional bias in depressive rumination in the literature, and the opposing cognitive performance manifestations of a negative attentional bias in the removal task versus the CIE paradigm, mean that interventions that target specific mechanisms may potentially have undesirable consequences. To illustrate, the attentional bias modification designed to reduce negative attentional bias in depression has been found to be effective in ameliorating depressive symptoms (Wells & Beevers, 2010; Yang, Ding, Dai, Peng, & Zhang, 2015). Nevertheless, while the attentional bias modification may attenuate the effects of a negative attentional bias in depressive ruminators, such that individuals may be less drawn towards negative materials, the attenuated negative attentional bias may also attenuate the salience of negative (mis)information. To the extent that salience facilitates knowledge revision, an attenuated negative attentional bias may thus contribute to an impairment in updating of negative misinformation in depressive rumination. Such a potential consequence would be undesirable and detrimental, particularly in our information-driven society where disseminated misinformation often requires correction or retraction (Nyhan & Reifler, 2015; Poland & Spier, 2010). This highlights the benefits of a more holistic approach to research to avoid undesirable repercussions of interventions (e.g., attentional bias modification) that
may benefit one aspect (e.g., reduced negative attentional bias) but may be
detrimental in another, potentially more important, aspect.

6.8 Limitations and Future Directions

Despite the novel and interesting results, some limitations warrant attention.
First, since we used novel tasks to investigate the potential nature of memory
updating impairments in depressive ruminators, we selected participants based on
rumination and depression measures concurrently. Disentangling the unique and
relative contributions of rumination and depression directly was beyond the scope of
the present thesis. A potential question for future research is thus whether depressed
participants with low rumination tendencies (or non-depressed ruminators) may
exhibit similar result patterns. This research may show that rumination is a better
predictor of updating performance in response-time tasks, since rumination
consumes cognitive resources (Levens, Muhtadie, et al., 2009; Meiran et al., 2011;
Watkins & Brown, 2002), whereas depression may be a better predictor of updating
on longer time scales. Furthermore, our studies relied on an undergraduate
population, which may limit the generalisability of the findings to a more diverse
clinical population. More specifically, although WM capacity was not measured, it is
plausible that WM capacity was generally high in the current sample of
undergraduates. This may have attenuated updating deficits and the continued
influence effect of misinformation. While the clear modulation of effects across
control and depressive-rumination groups suggests this was not a major limiting
factor, replication of findings in a more heterogeneous clinical group is desirable.
Such studies could also measure WM capacity to test more directly if WM capacity
may mediate the effects that a depressotypic worldview may have on updating.
Second, we did not control for potential effects of comorbidity. For example, the comorbidity of depression and anxiety is high, with a lifetime prevalence rate of over 50% (Borsboom, Cramer, Schmittmann, Epskamp, & Waldorp, 2011; Brown, Campbell, Lehman, Grisham, & Mancill, 2001; Mineka et al., 1998; Spinholven, van Balkom, & Nolen, 2011). That is, over 50% of depressed individuals also experience clinical anxiety at some point. To investigate the nature of cognitive impairments in depressive rumination, future studies could control for the effects of comorbid anxiety, as comorbidity can differentially influence attention and memory biases (LeMoult & Joormann, 2012). However, given the content-specificity hypothesis (Derry & Kuiper, 1981, Kuiper & Derry, 1982) of Beck’s cognitive model of depression (Beck, 1976; Beck, Brown, Steer, Eidelson, & Riskind, 1987), it seems unlikely that anxiety symptoms significantly influenced the observed findings, as we selected stimuli that are depression-specific; however, this remains a question for future research.

