Meta-analysis of the association between rumination and reduced autobiographical memory specificity

Connie P.Y. Chiu[1] (E: connie.py.chiu@gmail.com), James W. Griffith[2] (E: jameswgriffith@gmail.com; j-griffith@northwestern.edu), Bert Lenaert[3] (E: bert.lenaert@maastrichtuniversity.n[l]), Filip Raes[4] (E: filip.raes@kuleuven.be), Dirk Hermans[4] (E: dirk.hermans@kuleuven.be), Tom J. Barry[1,5*],

[1]Experimental Psychopathology Lab, Department of Psychology, The University of Hong Kong, Hong Kong.

[2]Department of Medical Social Sciences, Northwestern University, Feinberg School of Medicine Chicago, IL, USA

[3]School for Mental Health and Neuroscience, Maastricht University, Netherlands

[4]Centre for Learning Psychology and Experimental Psychopathology, University of Leuven, Leuven, Belgium

[5]The Institute of Psychiatry, Psychology & Neuroscience, King's College London, London, United Kingdom.

*Corresponding Author: Tom J. Barry

A: Department of Psychology, The University of Hong Kong, Jockey Club Tower, Pokfulam Road, Hong Kong

E: tom.j.barry@icloud.com; tjbarry@hku.hk

Abstract word count: 146

Word count: 5231

Figures: 5

Table: 1

Abstract

The CaRFAX model, proposed by Williams and colleagues (2006, *Cognition & Emotion*; 2007, *Psychological Bulletin*), posits that reduced autobiographical memory specificity, a key factor associated with the emergence and maintenance of emotional disorders, may result from heightened rumination. We provide the first meta-analysis of the relation between autobiographical memory specificity and trait rumination. PsycINFO, PsycARTICLES and MEDLINE databases were searched and the following were extracted: the correlation between the number of specific memories recalled in the Autobiographical Memory Test and self-reported trait rumination scores, and its sub-factors – brooding and reflection. The pooled effect size for the correlation between memory specificity and trait rumination was small ($d = -.05$) and did not differ significantly from zero ($p = .09$). The effect sizes for the correlation with brooding and reflection were not significantly different from zero. There is limited support for the association between trait rumination and memory specificity suggested in CaRFAX.

Keywords: memory; rumination; depression; post-traumatic stress disorder

General Audience Summary

People who are at risk of, or who have, a range of emotional disorders have been found to recall memories of their past with *reduced specificity*. Theories which try to explain this association have suggested that these memory specificity problems might be caused by the tendency to *ruminate,* or to repetitively think in a negative and unconstructive way. We conducted a meta-analysis, collating all of the existing evidence regarding the association between poor memory specificity and ruminative tendencies. When considering all of this evidence together, there was no evidence that poor memory specificity and rumination were associated with one another in the way that has been suggested. We suggest some other factors that might contribute towards memory specificity problems and the implications of this for depression and other emotional disorders.

Evidence accumulated over two decades suggests that reduced autobiographical memory specificity (rAMS) is an important cognitive factor associated with risk for a range of emotional disorders as well as the presence and course of these problems (Kleim & Ehlers, 2008; Sumner, Griffith, & Mineka, 2010). For example, people with depression may have difficulty recalling memories of specific situations that took place on particular days (e.g., "A party" versus "I went to my friend Jamie's 50th Birthday party where we ate cake"). Williams and colleagues (2006; 2007) proposed three processes which underlie and perpetuate rAMS: Capture and Rumination, Functional Avoidance, and impaired eXecutive capacity (CaRFAX). This remains the most widely cited explanation for the process by which memory specificity becomes compromised. Over the years researchers have sought to explore the validity of the CaRFAX model by examining the extent to which each of the constituent processes contributes towards rAMS (Sumner, 2012). Considering the strong association between rAMS and emotional disorders, and also the continued citation of the CaRFAX model in explaining rAMS, it is of utmost importance that the suggestions of this model are tested. The present investigation will provide the first meta-analytical study of the association between rAMS and rumination.

Relative to other aspects of CaRFAX, the relation between rumination and memory specificity has received a particularly significant amount of attention. This is perhaps because of evidence that rumination, or the tendency to think repetitively in an analytical, abstract and evaluative manner (Watkins, 2008; Watkins, Moberly, & Moulds, 2008), can cause rAMS (Crane, Barnhofer, Visser, Nightingale, & Williams, 2007; Raes, Watkins, Williams, & Hermans, 2008; Schönfeld & Ehlers, 2006; Spinhoven, Bamelis, Molendijk, Haringsma, & Arntz, 2009; Sutherland & Bryant, 2007) and be influenced by it (Raes, Williams, & Hermans, 2009), and that together rumination and rAMS might influence other negative outcomes associated with psychopathology such as poor social problem solving (Raes et al.,

2005). The present meta-analysis examines whether self-reports of heightened ruminative tendency are associated with rAMS given recent suggestions that rumination measured in this way may not be as strongly associated with memory specificity as previously thought (Smets, Griffith, Wessel, Walschaerts, & Raes, 2013). The results of this study will inform our understanding of how rAMS emerges and how specificity might be improved, perhaps by modifying ruminative tendencies with interventions that target and reduce rumination such as rumination-focused cognitive behavioural therapy (rfCBT) (Watkins et al., 2011). This might also inform the development or refinement of interventions which seek to improve memory specificity, such as Memory Specificity Training (MeST; Raes, Williams, & Hermans, 2009), by augmenting these programs with rumination interventions.

Autobiographical memory specificity (AMS) – or *overgeneral memory* as it has also been called – is typically assessed using the Autobiographical Memory Test (AMT) developed by Williams and Broadbent (1986). Participants are typically asked to recall a specific memory related to positive or negative cue words (e.g., safe, angry) that are presented sequentially. Participants are often instructed to respond to each cue word within a set time (e.g., 60 seconds) and their responses are then coded as specific or not. Specific memories are those which refer to a personal event which lasted for less than 24 hours. Although there are other ways to code AMT responses, there is limited psychometric support for these alternatives. Instead, existing evidence suggests that rAMS is best operationalised as fewer *specific* recollections, irrespective of the valence of the cue words used (Griffith et al., 2009, 2012; Heron et al., 2012; Takano, Gutenbrunner, Martens, Salmon, & Raes, 2017). That some people recall fewer specific memories rather than more general memories also supports the suggestion that this construct is best referred to as *reduced autobiographical memory specificity*, rather than as *overgeneral memory*. rAMS is evidenced amongst people with a range of pathologies, including depression, PTSD and personality disorders such as

borderline personality disorder (Hermans et al., 2008; Ono, Devilly, & Shum, 2015; Williams

et al., 2007). rAMS has also been found to predict the worsening of depressive symptoms

amongst depressed individuals (Sumner et al., 2010).

        Given the accumulating evidence of rAMS within psychopathology, research has also

focused on the mechanisms that contribute towards rAMS, and the CaRFAX model has

provided the foundation of this work. CaRFAX was developed based on Conway and

Pleydell-Pearce's (2000) self-memory system model which postulates that autobiographical

memory retrieval follows a hierarchical search from general details to more specific details.

The CaRFAX model suggests that rAMS is the result of premature termination of this search

caused by capture and rumination, functional avoidance and impaired executive capacity.

Capture and rumination refers to the process by which, during the retrieval of

autobiographical memories, one's attention and cognitive resources are captured when cues

activate general information concerning the relevance of this memory for their beliefs about

themselves. For example, a person might be retrieving a memory of a recent bicycle ride and

instead may become fixated on thoughts related to their poor fitness relative to their peers.

