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Not Wallowing in Misery—Retractions of Negative Misinformation are Effective in Depressive Rumination

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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. We investigated this effect in the context of depressive rumination. Given the prevalence of depressotypic worldviews in depressive rumination, we hypothesised 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. In two experiments, we found evidence against this hypothesis: in depressive ruminators, retractions of negative misinformation were at least as effective as they were in control participants, and more effective than retractions of positive misinformation. 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.

Keywords: misinformation; continued-influence effect; rumination; depression; attentional bias

Not Wallowing in Misery—Retractions of Negative Misinformation are Effective in Depressive Rumination

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 Thus, in order to maintain efficient interaction with a dynamic state of affairs and to avoid reliance on outdated information, people need to constantly amend their mental models of events and causal interrelations.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 Of particular relevance to the present paper, people often continue to rely on outdated or retracted misinformation in their reasoning even after they have received and acknowledged a retraction (Ecker, Lewandowsky, E. P. Chang, & Pillai, 2014;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; Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012).

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). For example, politically conservative participants have been found to show particularly strong CIEs if the misinformation is congruent with their worldview, such as misinformation that comes from conservative politicians (Nyhan & Reifler, 2010) or misinformation regarding misconduct in liberal politicians (Ecker & L. C. Ang, 2018). Thus, in the presence of relevant worldviews, at least part of the observed ineffectiveness of retractions can be attributed to motivated dismissal of retractions that serves to uphold attitudes and beliefs (Ecker, Swire, &

Lewandowsky, 2014; Kunda, 1990) similar to a disconfirmation bias (Taber & Lodge, 2006; Trevors, Muis, Pekrun, Sinatra, & Winne, 2016). In other words, there is evidence that people tend to "cling" to misinformation that supports their worldviews.

However, 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 hypothesise 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 false assertion that a specific robbery was committed by a minority person), even a racially-prejudiced person can accommodate a worldview-incongruent retraction as an exception to a rule, while maintaining their general, racially-prejudiced attitude (Kunda & Oleson, 1995; Richards & Hewstone, 2001). By contrast, with a general assertion (e.g., a false assertion that most robberies are committed by minority people), for a racially-prejudiced person to accept a worldview-incongruent retraction would require a certain degree of attitude change. Ecker and L. C. Ang (2018) found support for this hypothesis using fictional scenarios involving misconduct of politicians: Worldview-incongruent retractions were more effective in a specific scenario compared to a general scenario.

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 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). In other words, dysphorics (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 an effect would be in line with the fact that rumination—a repetitive and persistent focus on one's thoughts and worries (Nolen-Hoeksema, 1991)—is considered a hallmark symptom (Koster, De Lissnyder, Derakshan, & De Raedt, 2011; Watkins, 2008) of, as well as a vulnerability factor (Roberts, Gilboa, & Gotlib, 1998; Nolen-Hoeksema & Morrow, 1991) for, depression.

It is currently unclear whether rumination predisposes people to depression, or whether depression promotes rumination. 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, Rush, Shaw, & Emery, 1979; Lam et al., 2003; Vanderhasselt & De Raedt, 2012). These depressotypic worldviews feature prominently in cognitive theories of depression (e.g., Beck, 2005), and their assessment (e.g., using the Dysfunctional Attitude Scale; Weissman & Beck, 1978) often forms part of the diagnostic process.

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 through impairments in the suppression of negative information (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 or knowledge revision (Kendeou, Walsh, Smith, & O'Brien, 2014) 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.

Thus, the aim of the present study was to investigate the role of emotional valence on misinformation processing in participants with depressive symptoms and rumination tendencies, in a CIE paradigm. 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[1], 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.[2] Contrary to

[1] 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 (see Chang, Ecker, & Page [2017] for more detailed justification for sample selection criteria).

[2] 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.

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, 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.

The Present Study

The present study examined the processing of misinformation retractions in depressive rumination using a CIE paradigm (Ecker et al., 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. In Experiment 1, 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. We expected the retraction of negative misinformation to be less effective in depressive ruminators compared to

control participants with low rumination/depression scores, in particular in the general scenario. That is, 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 specific/general scenarios.

To foreshadow, while this was our working hypothesis, we found evidence *against* this hypothesis not only in Experiment 1, but also in Experiment 2, which used the same paradigm but focused on general scenarios and contrasted negative with positive misinformation. Retractions of worldview-congruent, negative misinformation were *as effective*[3] as (Experiment 1) or even *more effective* than (Experiment 2) retractions of worldview-incongruent misinformation. That is, across both experiments, retractions of negative misinformation were at least as effective in depressive ruminators as they were in control participants, and they were more effective than retractions of positive misinformation in depressive ruminators. We will thus interpret these results not in terms of motivated cognition, but in terms of attentional biases and salience effects.