Third, we used only positive and negative stimuli/scenarios to increase test sensitivity across both the WM updating task and the CIE paradigm. As discussed, negative attentional bias and positive insensitivity are not mutually exclusive (Duque & Vázquez, 2015); future studies including neutral stimuli/scenarios would be beneficial to differentiate the role of cognitive biases towards negative information (Everaert et al., 2013, 2014), cognitive biases away from positive information (Ji, Grafton, & MacLeod, 2017; Levens & Gotlib, 2009), or a combination of both cognitive biases (Duque & Vázquez, 2015; Everaert et al., 2018). However, as discussed, the findings in Study 3 favour an explanation in terms of negative attentional bias over positive insensitivity because depressive ruminators were quicker to encode and not impaired in their recall of positive compared to negative
items. Regardless, it should not be dismissed that research using only positive and negative stimuli in previous studies has advanced our understanding of the nature of cognitive biases in depressive rumination (De Lissnyder et al., 2010; Joormann, 2006; Joormann & Gotlib, 2008; Yoon et al., 2014).

Fourth, the materials we used could be further improved. Regarding Study 3, while we attempted to match self-referential valenced words on factors known to potentially influence cognitive processing, there were small differences in mean arousal and number of syllables, and a difference in mean self-referentiality ratings between valenced words as rated by healthy controls. These differences are likely inevitable when using valenced stimuli comparing depressive ruminators and healthy controls. While there is no evidence to suggest that these differences significantly influenced the observed findings in Study 3, future studies may benefit from further optimizing the selection of stimuli, given that arousal and valence may independently influence emotional memory (Kensinger & Corkin, 2004; Russell, 1980).

Furthermore, Anderson (2005) proposed that attentional bias for emotional materials is determined by arousal. However, the mean arousal for negative words was lower than for positive words (Study 1), hence it is unlikely that the observed findings in Study 3 were arousal-based. Nevertheless, given that depressive ruminators rated negative words as more self-referential than healthy controls (Study 2), it is plausible that mean arousal as rated by depressive ruminators may also be higher than normed arousal ratings provide by healthy controls; this is hypothesized to reduce or eliminate the difference in arousal ratings in depressive ruminators. Regarding the CIE paradigm used in Studies 4 and 5, given the potential significance of the self-reference effect (Rogers et al., 1977; also see Bower & Gilligan, 1979; Kuiper & Rogers, 1979; Maki & McCaul, 1985; Symons & Johnson, 1997) on memory
updating impairments in depressive rumination and the heterogeneity of depressive symptoms (Fried & Nesse, 2015), future studies could benefit from (1) scenarios that are more self-referential and better reflect depressotypic worldviews (for example, self-referentiality ratings of depressotypic themes could be obtained to select scenarios with high self-referentiality ratings), and (2) a greater variety of scenarios that better reflects the varied themes common in depression (Beck et al., 1987).

Finally, as treatment of psychopathology is moving towards a more integrated and transdiagnostic approach (Barlow et al., 2013; Disner, Beevers, Haigh, & Beck, 2011; Forgeard et al., 2011; Mansell, Harvey, Watkins, & Shafran, 2008)—where it is assumed that some cognitive processes (e.g., rumination or cognitive biases) contribute to symptomatology across multiple diagnostic categories of emotional disorders—research on psychopathology needs to also adopt a more holistic and integrated approach to inform evidence-based treatment with a stronger focus on clinical outcomes (Barlow et al., 2013; Hayes, et al., 2005). Correspondingly, a more holistic and integrated approach to theorizing and experimentation—developing more integrative accounts such as the combined cognitive biases hypothesis (Everaert et al., 2012, 2013, 2014, 2017), and using more ecologically valid paradigms such as the CIE paradigm, which simultaneously investigates various cognitive processes and biases—could advance research on psychopathology and improve clinical outcomes. Only by bridging the gap between research and practice (Goldfried & Wolfe, 1996; Hershenberg & Goldfried, 2015; Newnham & Page, 2010; Snyder, Miyake, & Hankin, 2015) can we further advance the field of psychotherapy.
6.9 Conclusion