Fixation on general, self-relevant memories is believed to disrupt the retrieval of specific,

episodic memories. The tendency to get fixated on this general processing level is said to be

particularly common amongst people who tend to engage in repetitive, self-evaluative,

thinking, that is abstract and language-based rather than concrete and imagery-based hence

the association between rumination and memory specificity that has been observed (see

Sumner, 2012). The difficulty some people experience in moving past the general, self-

relevant processing level is further disrupted by so-called functional avoidance of event-

specific details in an effort to regulate the potential negative affect that might accompany

retrieval of such details or their semantic associates. In the previous example, one might

avoid recalling the detail of previous bicycle rides to avoid recall of examples of their poor

fitness. Avoidance of specific, and potentially negative, information stored in memory is said

to arise in response to adverse early experiences and traumas where one's memories are

either directly and significantly negative or come to be semantically associated with such

memories. In our example, one might have been bullied earlier in life because of their

performance in school sports and as such, recall of other memories related to physical activity

have a chance of evoking similar memories or feelings of physical inadequacy. Indeed, meta-

analytical evidence suggests that rAMS is associated with exposure to trauma (Barry,

Lenaert, Hermans, Raes, & Griffith, 2018; Ono et al., 2015) and individual differences in the

tendency to avoid negative thoughts and feelings has been associated with rAMS (Debeer,

Raes, Williams, & Hermans, 2011; Schönfeld & Ehlers, 2006; Wessel, Merckelbach, &

Dekkers, 2002). Finally, impaired executive capacity has also been suggested to contribute

towards rAMS. Here, limits to the capacity of working memory and problems inhibiting

irrelevant thoughts and memories contribute towards difficulty holding in mind the result of a

memory search. As such, deficits in each of these separate aspects of executive functioning

have been associated with rAMS (see Sumner, 2012). These problems increase the likelihood

that one will be captured by an irrelevant memory and that even if a relevant memory is

retrieved that only limited detail will be accessed. These three mechanisms then lead to

rAMS independently and in tandem with one another (Sumner et al., 2014). rAMS then leads

to the symptoms of emotional disorders through its effects on several other disorder-related

processes, such as difficulty problem solving (Arie, Apter, Orbach, Yefet, & Zalzman, 2008;

Goddard, Dritschel, & Burton, 1996, 1997; Raes et al., 2005; Sutherland & Bryant, 2008),

increased hopelessness regarding one's future (Arie et al., 2008; Evans, Williams,

O'loughlin, & Howells, 1992) and deficits in regulating negative emotions (Hermans, Raes,

& Eelen, 2005).

Perhaps the most studied of the three CaRFAX mechanisms involves the association

between individual differences in trait rumination and rAMS. While the broader rumination

construct is typically used to refer to the tendency to think repetitively in an unconstructive

way on the causes, meanings and consequences of, rather than solutions to, one's feelings

(Nolen-Hoeksema, 1998; Watkins, 2008), two subtypes of rumination have also been

identified: brooding and reflection (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). Brooding

refers to the tendency to passively and repetitively think about one's current situation in

comparison with some unachieved standard without focusing on constructive ways to meet

this standard; whereas, reflection is defined as the tendency to think repetitively in a

purposeful and constructive manner (Treynor et al., 2003). Within the AMT literature, the

role of rumination has been examined in two ways, either by comparing participants'

memory specificity before and after an induction of state rumination (e.g., Sutherland &

Bryant, 2007), or by correlating self-reported trait rumination with memory specificity (e.g.,

Raes et al., 2005). An evaluative review conducted by Sumner (2012), which examined

findings from 38 studies which explored different aspects of CaRFAX published during the

period between 2005 and 2011, concluded that there was strong evidence in support of the

suggestion that higher state and trait rumination were associated with rAMS and that this

association was particularly prominent in studies involving a state rumination induction. In

these studies, participants who were induced to think in a repetitive, abstract, and evaluative

mode about their current state or personal characteristics were found to produce less specific

memories than those given either distraction inductions or inductions of other forms of non-

ruminative thinking (Raes et al., 2008; Sutherland & Bryant, 2008). Studies which adopted

self-report measures of trait rumination to examine their association with AMS have found

higher trait rumination to be significantly associated with rAMS in diverse populations,

including healthy and currently or formerly depressed adolescents and university students

(Debeer, Hermans, & Raes, 2009; Raes et al., 2005). However, more recent evidence

suggests that the strength of the association between trait rumination and rAMS may not be as strong as initially suggested by CaRFAX (Smets et al., 2013).

Though the evaluative review provided by Sumner (2012) supported the suggestions of CaRFAX, there has yet to be a meta-analytical study that systematically gathers and analyses all available literature where individual differences in trait rumination and AMS have been correlated. Also, although there is clear evidence of an association between rAMS and the presence and severity of a range of emotional disorders, and in particular depressive disorders (Ono et al., 2015; Van Vreeswijk & De Wilde, 2004; Williams et al., 2007), as well as an association between rumination and these disorders (Conway et al., 2000; Debeer et al., 2009; Nolen-Hoeksema, 2000; Raes et al., 2005; Spasojevic & Alloy, 2001), it is also unclear whether the relation between rAMS and rumination is moderated by other factors such as depression severity and clinical status. The present investigation provides such a meta-analysis. Focus is given to studies examining the association between self-reported trait rumination and AMS measured using the AMT. We do not explore the association between state rumination and AMS because trait rumination and AMS have been more widely studied and in the few studies that have explored the association with state rumination, there is significant methodological heterogeneity (e.g., different forms of rumination induction have been used between studies – positive versus negative rumination; abstract versus concrete rumination etc.; c.f. Raes et al., 2008; Sutherland & Bryant, 2008). This meta-analysis therefore examines the size of the pooled effect size, across all available studies, of the correlation between trait rumination and AMS. Evidence of a negative pooled effect size that differed significantly from zero, such that across studies higher rumination was often associated with lower specificity, would support the suggestions made by CaRFAX. Such a finding would also suggest that interventions that seek to target and improve memory specificity might first target rumination. The analysis also explored pooled effects within the

sub-factors of rumination – brooding and reflection – to examine whether one or both these factors are uniquely associated with memory specificity and if so, whether this explains any observed effect of the broader rumination construct. We also consider whether there is evidence of significant variance between studies in the size of the observed correlations and if so, whether other known correlates of rumination and AMS such as clinical status or mean depression symptom severity can explain these between-study differences. Also, given meta-analytical evidence that females show heightened ruminative tendencies relative to males (Johnson & Whisman, 2013) we also included gender in our moderator analyses.

Method

Search strategy

PsycINFO, PsycARTICLES and MEDLINE databases were searched using the terms autobiographical memory and either specificity or overgeneral, in addition to the terms rumination, worry, brooding, reflection, repetitive and pondering (e.g., autobiographical memory AND specificity AND rumination; autobiographical memory AND specificity AND worry, etc; autobiographical memory AND overgeneral AND rumination, etc.) Studies which reported Pearson's *r* between performance on a standardised AMT and a trait rumination measure were included. A standardised AMT refers to one in which participants are instructed to recall a specific memory to a series of negative, positive or neutral cue words. 17 studies were excluded because they used an atypical AMT such as using self-relevant cue words or the AMT was conducted in a semi-structured interview format with additional probing for details by interviewers (see Figure 1 for a study inclusion/exclusion flow chart).

Data extraction, handling and analysis

C.P.Y.C. extracted the following data: 1) Authors' names; 2) publication year; 3) sample size; 4) participants' mean age; 5) proportion of females; 6) the rumination measure used; 7) the mean score for this rumination measure; 8) the depression measure, if any, that

was used; 9) the mean score for this depression measure; 10) the proportion of participants

with a diagnosis of major depressive disorder; 11) the proportion of participants who met

criteria for any diagnosis; 12) the correlation coefficient between overall memory specificity

(not cue-specific scores) and rumination; 13) the correlation coefficient between memory

specificity and the brooding sub-factor of rumination; and, 14) the same for the reflection

sub-factor of rumination. For studies that gave positive and negative cue specificity scores

but not an overall score, the latter was computed by combining the totals from each cue.