Experiment 1

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.

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 of $f = 0.2$ at $\alpha = 0.05$, $1\text{-}\beta = 0.8$. Two hundred and fifty-five first-year psychology undergraduates from the

[3] 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.

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 a combination of 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[4] (DASS-21; Lovibond & Lovibond, 1995) across multiple screening exercises (total $N \approx 1{,}900$).

Given its temporal specificity (the measure assesses *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 their 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 randomly assigned to experimental conditions ($n = 23$-26 per cell). The high depressive rumination (DR) group comprised individuals with RRS scores ≥ 40 (following E. P. Chang et al., 2017; also see Onraedt & Koster, 2014; score range was 40-88; possible range is 22-88), and test-day DASS depression scores ≥ 10 (following Lovibond & Lovibond, 1995; score range was 10-42; possible range is 0-42). The low-DR group comprised individuals with RRS scores ≤ 33 (score range was 22-33) and test-day DASS depression scores ≤ 9 (score range was 0-9). Descriptive statistics of these measures by group are presented in

[4] We selected participants based on a combination of rumination and depression scores because of the exploratory nature of this work. While selecting participants on both rumination and depression scores does not allow us to disentangle the relative contributions of these two constructs, it provides a preliminary insight into whether, and how, these constructs collectively contribute to the CIE with valenced misinformation in depressive rumination. Future research can explore the specific relative contributions of rumination and depression. Due to a clerical error in the screening exercise, four participants were recruited based only on their RRS score.

Table 1. The mean RRS score in the high-DR group is comparable to the samples of Joormann and Gotlib (2008). The level of depression severity in the high-DR group was above the clinical cut-off proposed by Ronk, Korman, Hooke, and Page (2013).[5]

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 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 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 (DASS-Dep) and DASS-21 depression scale used in the initial screening of participants consists of 14 and seven items, respectively, 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]; the DASS-Dep correlations with RRS and DASS-21 were $r = .86$ and $r = .84$, respectively, $ps < .001$.

[5] For sake of transparency, we note that we additionally administered the Dysfunctional Attitude Scale (DAS-A; Weissman & Beck, 1978) for potential use as a continuous predictor in lieu of the DASS-Dep/RRS grouping. The DAS-A is a 40-item self-report questionnaire that assesses the intensity of dysfunctional attitudes. Analyses using the DAS-A closely mirrored the analyses reported in the following, and are detailed in the Supplemental Online Material 1.

Scenarios. There were two fictitious news reports, each comprising a series of 11 messages. The reports dealt with suicide, and detailed either a specific event (suicide death of a young celebrity singer) or a general assertion (increase in youth suicide rates; scenarios provided in Supplemental Online Material 2). Reports were matched in terms of structure, length, and trustworthiness of the retraction source (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, 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 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 […the] 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.*"

Test questionnaire. Following ample precedent (e.g., Ecker, Lewandowsky, Fenton, et al., 2014), 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. They were included to ensure sufficient encoding of the report, and 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 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 (see Supplemental Online Material 2) were made as similar as possible except for differences specific to each scenario.

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, after being 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; Rayner & Clifton, 2009) to ensure sufficient but not excessive encoding time. The pen and paper test questionnaire was administered after an unrelated 20-minute distractor task. Participants were instructed to complete all questions in the sequence

they were presented. Participants then completed the DASS before they were fully debriefed. The experiment took approximately 45 minutes.

Results

Coding of responses. Responses were coded by a scorer who was blind to group and experimental conditions, following a scoring guide. A second, independent scorer coded 40 randomly selected questionnaires (5 per condition) in order to calculate inter-rater reliability, which was high, $r = .91$. Following ample precedent (e.g., Ecker & Ang, 2018; 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. 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[6]. 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.

Recall accuracy. Mean recall accuracy was sufficiently high—and comparable to previous CIE research (e.g., Ecker & Ang, 2018)—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), these participants were included, but we re-ran all analyses excluding them to corroborate results

[6] 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 2 rating scale questions, so it is not ideal to base any analysis on rating scale questions only.

(discrepant outcomes will be reported in footnotes). Condition-specific descriptive statistics are presented in Table 2.

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 scenario by group 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.[7] All other effects were non-significant, $F < 1.9$.