To conclude, the present thesis presents the first studies using a novel WM updating task, which provides a measure of people’s updating efficiency, and the CIE paradigm, which assesses conceptual updating more reflective of real-world information processing, to investigate the nature of memory updating impairments in depressive ruminators. The findings provide preliminary, but converging, evidence that depressive rumination is associated with a negative attentional bias that (1) contributes to a valence-generic deficit in the removal of outdated information in WM, but (2) facilitates the correction of negative misinformation when reading news or event reports. We proposed that the observed effects represent differential manifestations of a negative attentional bias across different paradigms, highlighting the limitations of tasks investigating individual cognitive processes in isolation. This further underscores the importance of a more holistic and integrative approach to experimental psychopathology research. The findings in the present thesis contribute to an emerging line of research that investigates the potentially complex and interactive relationships between multiple cognitive processes and biases on cognitive impairments in psychopathology. Such an approach has greater ecological validity and more relevance to bridging the gap between research and practice, thereby potentially advancing the field of psychotherapy.
6.10 References


Appendix A: Chapter 3 Stimuli
<table>
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<th>Positive word</th>
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Appendix B: Chapter 4 Correlation Matrix and Stimuli
Table 6

Pearson correlation coefficients between RRS, DASS-depression, DASS-anxiety, and DASS-stress scales

<table>
<thead>
<tr>
<th>Variable</th>
<th>RRS</th>
<th>DASS-depression</th>
<th>DASS-anxiety</th>
<th>DASS-stress</th>
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</thead>
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<tr>
<td>RRS</td>
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<td></td>
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<tr>
<td>DASS-depression</td>
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<td>DASS-anxiety</td>
<td>.71***</td>
<td>.78***</td>
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<td>DASS-stress</td>
<td>.75***</td>
<td>.80***</td>
<td>.82***</td>
<td></td>
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</tbody>
</table>

Note. RRS = Ruminative Response Scale; DASS = Depression Anxiety Stress Scale
***p < .001.
Specific Scenario

1. Singer/songwriter Eleanor Bell was found dead in her London apartment yesterday.
2. It was announced this morning on the BBC that the singer had taken pills and that her death is being treated as a suicide.
3. Bell was just 27 years of age. There have been consistent rumours she had been struggling with depression.
4. She leaves behind her husband Brian Hodgetts, a 31-year-old professional hockey player. The devastated Hodgetts said he was struggling to understand what had happened and has left a training camp in the US to return home.
5. Bell is another talented artist to join the “club of 27”, a group of well-known artists who committed suicide at the same age.
6. Bell’s debut single “Soulcage” conquered the UK R’n’B charts in 2012. She was scheduled to go on a local tour. Fans were looking forward to her performing songs from her new album.
7. Bell had made snippets of the new songs from her forthcoming album “Thorns” available via social media only days before her death. Her twitter account has been shut down.
8. The White Torch Institute—a support group for relatives of young suicide victims—just proposed a suicide awareness campaign to be launched on December 1. The institute has a growing social media presence; its Facebook page has over 1 million members worldwide.
9. Various under-30 celebrities have agreed to support the campaign and have pledged over £50,000 to fund the activities of the campaign.
10. In a ‘special report’, it was stated that fans have congregated at Bell’s apartment to lay down flowers, soft toys, and letters. Bell’s agent, William Clarke, said he was touched by the fans’ response. (No retraction)
10. In a ‘special report’, it was stated today that there had been a misrepresentation; according to medical reports that have been released, Bell’s death did not result from suicide. Bell’s agent, William Clarke, said he was glad this could be rectified. (Retraction)
11. People struggling with depression or suicidal thoughts are urged to contact a trusted medical professional or call LifeLineUK on 0800 0600.
General Scenario