STATA 14.2 metan and metareg package were used for analyses. Correlation

coefficients were first Z transformed using the following formula so that they could be

handled by the STATA metan package:

$$\text{Effect size } (Zr) = 0.5 \times log((1+r)/(1-r))$$

Standard errors for these effect sizes were computed as follows:

$$\text{Standard Error } (SE) = \sqrt{(1/(n-3))}$$

A random effects framework was used in the analyses, making the assumption that

the size of the relation between rumination and specificity differs between studies due to

methodological and sample differences between studies (Field & Gillett, 2010). Pooled effect

sizes were computed using Cohen's method and the DerSimonian-Laird method was used to

estimate heterogeneity between effect sizes. Following the recommendations of Borenstein

and colleagues (2017), tau-squared (τ^2) served as the index of between-study heterogeneity.

The extent to which the pooled effect sizes differed from zero was calculated using a Z test.

In our main analysis of the broader rumination construct, where there was evidence of

significant heterogeneity between studies, a random-effects general linear model, or meta-

regression, was used to examine whether the heterogeneity between effect sizes was

moderated by study characteristics (e.g., age, gender, proportion of depressed or clinically

diagnosed participants, and whether there was a continuous relation with self-reported depressive symptoms).

The presence of publication bias was examined, first, by visually inspecting funnel plots and then using Egger's test to assess whether the effect size of a given study was related to the size of the sample within that study. After this, Vevea and Woods (2005) sensitivity analysis was performed. This adjusts pooled effect sizes based on the presence of moderate and severe one- and two-tailed selection biases. Where there is little or no publication bias, one would expect the adjusted effect sizes to be similar to those estimated in the main analysis, such that one's conclusions would be the same irrespective of which effect sizes (unadjusted or adjusted) were chosen.

Measures

Rumination

The data that were extracted involved several different measures of trait rumination and in particular, The Ruminative Response Scale (RRS) and The Rumination on Sadness Scale (RSS). The RRS is the most common measure of trait ruminative tendencies. The RRS consists of 22 items which assess one's coping style in dealing with depressive mood such as the extent to which one repetitively thinks about one's symptoms, their causes and effects, and the value that one places in such thinking (Nolen-Hoeksema & Morrow, 1991). The RRS has also been adapted such that alternative total scores are computed. These adaptations only include those items which load on its supposed sub-factors, brooding and reflection (e.g., The RRS-10 and RRS-B). Other measures such as the Rumination on Sadness Scale (RSS) developed by Conway et al. (Conway, Csank, Holm, & Blake, 2000) have also been adopted in some studies. The RSS consists of 13 items which assess the extent to which one ruminates in response to sad mood and in circumstances related to sad mood. Both measures have been found to be reliable and sensitive to predicting depressive symptoms (Conway et al., 2000;

Spasojevic & Alloy, 2001). For both of these measures, a higher score reflects greater ruminative tendency.

Depression

The majority of studies that assessed current levels of depressive symptoms did so using the Beck Depression Inventory version II (Beck, Steer, & Brown, 1996). The BDI-II is a self-report questionnaire including 21 items where participants report their experience of typical depressive symptoms on scales ranging from 0 to 3, such that a higher score reflects greater experience of depressive symptoms.

Results

Study characteristics

The final sample included data from 17 studies (included studies are noted with an asterisk in reference list), within which there were 17 effect sizes regarding the correlation between memory specificity and the broader construct of trait rumination, 15 effect sizes regarding the correlation with the brooding sub-factor of rumination, and 8 effect sizes regarding the correlation with the reflection sub-factor of rumination (cf. Table 1 for a full outline of study characteristics). Across all studies participants were on average approximately 34 years of age and were mostly female (Mean percentage: 62%) with most participants free from depression or other clinical diagnoses (Mean percentage with depression: 29%; Mean percentage meeting criteria for any diagnosis: 36%). Among the 17 effect sizes for the correlation between the broader rumination construct and memory specificity, the majority of these considered rumination in terms of the RRS 22-item version ($k = 10$; $N = 2075$; *Mean* $= 38.99$; *SD* $= 14.22$), and measured depressive symptoms using the BDI-II ($k = 9$; $N = 662$; *Mean* $= 14.30$; *SD* $= 11.30$).

Meta-analysis

The pooled effect size for the correlation between rumination and autobiographical memory specificity was small and did not differ significantly from zero, $d = -.054$, 95% CI [-.116, .008], $Z = 2.17$, $p = .090$ (cf. Figure 3 for forest plot). There was a significant amount of heterogeneity between the studies included in the analysis, $\tau^2 = .007$, $\chi^2(16) = 32.45$, $p = .009$, with effect sizes (Zr) ranging from -.56 ($r = -.42$; Raes et al., 2006) to .15 ($r = .15$; Smets, Wessel, & Raes, 2014). As the overall 95% prediction intervals overlapped with zero (cf. Figure 3), the heterogeneity between study effect sizes was such that there is a substantial likelihood that if researchers were to perform a new correlational study, that it would show no correlation between individual differences in rumination and memory specificity. Across the available literature, self-reports of higher levels of rumination were weakly, and non-significantly, associated with recall of fewer specific autobiographical memories and there was substantial variability between studies in the size of these effects.

The pooled effect sizes for the correlations between the sub-factors of rumination, brooding and reflection, and memory specificity, were not significantly different from zero (brooding: $d = .008$, 95% CI [-.087, .103], $Z = .16$, $p = .876$; reflection: $d = .028$, 95% CI [-.094, .150], $Z = .45$, $p = .653$) (cf. Figure 4 and Figure 5).

Moderator analysis

Meta-regression was used to explore whether there were moderator variables that might explain the heterogeneity between studies in the meta-analysis of the effect sizes for the broader construct of rumination and its relation with memory specificity. Neither the mean age of participants, $B = -.002$, $SE = .003$, $t = -.68$, $p = .506$, the proportion of females, $B = -.134$, $SE = .236$, $t = -.57$, $p = .581$, the proportion of participants with diagnoses of depression, $B = .139$, $SE = .233$, $t = .60$, $p = .562$, nor the proportion of participants with any diagnosis, $B = -.172$, $SE = .201$, $t = -.85$, $p = .409$ explained a significant amount of the variance in effect sizes between studies. The overall model did not explain a significant

amount of variance in effect sizes between studies, $R^2 = -.43$, $F(4, 12) = .32$, $p = .859$. A

separate meta-regression selected only those studies which used the BDI-II and explored

whether mean self-reported depressive symptoms explained the variance between studies in

effect sizes, however, this was also not a significant moderator, $B = -.003$, $SE = .007$, $t = -.53$,

$p = .611$.

Publication bias

Visual inspection of the funnel plots of effect sizes of the relation between rumination

– and its sub-factors – and memory specificity and the standard error for these effect sizes

(Figure 2) indicated that there was little evidence of publication bias within the studies

selected. This was confirmed by Egger's test (all p's > .1) and was further confirmed by

inspection of Vevea and Woods (2005) adjusted effect sizes accounting for severe two-tailed

bias, which were similar to the unadjusted effect sizes (Rumination: -.05; Brooding: .006;

Reflection: -.066). These adjusted effect sizes would not alter our interpretation of the main

meta-analysis results. This suggests that the unadjusted effect sizes are unlikely to be

severely influenced by unpublished studies.