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. Mean inference scores across conditions are shown in Figure 1. One-sample *t*-tests confirmed that all scores in the retraction conditions differed significantly from zero, all *t*s(23-25) > 7.41, *p*s < .001. This demonstrates a significant CIE in all retraction conditions.

A three-way ANOVA on mean inference scores 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, $F(1,189) = 3.91$, $p = .050$, $\eta_p^2 = .02$.[8] These main effects were qualified by a scenario by group interaction, $F(1,189) = 5.64$, $p = .019$, $\eta_p^2 = .03$, indicating greater inference scores in the specific scenario condition in the high-DR

[7] The effects of group and scenario × group were non-significant after exclusion of participants with recall accuracy < 2; *p*s > .103.

[8] Excluding the 15 participants with retraction-awareness scores of zero, the main effect of group was non-significant, $F(1,174) = 3.34$, $p = .069$, $\eta_p^2 = .02$.

group. All other interaction effects were non-significant, *F*s < 1. Importantly, there were no significant interactions involving the retraction factor, indicating that neither type of scenario nor DR group 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 hypothesised it may be ineffective.

Discussion

The aim of Experiment 1 was to investigate if the specificity of a negative scenario would affect the effectiveness of a retraction in depressive rumination (DR). We hypothesised that the high-DR group would exhibit greater post-retraction reliance on negative misinformation—that is, a larger CIE—in the general scenario compared to both the specific scenario and the low-DR group.

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. This demonstrates the presence of a significant CIE across conditions; that is, there was a CIE even in low-DR individuals who had 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 did not differ across levels of 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 L. C. Ang (2018), who found that pre-existing political attitudes impacted on retraction effectiveness especially with a general scenario. This discrepancy could arise for two reasons. First, general (e.g., political) worldviews could differ fundamentally from the depressotypic worldviews that characterise depressive rumination in the way they affect information processing. Second, salience effects may have dominated any potential worldview effects in the present study.

Regarding the first point, the depressotypic worldviews present in depressive rumination clearly differ qualitatively from generic (e.g., political) worldviews. 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 attitudes 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* (Higgins, 1987). 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 motivated to defend their beliefs (Ecker, Swire, et al., 2014; Taber & Lodge, 2006), but this may simply not apply to the depressotypic worldviews found in depressive rumination. In other words, while depressotypic worldviews are a characteristic of depressive rumination (Lam et al., 2003), they may not have a hindering impact on belief updating.

The second reason why results disconfirmed our original hypothesis may lie in the salience of the misinformation. Various authors have advocated that salience of the misinformation is an important prerequisite for corrections to be effective. Stadtler et al. (2013) argued that salience of both misinformation and correction enhances conflict detection, which facilitates memory updating. Kendeou et al. (2014) asserted that salience enhances the co-activation of misinformation and retraction, allowing for more efficient correction. Furthermore, Ecker et al. (2017) demonstrated that repeating the misinformation within a correction improves the effectiveness of a correction, which suggests that integration of the corrective information is facilitated if misinformation salience is high during processing of the correction. Our finding may suggest that misinformation 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 would arguably enhance co-activation and conflict detection.

In this vein, the data suggest that the celebrity suicide scenario was particularly salient in the high-DR group, as both fact-recall and inference scores were elevated in this condition. Celebrity news in general have great appeal to young adults (Dubied & Hanitzsch, 2014), and the celebrity suicide may have been particularly salient to young high-DR participants given that the negative thoughts in depression often involve themes of loss, death, and suicide (Beck et al., 1987; Nordentoft & Mortensen, 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.

In sum, Experiment 1 provided some preliminary evidence that discounting of negative misinformation is not impaired in depressive ruminators (also see E. P. Chang et al., 2017). In

order to replicate this unexpected finding, we ran Experiment 2. We have argued that retractions may be more effective if the misinformation is particularly salient. In the context of depressive rumination, salience may depend on the valence of the misinformation. Thus, we manipulated the misinformation's valence in Experiment 2, to test if high-DR individuals might exhibit enhanced discounting of negative (i.e., presumably salient) misinformation when compared to discounting of positive misinformation. Alternatively, if salience does not carry the hypothesised weight, Experiment 2 allowed an additional test of our original hypothesis that depressive rumination may be associated with impaired discounting of negative misinformation when contrasted against positive misinformation[9].