1. A report out of Queen’s University London has raised concerns regarding a trend in the leading causes of death in UK ‘twens’.
2. It was announced this morning on the BBC that suicide rates in young adults 20-29 years of age have risen in recent years.
3. The biggest relative increase was found in people in their late twenties. Most suicide victims struggled with depression, and the most common method of suicide was medication overdose.
4. Suicide is devastating for the relatives left behind; on average, a suicide has significant effects on the mental health of six other people.
5. Commentators have linked the finding to the “club of 27”, a group of well-known artists who committed suicide at that age.
6. The research was funded jointly by SUPY, the national charity dedicated to Suicide Prevention in Young people, and the UK Research Council, which recently announced mental illness as a national research priority.
7. The findings were discussed at a press conference during this month’s British Science Week.
8. The White Torch Institute—a support group for relatives of young suicide victims—just proposed a suicide awareness campaign to be launched on December 1. The institute has a growing social media presence; its Facebook page has over 1 million members worldwide.
9. Various under-30 celebrities have agreed to support the campaign and have pledged over £50,000 to fund the activities of the campaign.
10. In a ‘special report’, it was stated today that there had been a large number of media requests, and that researchers were preparing a summary of findings for public release. A speaker for the University, Professor William Clarke, said he was pleased with the public’s interest. (No retraction)
10. In a ‘special report’, it was stated today that there had been a misrepresentation; according to the scientists involved, suicide rates in young adults were not, in fact, on the rise. A speaker for the University, Professor William Clarke, said he was glad this could be rectified. (Retraction)
11. People struggling with depression or suicidal thoughts are urged to contact a trusted medical professional or call LifeLineUK on 0800 0600.
Questionnaire – Specific Scenario

The following questions will probe your understanding of the news report presented to you earlier. Some of these questions ask you to recall information contained in the report, other questions ask you to make a judgement or voice your opinion. Please complete all the following questions in the order they are given.

1. What do you think could be the consequences of the event? (Please elaborate)

2. What do you think prompted the White Torch Institute to launch a suicide awareness campaign? (Please elaborate)

3. Why do you think under-30 celebrities have agreed to support the campaign? (Please elaborate)

4. What should health authorities do now and why? (Please elaborate)

5. What conclusions can be drawn from the news report? (Please elaborate)

6. Why might the public be concerned by the news report? (Please elaborate)

7. What would be a good headline for the report? (Please elaborate)

8. Why did the media report on the event? (Please elaborate)

9. Why do you think there is a growing social media presence of the White Torch Institute? (Please elaborate)

10. Was Bell a good role model? (0-10; please circle one)

   | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

   Absolutely Not                                          Absolutely

11. Do you think Bell died by suicide? (0-10; please circle one)

   | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

   Absolutely Not                                          Absolutely
12. Which city was Bell found dead in?
13. Which media channel reported the death of Bell?
14. How old was Bell when she died?
15. Where was Bell’s husband at the time of her death?
16. What “club” did commentators link Bell with?
17. Which year did Bell’s debut single conquer the R’n’B charts?
18. What is the title of Bell’s forthcoming album?
19. How many members does the White Torch Institute Facebook page have?
20. How much has been pledged to fund the activities of the campaign?
21. What was the name of Bell’s agent?
22. What was the content of the ‘special report’?
23. Was any of the information in the report subsequently corrected or altered? And if so, what was it?
Questionnaire – General Scenario

The following questions will probe your understanding of the news report presented to you earlier. Some of these questions ask you to recall information contained in the report, other questions ask you to make a judgement or voice your opinion. Please complete all the following questions in the order they are given.

1. Why do you think depression is a serious issue among young people? (Please elaborate)
2. What do you think prompted the White Torch Institute to launch a suicide awareness campaign? (Please elaborate)
3. Why do you think under-30 celebrities have agreed to support the campaign? (Please elaborate)
4. What should health authorities do now and why? (Please elaborate)
5. What conclusions can be drawn from the UK study? (Please elaborate)
6. Why might the public be concerned by the findings discussed in the report? (Please elaborate)
7. What would be a good headline for the report? (Please elaborate)
8. Why did the media report on the research? (Please elaborate)
9. Why do you think there is a growing social media presence of the White Torch Institute? (Please elaborate)
10. What has happened to suicide rates in young adults in the UK in recent years? (please circle one)

<p>| | | | | | | | |</p>
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<thead>
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<td>0</td>
<td>+5%</td>
<td>+10%</td>
<td>+15%</td>
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</table>

Decrease          Increase
11. How will suicide rates of young adults in the UK change over the next 5 years? (please circle one)