<div align="center">

Discussion

</div>

The present meta-analysis aimed to test the theoretical assumptions made by Williams

and colleagues (Williams, 2006; Williams et al., 2007) regarding the association between

rumination and autobiographical memory specificity. We hypothesised that higher trait

rumination would be associated with lower autobiographical memory specificity. The effect

sizes for the correlation between the number or proportion of specific memories recalled in

the Autobiographical Memory Test and self-reported differences in trait ruminative tendency

and its sub-factors – brooding and reflection – were calculated and pooled. The effect size for

the association between AMS and rumination was small and did not differ significantly from

zero. Also, given the overlap between the 95% prediction interval with zero, there is a high

probability that future studies which explore this association will elicit non-significant correlations. The effect sizes for the correlations with brooding and reflection were also small and did not significantly differ from zero. As both rAMS and rumination have been associated with the presence of emotional disorders and self-reported symptoms of these disorders (Conway et al., 2000; Debeer et al., 2009; Nolen-Hoeksema, 2000; Raes et al., 2005; Spasojevic & Alloy, 2001) we also expected that differences between studies in mean self-reported depressive symptoms or the proportion of diagnoses of depression or any emotional pathology might explain some of the variability between studies in the size of the correlation between rumination and AMS. However, these variables showed no evidence of moderating study effect sizes. In summary, when the wealth of available evidence regarding the association between individual differences in trait rumination and memory specificity was considered together, we found no support for this aspect of the CaRFAX model, or that any relation that does exist between these variables is specific to sub-factors of rumination or is moderated by emotional pathology. In further support of these conclusions, we also found that there was no evidence of publication bias across the studies we sampled and our sensitivity analysis indicated that our conclusions would likely remain unchanged even if there was severe publication bias.

Several limitations of the present analysis are of note, however. The focus of this analysis was on self-reported trait rumination rather than state inductions of rumination. As discussed previously, the literature regarding state inductions of rumination is limited and highly heterogeneous with studies testing inductions of various different forms of rumination. Such sample limitations precluded a meta-analysis of these studies. Therefore it remains possible that individual differences in state rumination at the time of recall could still have an important influence on AMS even if trait rumination tendencies have little such influence (Smets et al., 2013). It might also be that the relation between rumination and memory

specificity is more prominent when one is recalling memories that are cued by self-relevant words. For example, Crane et al. (2007) found a significant negative correlation between the numbers of self-relevant cues in an AMT and the number of specific memories recalled amongst depressed participants but not controls, a finding that has been replicated elsewhere (Raes, Schoofs, Griffith, & Hermans, 2012; Smets et al., 2013). The authors suggest that these between-group differences might in part be due to a greater predisposition to ruminative thinking in depressed participants, which was evoked by the self-relevant nature of the cue words used in the AMT. Self-relevant cues might indeed be more appropriate in testing the CaRFAX assumptions as it was originally hypothesised that rumination could disrupt the memory retrieval process by *capturing* one's attention on self-relevant concerns related to the memory that is being cued (Williams, 2006). These studies were not included in the present analysis as they would have contributed to additional between-study heterogeneity and, as they are not commonly used, we would have had insufficient statistical power to examine these methodological differences as a moderating factor. Future research on rumination and AMS would benefit from a clarification of whether personalized, self-relevant, cue words are necessary to evoke an association between trait rumination and memory specificity.

Although not specifically stated by the CaRFAX model, it may be that the association between rumination and AMS is only evident in the presence of other facets of the model such as when a person exhibits a tendency to avoid negative affect or in the presence of impoverished executive capacity. In other words, perhaps interactive effects of rumination are necessary rather than a main effect of rumination on AMS. For example, reduced memory specificity has been associated with the experience of trauma (Barry et al., 2018; Ono et al., 2015) and the extent to which one attempts to avoid trauma-related thoughts (Wessel et al., 2002). Moreover, there is evidence that individual differences in the extent to which people behaviourally avoid social or personally challenging situations is associated with recall of

fewer specific memories (Debeer et al., 2011). It might be that heightened ruminative tendency is most associated with rAMS amongst avoidant people who have experienced an early trauma or when a person is primed to think that the cue words in the AMT may also cue the retrieval of painful memories from their past (Debeer et al., 2011). Similarly, it has been found that rAMS is associated with executive capacity limits and in particular, impaired cognitive inhibition, working memory capacity (the ability to update and maintain information in working memory) and verbal fluency (Sumner, 2012; Takano, Gutenbrunner, et al., 2017). It might be possible that executive capacity limits and ruminative tendencies exacerbate one another and together, worsen memory specificity.

There are potentially important implications for our null findings regarding the sub-factors of rumination. We might have expected that rAMS would be particularly associated with brooding and not reflection. This is because the definition of brooding is more in line with the assumptions of the CaRFAX model – that rumination characterized by repetitive, unconstructive, thinking about one's self contributes towards rAMS. However, we found no evidence that AMS was associated with self-reports of either brooding or reflective tendencies. This finding could be due to the size of the overall effect when considering the broader construct of rumination. It may be that when a smaller sample of studies is considered, as in our analyses of brooding and reflection, that the effect size becomes even smaller. It is also possible that a rumination-rAMS association might have been found with better measures of rumination and perhaps also these subfactors. Some empirical studies are not consistent with the reflection-brooding distinction and suggest that the reflection items of the RRS do not form a cohesive factor (Griffith & Raes, 2015). Clarification of this issue might require better tools for measuring trait rumination than the questionnaires sampled in this meta-analysis.

Finally, we found no evidence that self-reported depressive symptoms or the presence of participants with clinical diagnoses within a given study was associated with differences between studies in the AMS and rumination correlation. This finding contrasts with other studies that suggest that heightened rumination may be particularly associated with reduced memory specificity amongst participants who are highly depressed (Smets et al., 2013). It is possible that the studies which reported the correlation between rumination and specificity, and so those studies which were included in the present analysis, had insufficient variability in depressive symptoms or included too few participants with clinical diagnoses for these variables to explain sufficient variance in between-study effect sizes. In line with this, it could be that any association between emotional pathology and rAMS and rumination may only be present among participants who meet criteria for clinical diagnoses (Raes, Hermans, Williams, & Eelen, 2007) therefore considering depression continuously and considering the proportion of clinical participants within a study might not be sufficient for exploring these effects.

It is important to note that some studies were excluded despite having measured both trait rumination and AMS, because they did not report the correlation coefficient or they reported the correlation with general/categorical memories instead of specific memories. As mentioned before, evidence suggests that rAMS is best operationalised as having fewer specific memories rather than as increased recall of general memories (Griffith et al., 2009, 2012; Heron et al., 2012; Takano, Gutenbrunner, et al., 2017). In order to facilitate future meta-analyses in this area, we recommend that future studies should report the number or proportion of specific memories recalled even if authors choose to focus their analyses on another aspect of AMT performance. We would also recommend that similar procedures be followed regarding the reporting of correlation coefficients. We also excluded several studies because they examined other aspects of memory specificity (e.g., specificity of memories

cued by trauma-related words) or used additional probing of memories within an interview format. These methodological differences would have contributed additional heterogeneity to the meta-analysis that would have impacted our overall analyses. We would have been unable to examine their moderating influence in our main analysis as these methodological techniques are not sufficiently common within the literature. In the future when more such studies have been published, an analysis of these studies might be possible.

In conclusion, we performed a broad meta-analysis on existing literature regarding correlations between individual differences in trait rumination and the number of specific memories recalled in the AMT. We found a very weak, non-significant, effect size for the association between memory specificity and rumination and the likelihood for future studies to produce a significant correlation was found to be small. Also, despite marked heterogeneity between published studies, this was not moderated by severity of depressive symptoms or clinical populations. We suggest that future studies should direct their focus towards examining whether self-focused concerns or state rumination might be related to rAMS and to further test other aspects of the CaRFAX model by examining whether an individual's avoidance tendencies and executive capacity limits contribute more towards rAMS than rumination.

Author Contributions, Conflicts of Interest and Disclosures

TJB, JWG, BL, FR and DH developed the idea for the meta-analysis and decided on the

search strategy and inclusion/exclusion criteria, CPYC gathered and processed the data, TJB

analysed the data, CPYC and TJB prepared the first draft of the manuscript and JWG, BL, FR

and DH reviewed and edited subsequent drafts.

The authors have no financial disclosures or conflicts of interest. The research was conducted

independently of any funding arrangement.