Regarding the low-DR group, we did not expect any difference in retraction effectiveness across positive and negative reports: One may argue that positive scenarios may be more salient to low-DR participants (Grafton, C. Ang, & MacLeod, 2012; Levens & Gotlib, 2010), and thus retraction of positive misinformation 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 (Rozin & Royzman, 2001). For example, Guillory and Geraci (2016) found that unselected 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 scenarios in their potential to elicit references to the critical information, so methodological artifacts might have contributed to this finding; in the current study, we addressed this by matching questions across scenarios as closely as possible. Given these inconsistencies, we made no strong predictions regarding the low-DR group.

[9] As this is the first study to investigate the effects of emotional valence on depressive rumination using the CIE paradigm, 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, or cognitive biases away from positive information.

Experiment 2

Experiment 2 was run 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 & Ang, 2018), Experiment 2 used only general scenarios involving positive or negative misinformation, and was thus similar to the general scenario condition of Experiment 1. As the valence manipulation (unlike the specificity manipulation in Experiment 1) required conceptually different scenarios, it was applied within-subjects. Apart from those changes, the procedure was very similar to Experiment 1, with minor changes specified below.

Method

Valence and retraction factors were fully crossed and varied within-subjects. Experiment 2 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.

Participants. Sample size was based on previous CIE research using a repeated-measures design (e.g., Ecker, Hogan, & Lewandowsky, 2017). Eighty-six participants were selected from multiple screening exercises ($N \approx 1{,}500$); none of them had participated in Experiment 1. We applied the same selection criteria across Experiments 1 and 2.[10] 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). Descriptive statistics of the measures by

[10] However, in Experiment 2, 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.

group are presented in Table 1. The internal consistencies of the RRS and DASS-Dep scores were αs > .97, and coefficient omegas > .95, 95% CI [.93, .97], and the correlations among RRS, DASS-Dep, and DASS-21 depression scores were *r*s > .80, *p*s < .001.

Scenarios. There were four fictitious news reports; each consisted of a series of seven messages. 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. Reports were matched on length, structure and trustworthiness of the retraction source (Guillory & Geraci, 2013).

Across reports, message 2 contained the critical piece of information and message 6 contained its retraction (or arbitrary information in the no-retraction condition). For example, 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 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*". All reports are available in Supplemental Online Material 2.

Test questionnaire. The questionnaire booklet (see Supplemental Online Material 2) 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. 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 Experiment 1 suggested adequate encoding, and for pragmatic reasons, recall accuracy questions were excluded from Experiment 2.

Procedure. Participants read the four news reports, with each message presented individually, similar to Experiment 1; 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 × 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.

Results

Coding of responses. The coding procedure was identical to Experiment 1. Inter-rater reliability, based on 20 questionnaires across conditions and groups, was high, $r = .91$.

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 2. One-sample *t*-tests confirmed that all scores in the retraction conditions differed significantly from zero, all $ts(31) > 11.13$, $ps < .001$. 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, $F(1,62) = 4.78$, $p = .033$, $\eta_p^2 = .07$,[11] which was qualified by a significant three-way interaction, $F(1,62) = 5.50$, $p = .022$, $\eta_p^2 = .08$. All other effects were non-significant, all $Fs < 1$ (except $F[1,62] = 2.58$, $p = .113$, for the valence by group interaction).

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 (ineffective, $F < 1$) retraction of positive misinformation, $F(1,62) = 4.33$, $p = .042$, $MSE = 0.05$, for the interaction of retraction and valence.[12] Conversely, the low-DR group demonstrated the opposite trend: Here, the retraction of negative misinformation was ineffective, $F < 1$; the retraction of positive misinformation was seemingly effective although the

[11] Excluding the seven participants with no retraction-awareness, this effect was non-significant, $F(1,55) = 3.30$, $p = .075$.
[12] Excluding the seven participants with no retraction-awareness, this effect was non-significant, $F(1,55) = 2.37$, $p = .129$.

effect did not reach statistical significance, $F(1,62) = 3.22$, $p = .077$, $MSE = 0.05$ ($F[1,62] = 1.53$, $p = .221$, $MSE = 0.05$, for the interaction contrast).

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.

Discussion

The aim of Experiment 2 was to investigate if misinformation valence would affect retraction effectiveness in depressive rumination (DR). Our original hypothesis was that depressive ruminators would exhibit a larger CIE with negative compared to positive reports, in line with studies investigating the impact of worldviews on the CIE. Alternatively, in light of the Experiment 1 finding 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.