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<tr>
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<th>-15%</th>
<th>-10%</th>
<th>-5%</th>
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<th>+5%</th>
<th>+10%</th>
<th>+15%</th>
<th>+20%</th>
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</thead>
</table>

Decrease | Increase

12. Which university did the report come out of?

13. Which media channel announced the findings of the report?

14. According to the report, what was the most common method of suicide in young adults in the UK?

15. According to the report, the mental health of how many people is affected by a suicide, on average?

16. What “club” have commentators linked the finding in the report to?

17. Which charity partly funded the research?

18. During which event was the press conference being held?

19. How many members does the White Torch Institute Facebook page have?

20. How much has been pledged to fund the activities of the campaign?

21. What was the name of the university’s speaker?

22. What was the content of the ‘special report’?

23. Was any of the information in the report subsequently corrected or altered?
   And if so, what was it?
Appendix C: Chapter 5 Correlation Matrix and Stimuli
Table 7

Pearson correlation coefficients between RRS, DASS-depression, DASS-anxiety, and DASS-stress scales

<table>
<thead>
<tr>
<th>Variable</th>
<th>RRS</th>
<th>DASS-depression</th>
<th>DASS-anxiety</th>
<th>DASS-stress</th>
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<tr>
<td>RRS</td>
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<td>DASS-depression</td>
<td>.83***</td>
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<td>DASS-stress</td>
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</table>

*Note.* RRS = Ruminative Response Scale; DASS = Depression Anxiety Stress Scale

***p < .001.
Scenarios

Suicide Rates
1. A study out of Sydney University has raised concerns regarding a trend in the leading causes of death in Australian young adults.
2. The sad statistic announced today was that suicide rates in young Australian adults 20-29 years of age have risen substantially in recent years.
3. Most suicide victims struggled with depression and the most common method of suicide was medication overdose.
4. Suicide is devastating for the relatives left behind; on average, a suicide has significant effects on the mental health of six other people.
5. The research was funded by the Australian Research Council, which recently announced mental illness as a national research priority.
6. In a ‘special report’, it was stated later today that because of the number of media requests, the researcher involved, Professor Chris Howard, was preparing a summary of findings for public release. *(No retraction)*
6. In a ‘special report’, it was stated later today that according to the researcher involved, Professor Chris Howard, suicide rates in young adults were actually not on the rise in Australia. *(Retraction)*
7. People struggling with depression or suicidal thoughts are urged to contact a trusted medical professional or call Lifeline on 13 11 14.

Happiest Country
1. The Australian online edition of the Guardian has reported on the results of the most recent “World Happiness Poll”, an annual survey conducted by Gallup World Poll.
2. For the first time, Australians are ranked the happiest people in the world, with some indicators soaring to all-time highs.
3. Australia scored highly for its strong community spirit and quality of life, among other indicators used for this ranking, ranging from education to environmental quality.
4. Australia continues to be the only non-European country in the top 10 list of the happiest countries, which includes countries such as Denmark, Norway, Switzerland, and the Netherlands.
5. Local results of the survey are based on telephone interviews with a random sample of close to 2,000 adults, across all States and Territories.

6. The Guardian subsequently reported that there had been a surge in comments on their website in response to this report. (No retraction)

6. The Guardian subsequently clarified that Australia did not actually top the list, and that local happiness indicators did not show an upward trend. (Retraction)

7. The World Happiness Poll remains the world’s most popular measure of the average psychological and physical well-being of a nation.

Abandoned Babies

1. A UNICEF report on infant abandonment has caught the media spotlight in Australia.

2. It was reported today that alarmingly, the number of abandoned babies in Australia has increased manifold over the past 10 years.

3. While most babies survive the abandonment because they are left outside of hospitals, deaths have occurred. The research found that the stigma of an unwanted pregnancy and the mother’s own circumstances are possible reasons for abandonment.

4. One suggestion being debated is the establishment of “baby hatches” outside hospitals, a service operating in many countries, including Germany, where parents can safely and anonymously place unwanted babies.