References

Arie, M., Apter, A., Orbach, I., Yefet, Y., & Zalzman, G. (2008). Autobiographical memory,

interpersonal problem solving, and suicidal behavior in adolescent inpatients.

Comprehensive Psychiatry, *49*(1), 22–29.

https://doi.org/10.1016/j.comppsych.2007.07.004

Barry, T. J., Lenaert, B., Hermans, D., Raes, F., & Griffith, J. W. (2018). Meta-analysis of the

association between autobiographical memory specificity and exposure to trauma.

Journal of Traumatic Stress.

Beck, A., Steer, R., & Brown, G. (1996). Beck Depression Inventory-II. *San Antonio*, 12–15.

https://doi.org/10.1037/t00742-000

*Belcher, J., & Kangas, M. (2015). Autobiographical Memory and Imagining Future

Personal Events: Event Specificity and Symptoms of Depression and Stress Following

Exposure to an Analogue Trauma. *Stress and Health*, *31*(5), 419–431.

https://doi.org/10.1002/smi.2567

*Beyderman, I., & Young, M. A. (2016). Rumination and overgeneral autobiographical

memory as mediators of the relationship between attachment and depression.

Personality and Individual Differences, *98*, 37–41.

https://doi.org/10.1016/j.paid.2016.03.077

Borenstein, M., Higgins, J. P. T., Hedges, L. V., & Rothstein, H. R. (2017). Basics of meta-

analysis: I2 is not an absolute measure of heterogeneity. *Research Synthesis Methods*,

8(1), 5–18. https://doi.org/10.1002/jrsm.1230

*Brennan, K., Barnhofer, T., Crane, C., Duggan, D., & Williams, J. M. G. (2015). Memory

specificity and mindfulness jointly moderate the effect of reflective pondering on

depressive symptoms in individuals with a history of recurrent depression. *Journal of

Abnormal Psychology*, *124*(2), 246–255. https://doi.org/10.1037/abn0000027

Conway, M. A., & Pleydell-Pearce, C. W. (2000). The construction of autobiographical

memories in the self-memory system. *Psychological Review*, *107*(2), 261–288.

https://doi.org/10.1037/0033-295X.107.2.261

Conway, M., Csank, P. A. R., Holm, S. L., & Blake, C. K. (2000). On Assessing Individual

Differences in Rumination on Sadness. *Journal of Personality Assessment*, *75*(3), 404–

425. https://doi.org/10.1207/S15327752JPA7503_04

Crane, C., Barnhofer, T., Visser, C., Nightingale, H., & Williams, J. M. G. (2007). The

effects of analytical and experiential rumination on autobiographical memory specificity

in individuals with a history of major depression. *Behaviour Research and Therapy*,

45(12), 3077–3087. https://doi.org/10.1016/j.brat.2007.05.009

Crane, C., Barnhofer, T., & Williams, J. M. G. (2007). Cue self-relevance affects

autobiographical memory specificity in individuals with a history of major depression.

Memory, *15*(3), 312–323. https://doi.org/10.1080/09658210701256530

*Debeer, E., Hermans, D., & Raes, F. (2009). Associations between components of

rumination and autobiographical memory specificity as measured by a Minimal

Instructions Autobiographical Memory Test. *Memory (Hove, England)*, *17*(8), 892–903.

https://doi.org/10.1080/09658210903376243

Debeer, E., Raes, F., Williams, J. M. G., & Hermans, D. (2011). Context-dependent

activation of reduced autobiographical memory specificity as an avoidant coping style.

Emotion, *11*(6), 1500–1506. https://doi.org/10.1037/a0024535

Evans, J., Williams, J. M. G., O'loughlin, S., & Howells, K. (1992). Autobiographical

memory and problem-solving strategies of parasuicide patients. *Psychological Medicine*,

22(2), 399–405. https://doi.org/10.1017/S0033291700030348

Field, A. P., & Gillett, R. (2010). How to do a meta-analysis. *The British Journal of

Mathematical and Statistical Psychology*, *63*(Pt 3), 665–94.

https://doi.org/10.1348/000711010X502733

Goddard, L., Dritschel, B., & Burton, a. (1996). Role of autobiographical memory in social

problem solving and depression. *Journal of Abnormal Psychology*, *105*(4), 609–616.

https://doi.org/10.1037/0021-843X.105.4.609

Goddard, L., Dritschel, B., & Burton, a. (1997). Social problem solving and autobiographical

memory in non-clinical depression. *The British Journal of Clinical Psychology / the*

British Psychological Society, *36 (Pt 3)*, 449–451. https://doi.org/10.1037/0021-

843X.105.4.609

Griffith, J. W., & Raes, F. (2015). Factor structure of the Ruminative Responses Scale: A

community-sample study. *European Journal of Psychological Assessment*, *31*(4), 247–

253. https://doi.org/10.1027/1015-5759/a000231

Griffith, J. W., Sumner, J. A., Debeer, E., Raes, F., Hermans, D., Mineka, S., … Craske, M.

G. (2009). An item response theory/confirmatory factor analysis of the autobiographical

memory test. *Memory*, *17*(6), 609–623. https://doi.org/10.1080/09658210902939348

Griffith, J. W., Sumner, J. A., Raes, F., Barnhofer, T., Debeer, E., & Hermans, D. (2012).

Current psychometric and methodological issues in the measurement of overgeneral

autobiographical memory. *Journal of Behavior Therapy and Experimental Psychiatry*,

43(SUPPL. 1), 21–31. https://doi.org/10.1016/j.jbtep.2011.05.008

Hermans, D., Raes, F., & Eelen, P. (2005). Mood and memory: A cognitive psychology

perspective on maintenance of depressed mood and vulnerability for relapse. In J.

Corveleyn, P. Luyten, & S. J. Blatt (Eds.), *The Theory and Treatment of Depression:*

Towards a Dynamic Interactionism Model (pp. 43–66). Leuven, Belgium/Mahwah, NJ:

Leuven University Press/Lawrence Erlbaum Associates.

https://doi.org/10.4324/9780203763995

Hermans, D., Vandromme, H., Debeer, E., Raes, F., Demyttenaere, K., Brunfaut, E., &

Williams, J. M. G. (2008). Overgeneral autobiographical memory predicts diagnostic

status in depression. *Behaviour Research and Therapy*, *46*(5), 668–677.

https://doi.org/10.1016/j.brat.2008.01.018

Heron, J., Crane, C., Gunnell, D., Lewis, G., Evans, J., & Williams, J. M. G. (2012). 40,000

memories in young teenagers: Psychometric properties of the Autobiographical Memory

Test in a UK cohort study. *Memory*, *20*(3), 300–320.

https://doi.org/10.1080/09658211.2012.656846

Johnson, D. P., & Whisman, M. A. (2013). Gender differences in rumination: A meta-

analysis. *Personality and Individual Differences*, *55*(4), 367–374.

https://doi.org/10.1016/j.paid.2013.03.019

*Kleim, B., & Ehlers, A. (2008). Reduced autobiographical memory specificity predicts

depression and posttraumatic stress disorder after recent trauma. *Journal of Consulting

& Clinical Psychology*, *76*(2), 231–242. https://doi.org/10.1037/0022-006X.76.2.231

*Kyung, Y., Yanes-Lukin, P., & Roberts, J. E. (2016). Specificity and detail in

autobiographical memory: Same or different constructs? *Memory*, *24*(2), 272–284.

https://doi.org/10.1080/09658211.2014.1002411

Nolen-Hoeksema, S. (1998). The Other End of the Continuum: The Costs of Rumination.