Replicating the findings of Experiment 1 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 in Experiment 2 suggesting that the effectiveness of a retraction varied systematically across valence levels and groups. Consistent with Experiment 1, 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 et al., 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 et al., 2014) and/or conflict detection (Stadtler et al., 2013; also see Ecker et al., 2011).[13]

Naturally, our data offer no strong evidence that the observed effects were driven by an attentional bias. Alternatively, negative interpretative or memory biases, or any combination of attentional, interpretative, and memory biases, may have been responsible for the observed findings. Indeed, emerging research on the combined cognitive bias hypothesis (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.

The no-retraction control condition of Experiment 2 yielded additional evidence for a valence-related attentional bias: Both groups made more references to un-retracted information that was worldview-congruent—that is, positive for low-DR and negative for high-DR participants. This is consistent with a general tendency to refer preferentially to worldview-

[13] Regarding the question of whether depression or rumination scores were the better predictor of inference scores, we can only speculate: Exploratory regression and commonality analyses reported in the Online Supplementary Materials suggested that in the high-DR group, depression but not rumination scores predicted reliance on negative (mis)information. However, we cannot know whether those who are high on depression but low on rumination measures might attenuate this effect, since this group was not included in our sample.

congruent information (e.g., see Ecker, Lewandowsky, Fenton et al., 2014). In light of this, another way to frame the main finding of Experiment 2 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.

However, this can of course not explain the unexpected finding that retractions of worldview-incongruent information were entirely ineffective. Our interpretation in terms of weaker encoding of less salient worldview-incongruent misinformation and a potential lack of co-activation and conflict detection (Kendeou et al., 2014; Stadtler et al., 2013) is broadly consistent with the literature on positive insensitivity in rumination and depression on the one hand (Levens & Gotlib, 2010), and negative materials promoting withdrawal responses in an unselected sample on the other (Recio, Conrad, Hansen, & Jacobs, 2014).

The finding that a retraction of negative misinformation was not effective in the low-DR group in Experiment 2 stands in contrast to Experiment 1. 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). Future research should aim to replicate the enhanced effectiveness of negative-misinformation retractions in depressive rumination.

General Discussion

The aim of the present study was to investigate potential memory updating deficits in depressive rumination (DR) in a real-world context. We used the continued-influence effect (CIE; Johnson & Seifert, 1994) paradigm, varying the specificity (Experiment 1) and valence (Experiment 2) of the fictional news reports presented, to assess participants' reliance on

retracted misinformation. We hypothesised that high-DR participants would exhibit a stronger CIE with negative misinformation compared to low-DR participants and/or positive misinformation (and in particular with general assertions as compared to specific event scenarios).

The novel and consistent finding across both experiments 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, 2018; Nyhan & Reifler, 2010). Our interpretation in terms of negative information being especially salient due to an attentional bias in dysphoric rumination remains speculative, but we note that it is consistent with a recent study by Owens and Gibb (2017), who used eye-tracking as a direct measure of negative attentional bias in rumination.

The findings in the present study are contrary to the literature on impaired memory updating of negative information in depression. However, most studies demonstrating memory updating deficits for negative information in depression or rumination have relied on response-time or list-recall measures in short-term working memory (Joormann & Gotlib, 2008; Levens & Gotlib, 2010; cf. Everaert et al., 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 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, 2018; Higgins, 1987; Taber & Lodge, 2006).

From a clinical perspective, the findings in the present study suggest that increasing the salience of negative information/thoughts before implementing strategies to replace them with more positive and adaptive information/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, given that hypersalience of incorrect information in schizophrenia has been found to reduce belief revision (Balzan, Delfabbro, Galletly, & Woodward, 2013), further research is necessary to ascertain if there is an optimal level of salience beyond which memory updating in depressive rumination may instead be impaired.

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 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. Future research could aim to replicate the observed effects, perhaps (i) utilising scenarios that—rather than implementing a valence differentiation—are more self-relevant and map more specifically onto relevant depressotypic worldviews, and (ii) adopting more specific participant selection criteria to adequately disentangle the relative contributions of rumination and depression to the observed effects.

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Tables and Figures

Table 1. *Rumination and depression scales descriptive statistics by group*

Table 2. *Recall accuracy descriptive statistics by retraction condition, scenario, and group*

Figure 1. Mean inference score by retraction condition, scenario and DR group in Experiment 1. Error bars indicate standard errors of the mean.

Note. DR = Depressive rumination.

Figure 2. Mean inference score by retraction condition, valence, and DR group in Experiment 2. Error bars indicate within-subject standard errors of the mean.

Note. DR = Depressive rumination.

Supplemental Online Material Caption

Supplemental Online Material 1: Additional Analyses Including Dysfunctional Attitude Scale Scores

Supplemental Online Material 2: Scenarios and Questionnaires

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