5. Proponents of this service argued that increased stresses on vulnerable families could otherwise lead to increased risk of child abuse and neglect.

6. It was later explained by a UNICEF speaker that a report was forthcoming regarding the impact of the establishment of baby hatches internationally. (No retraction)

6. It was later clarified by a UNICEF speaker that the number of abandoned children in Australia in fact has not increased in the past 10 years. (Retraction)

7. In Australia, abandoning a child is still an offence under the Criminal Code.
Charity Giving

1. A recent study on philanthropy in Australia has found that Australians are generally a generous bunch.
2. The study suggested that Australians do care about each other, highlighting that inflation-corrected donations to charities have increased steadily over the past 5 years.
3. The findings of the study were presented at the opening address of the National Philanthropy Week in Melbourne.
4. The objective of the National Philanthropy Week is to showcase the many volunteer-driven charities which receive no government funding and rely on philanthropic giving.
5. The week-long event serves as a platform for volunteer recruitment and sponsorship deals by these charities.
6. Later today, the lead author of the study, Professor Dean Russell explained on ABC Radio that the work done by charities in Australia deserved support and recognition. *(No retraction)*
7. Later today, the lead author of the study, Professor Dean Russell, explained on ABC Radio that donations to charities in Australia have actually not increased in the past 5 years. *(Retraction)*
8. The National Philanthropy Week will draw to a close tomorrow with a range of free entertainment at various venues around the Docklands precinct.
**Questionnaire**

The following questions will probe your understanding of the news reports presented to you earlier. Some of these questions ask you to recall information contained in the report, other questions ask you to make a judgement or voice your opinion. Please complete all the following questions in the order they are given.

**Suicide Rates**

1. In a sentence, what was the report about?
2. What conclusions can be drawn from this report? (Please elaborate)
3. Why do you think the study has generated public interest? (Please elaborate)
4. What has happened to suicide rates in young adults in Australia in recent years? (Please circle one)
   - Decrease
   - Increase

5. How will suicide rates of young adults in Australia change over the next 5 years? (Please circle one)
   - Decrease
   - Increase

6. What was the content of the ‘special report’?
7. Was any of the information in the report subsequently corrected or altered? And if so, what was it?

**Happiest Country**

1. In a sentence, what was the report about?
2. What conclusions can be drawn from this report? (Please elaborate)
3. Why do you think the study has generated public interest? (Please elaborate)
4. What has happened to happiness indicators in Australia in recent years? (Please circle one)
   
   ![Graph showing percentage changes from -8% to +8%]
   
   Decrease
   Increase

5. How will happiness indicators in Australia change over the next 5 years? (Please circle one)
   
   ![Graph showing percentage changes from -8% to +8%]
   
   Decrease
   Increase

6. What was the content of the subsequent message from the Guardian?
7. Was any of the information in the report subsequently corrected or altered? And if so, what was it?

**Abandoned Babies**
1. In a sentence, what was the report about?
2. What conclusions can be drawn from this report? (Please elaborate)
3. Why do you think the study has generated public interest? (Please elaborate)
4. What has happened to the number of abandoned babies in Australia in the past 10 years? (Please circle one)
   
   ![Graph showing percentage changes from -400% to +400%]
   
   Decrease
   Increase
5. How will the number of abandoned babies in Australia change over the next 5 years? (Please circle one)

<table>
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<tr>
<th>-400%</th>
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6. What was the content of the subsequent message from the UNICEF speaker?

7. Was any of the information in the report subsequently corrected or altered? And if so, what was it?

**Charity Giving**

1. In a sentence, what was the report about?
2. What conclusions can be drawn from this report? (Please elaborate)
3. Why do you think the study has generated public interest? (Please elaborate)
4. What has happened to the amount of donations to charities in Australia over the last 5 years? (Please circle one)

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5. How will donations to charities in Australia change over the next 5 years? (Please circle one)

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6. What was the content of the subsequent message from the lead author of the study?
7. Was any of the information in the report subsequently corrected or altered? And if so, what was it?