Psychological Inquiry, *9*(3), 216–219. https://doi.org/10.1207/s15327965pli0903_5

Nolen-Hoeksema, S. (2000). The role of rumination in depressive disorders and mixed

anxiety/depressive symptoms. *Journal of Abnormal Psychology*, *109*(3), 504–511.

https://doi.org/10.1037/0021-843X.109.3.504

Nolen-Hoeksema, S., & Morrow, J. (1991). A prospective study of depression and

posttraumatic stress symptoms after a natural disaster: the 1989 Loma Prieta

Earthquake. *Journal of Personality and Social Psychology*, *61*(1), 115–121.

https://doi.org/10.1037/0022-3514.61.1.115

Ono, M., Devilly, G. J., & Shum, D. H. K. (2015). A meta-analytic review of overgeneral

memory: The role of trauma history, mood, and the presence of posttraumatic stress

disorder. *Psychological Trauma: Theory, Research, Practice, and Policy*, *8*(2), 157–

164. https://doi.org/http://dx.doi.org/10.1037/tra0000027

*Raes, F., Hermans, D., Williams, J. M. G., Beyers, W., Eelen, P., & Brunfaut, E. (2006).

Reduced autobiographical memory specificity and rumination in predicting the course of

depression. *Journal of Abnormal Psychology*, *115*(4), 699–704.

https://doi.org/10.1037/0021-843X.115.4.699

Raes, F., Hermans, D., Williams, J. M. G., Demyttenaere, K., Sabbe, B., Pieters, G., & Eelen,

P. (2005). Reduced specificity of autobiographical memory: A mediator between

rumination and ineffective social problem-solving in major depression? *Journal of

Affective Disorders*, *87*(2–3), 331–335. https://doi.org/10.1016/j.jad.2005.05.004

Raes, F., Hermans, D., Williams, J. M. G., & Eelen, P. (2007). A sentence completion

procedure as an alternative to the autobiographical memory test for assessing

overgeneral memory in non-clinical populations. *Memory*, *15*(5), 495–507.

https://doi.org/10.1080/09658210701390982

*Raes, F., Schoofs, H., Griffith, J. W., & Hermans, D. (2012). Rumination relates to reduced

autobiographical memory specificity in formerly depressed patients following a self-

discrepancy challenge: The case of autobiographical memory specificity reactivity.

Journal of Behavior Therapy and Experimental Psychiatry, *43*(4), 1002–1007.

https://doi.org/10.1016/j.jbtep.2012.03.003

Raes, F., Watkins, E. R., Williams, J. M. G., & Hermans, D. (2008). Non-ruminative

processing reduces overgeneral autobiographical memory retrieval in students.

Behaviour Research and Therapy, *46*(6), 748–756.

https://doi.org/10.1016/j.brat.2008.03.003

Raes, F., Williams, J. M. G., & Hermans, D. (2009). Reducing cognitive vulnerability to

    depression: A preliminary investigation of MEmory Specificity Training (MEST) in

    inpatients with depressive symptomatology. *Journal of Behavior Therapy and*

    Experimental Psychiatry, *40*(1), 24–38. https://doi.org/10.1016/j.jbtep.2008.03.001

*Ricarte, J. J., Hernández, J. V., Latorre, J. M., Danion, J. M., & Berna, F. (2014).

    Rumination and autobiographical memory impairment in patients with schizophrenia.

    Schizophrenia Research, *160*(1–3), 163–168.

    https://doi.org/10.1016/j.schres.2014.10.027

*Ricarte, J. J., Ros, L., Latorre, J. M., Muñoz, M. D., Aguilar, M. J., & Hernandez, J. V.

    (2016b). Role of anxiety and brooding in specificity of autobiographical recall.

    Scandinavian Journal of Psychology, *57*(6), 495–500.

    https://doi.org/10.1111/sjop.12323

*Ricarte, J., Ros, L., Serrano, J. P., Martínez-Lorca, M., & Latorre, J. M. (2016a). Age

    differences in rumination and autobiographical retrieval. *Aging and Mental Health*,

    20(10), 1063–1069. https://doi.org/10.1080/13607863.2015.1060944

*Ros, L., Latorre, J. M., Serrano, J. P., & Ricarte, J. J. (2017). Overgeneral autobiographical

    memory in healthy young and older adults: Differential age effects on components of the

    capture and rumination, functional avoidance, and impaired executive control

    (CaRFAX) model. *Psychology and Aging*, *32*(5), 447–459.

    https://doi.org/10.1037/pag0000175

Schönfeld, S., & Ehlers, A. (2006). Overgeneral memory extends to pictorial retrieval cues

    and correlates with cognitive features in posttraumatic stress disorder. *Emotion*

    (Washington, D.C.), *6*(4), 611–621. https://doi.org/10.1037/1528-3542.6.4.611

Smets, J., Griffith, J. W., Wessel, I., Walschaerts, D., & Raes, F. (2013). Depressive

    symptoms moderate the effects of a self-discrepancy induction on overgeneral

autobiographical memory. *Memory*, *21*(6), 751–761.

https://doi.org/10.1080/09658211.2012.756039

*Smets, J., Wessel, I., & Raes, F. (2014). Reduced autobiographical memory specificity

relates to weak resistance to proactive interference. *Journal of Behavior Therapy and*

Experimental Psychiatry, *45*(2), 234–241. https://doi.org/10.1016/j.jbtep.2013.11.002

Spasojevic, J., & Alloy, L. B. (2001). Rumination as a common mechanism relating

depressive risk factors to depression. *Emotion*, *1*(1), 25–37.

https://doi.org/10.1037//1528-3542.1.1.25

Spinhoven, P., Bamelis, L., Molendijk, M., Haringsma, R., & Arntz, A. (2009). Reduced

Specificity of Autobiographical Memory in Cluster C Personality Disorders and the

Role of Depression, Worry, and Experiential Avoidance. *Journal of Abnormal*

Psychology, *118*(3), 520–530. https://doi.org/10.1037/a0016393

Sumner, J. A. (2012). The mechanisms underlying overgeneral autobiographical memory: An

evaluative review of evidence for the CaR-FA-X model. *Clinical Psychology Review*,

32(1), 34–48. https://doi.org/10.1016/j.cpr.2011.10.003

Sumner, J. A., Griffith, J. W., & Mineka, S. (2010). Overgeneral autobiographical memory as

a predictor of the course of depression: A meta-analysis. *Behaviour Research and*

Therapy, *48*(7), 614–625. https://doi.org/10.1016/j.brat.2010.03.013

*Sumner, J. A., Mineka, S., Adam, E. K., Craske, M. G., Vrshek-schallhorn, S., Wolitzky-

taylor, K., & Zinbarg, R. E. (2014). Testing the CaR – FA – X Model : Investigating the

Mechanisms Underlying Reduced Autobiographical Memory Specificity in Individuals

With and Without a History of Depression, *123*(3), 471–486.

Sutherland, K., & Bryant, R. A. (2007). Rumination and overgeneral autobiographical

memory. *Behaviour Research and Therapy*, *45*(10), 2407–2416.

https://doi.org/10.1016/j.brat.2007.03.018

Sutherland, K., & Bryant, R. A. (2008). Social problem solving and autobiographical

memory in posttraumatic stress disorder. *Behaviour Research and Therapy*, *46*(1), 154–

161. https://doi.org/10.1016/j.brat.2007.10.005

Takano, K., Gutenbrunner, C., Martens, K., Salmon, K., & Raes, F. (2017). Computerized

Scoring Algorithms for the Autobiographical Memory Test. *Psychological Assessment*,

No-Specified. https://doi.org/10.1037/pas0000472

*Takano, K., Mori, M., Nishiguchi, Y., Moriya, J., & Raes, F. (2017). Psychometric

properties of the written version of the autobiographical memory test in a japanese

community sample. *Psychiatry Research*, *248*(December 2016), 56–63.

https://doi.org/10.1016/j.psychres.2016.12.019

Treynor, W., Gonzalez, R., & Nolen-Hoeksema, S. (2003). Rumination reconsidered: A

psychometric analysis. *Cognitive Therapy and Research*, *27*(3), 247–259.

https://doi.org/10.1023/A:1023910315561

*Van Den Broeck, K., Claes, L., Pieters, G., & Raes, F. (2012). Memory specificity in

borderline personality disorder: Associations with depression and self-discrepancy.

Journal of Behavior Therapy and Experimental Psychiatry, *43*(SUPPL. 1), S51–S59.

https://doi.org/10.1016/j.jbtep.2011.02.001

Van Vreeswijk, M. F., & De Wilde, E. J. (2004). Autobiographical memory specificity,

psychopathology, depressed mood and the use of the Autobiographical Memory Test: A

meta-analysis. *Behaviour Research and Therapy*, *42*(6), 731–743.

https://doi.org/10.1016/S0005-7967(03)00194-3

Vevea, J. L., & Woods, C. M. (2005). Publication bias in research synthesis: sensitivity

analysis using a priori weight functions. *Psychological Methods*, *10*(4), 428–443.

https://doi.org/10.1037/1082-989X.10.4.428

Watkins, E. R. (2008). Constructive and unconstructive repetitive thought. *Psychological*

Bulletin, *134*(2), 163–206. https://doi.org/10.1037/0033-2909.134.2.163

Watkins, E. R., Moberly, N. J., & Moulds, M. L. (2008). Processing Mode Causally

Influences Emotional Reactivity: Distinct Effects of Abstract Versus Concrete Construal

on Emotional Response. *Emotion*, *8*(3), 364–378. https://doi.org/10.1037/1528-

3542.8.3.364

Watkins, E. R., Mullan, E., Wingrove, J., Rimes, K., Steiner, H., Bathurst, N., … Scott, J.

(2011). Rumination-focused cognitive-behavioural therapy for residual depression:

Phase II randomised controlled trial. *British Journal of Psychiatry*, *199*(4), 317–322.

https://doi.org/10.1192/bjp.bp.110.090282

Wessel, I., Merckelbach, H., & Dekkers, T. (2002). Autobiographical memory specificity,

intrusive memory, and general memory skills in Dutch-Indonesian survivors of the

World War II Era. *Journal of Traumatic Stress*, *15*(3), 227–234.

https://doi.org/10.1023/A:1015207428675

Williams, J. M. G. (2006). Capture and rumination, functional avoidance, and executive

control (CaRFAX): Three processes that underlie overgeneral memory. *Cognition and

Emotion*. https://doi.org/10.1080/02699930500450465

Williams, J. M. G., Barnhofer, T., Crane, C., Herman, D., Raes, F., Watkins, E., & Dalgleish,

T. (2007). Autobiographical memory specificity and emotional disorder. *Psychological

Bulletin*, *133*(1), 122–148. https://doi.org/10.1037/0033-2909.133.1.122

Williams, J. M. G., & Broadbent, K. (1986). Autobiographical memory in suicide attempters.

Journal of Abnormal Psychology, *95*(2), 144–149. https://doi.org/10.1037/0021-

843X.95.2.144

*Yanes, P. K., Morse, G., Hsiao, C. Bin, Simms, L., & Roberts, J. E. (2012).

Autobiographical memory specificity and the persistence of depressive symptoms in

HIV-positive patients: Rumination and social problem-solving skills as mediators.

Cognition and Emotion, *26*(8), 1496–1507.

https://doi.org/10.1080/02699931.2012.665028

Table 1. Sample characteristics.

	Rumination	Brooding	Reflection
k	17	15	8
N	2756	2044	1064
Mean Age	33.46(13.19)	34.40(16.43)	34.62(16.44)
Mean percentage of Females	58.49%(21.2)	64.53%(19.2)	60.71%(25.9)
Mean percentage with depression	26.51%(42.9)	22.27%(41.2)	12.5%(35.4)
Mean percentage with any diagnosis	37.61%(48.4)	28.93%(45.2)	25%(46.29)
Measures			
RRS-10	2	4	0
RRS-22	11	8	8
RRS-B	0	5	0
RRS/RSS composite	1	0	0
VARS	2	0	0
RIS	1	0	0

Note. Study characteristics: RRS-10/RRS-22/RRS-B: Ruminative Response Scale, 10-item, 22-item and brooding sub-factor versions; RSS: Rumination on Sadness; VARS: Visual Analogue Rumination Scale; RIS: Response to Intrusions. Values given in parentheses are standard deviations.

Figure 1. Study inclusion and exclusion flow chart.


```
┌─────────────────────────────────────────┐
│ 1173 studies identified from database search │
└─────────────────────────────────────────┘
                    │
                    │────────────────────────▶ ┌──────────────────────────┐
                    │                           │ 118 duplicates removed    │
                    │                           └──────────────────────────┘
                    ▼
┌─────────────────────────────────────────┐
│ 1055 studies screened (title/abstract)   │
└─────────────────────────────────────────┘
                    │
                    │                           ┌──────────────────────────────────┐
                    │                           │ 955 excluded                      │
                    │────────────────────────▶  │    915 not relevant (title)       │
                    │                           │    29 not relevant (abstract)     │
                    │                           │    11 unable to source/not English│
                    ▼                           └──────────────────────────────────┘
┌─────────────────────────────────────────┐
│ 100 studies screened (full text)         │
└─────────────────────────────────────────┘
                    │
                    │                           ┌──────────────────────────────────────────┐
                    │                           │ 83 excluded                                │
                    │                           │    33 no measure of trait rumination       │
                    │                           │    17 no or atypical AMT used              │
                    │────────────────────────▶  │    5 both of the above                      │
                    │                           │    19 insufficient data (e.g., r coefficients)│
                    │                           │    8 review paper                          │
                    │                           │    3 alternate analysis of data already included│
                    ▼                           └──────────────────────────────────────────┘
┌─────────────────────────────────────────┐
│ 17 studies included                       │
│    17 effect sizes (corr. with rumination)│
│    15 effect sizes (corr. with brooding)  │
│    8 effect sizes (corr. with reflection) │
└─────────────────────────────────────────┘
```

Note. Study selection and exclusion flow chart (corr. = correlation; AMT = Autobiographical Memory Test).

Figure 2. Funnel plots.
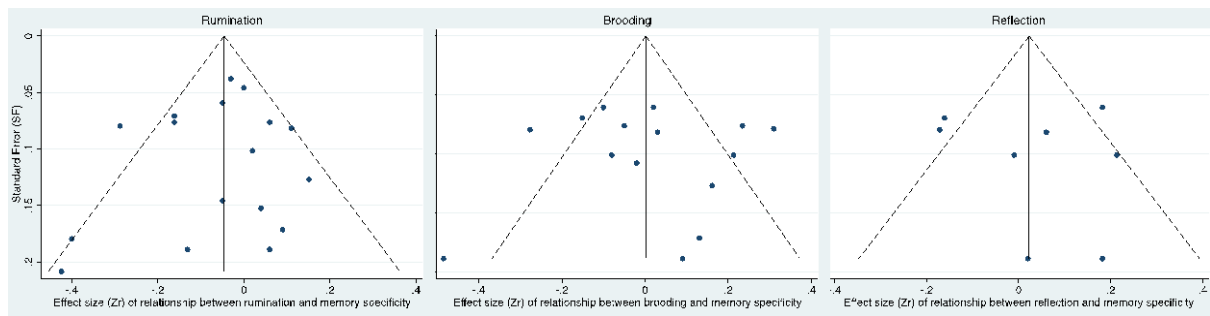
Note. Funnel plots of effect sizes (*Zr*) of three rumination variables (from left to right:

general rumination, brooding, reflection) and their correlation with memory specificity,

against the Standard Error (SE) for each effect size.

Figure 3. Forest plot – rumination.
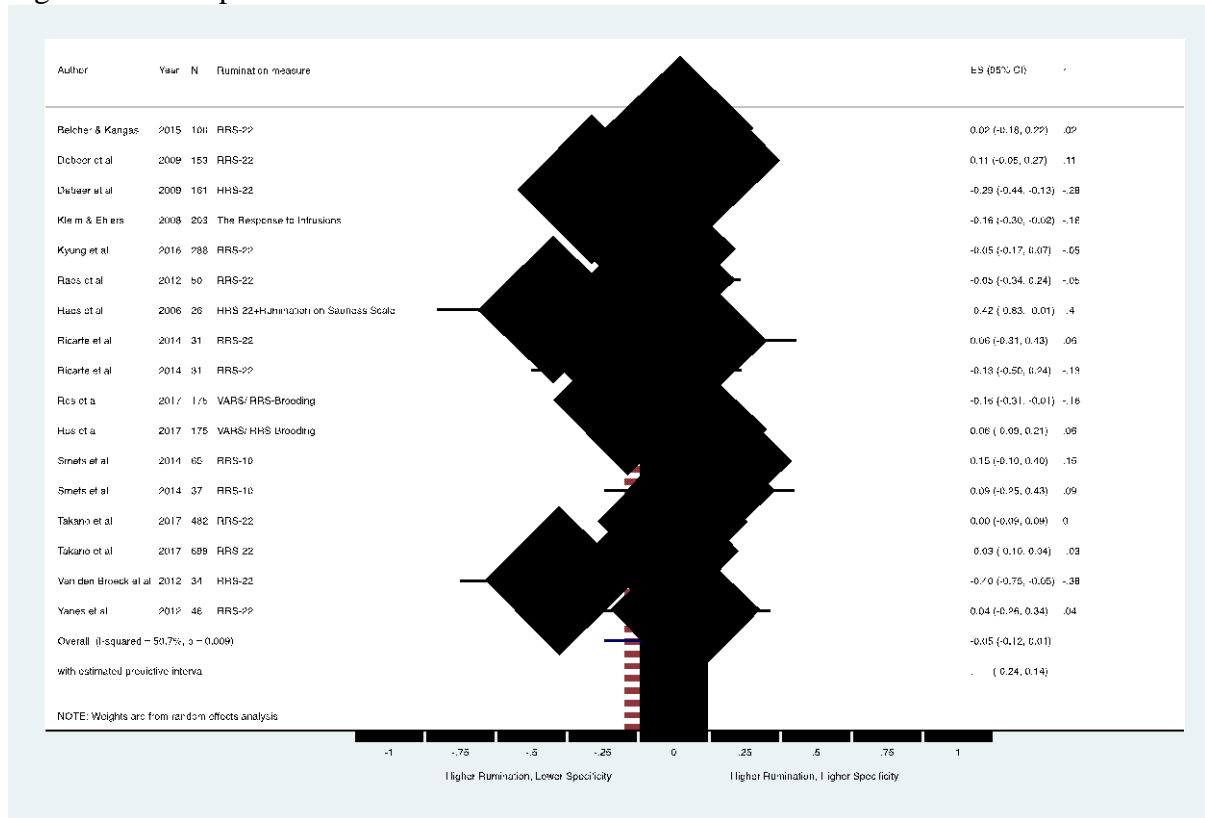
Note. Forest plot of effect sizes (ES; *Zr*), with confidence intervals (CI), of the relation

between rumination and memory specificity.

Figure 4. Forest plot – brooding.

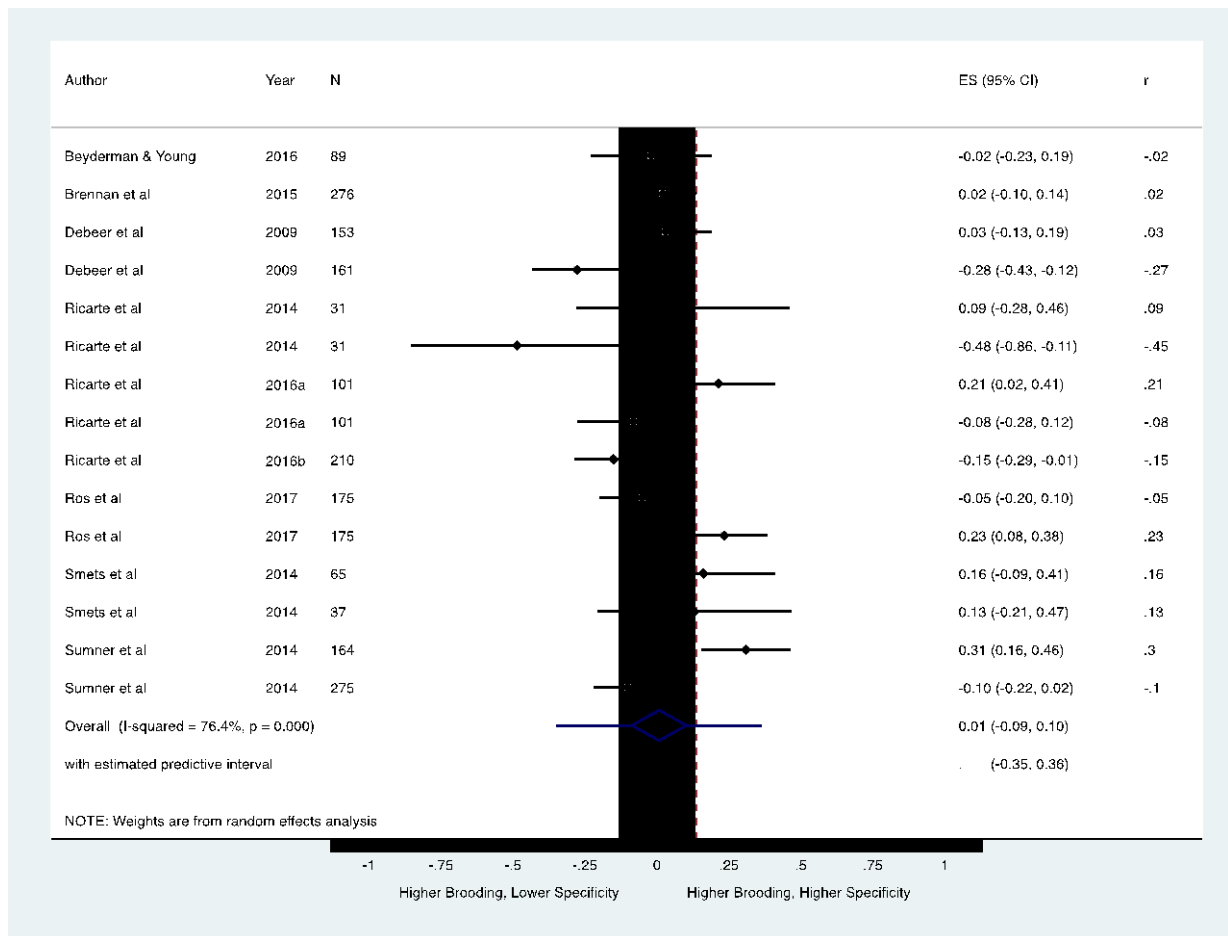| Author	Year	N		ES (95% CI)	r
Beyderman & Young	2016	89		-0.02 (-0.23, 0.19)	-.02
Brennan et al	2015	276		0.02 (-0.10, 0.14)	.02
Debeer et al	2009	153		0.03 (-0.13, 0.19)	.03
Debeer et al	2009	161		-0.28 (-0.43, -0.12)	-.27
Ricarte et al	2014	31		0.09 (-0.28, 0.46)	.09
Ricarte et al	2014	31		-0.48 (-0.86, -0.11)	-.45
Ricarte et al	2016a	101		0.21 (0.02, 0.41)	.21
Ricarte et al	2016a	101		-0.08 (-0.28, 0.12)	-.08
Ricarte et al	2016b	210		-0.15 (-0.29, -0.01)	-.15
Ros et al	2017	175		-0.05 (-0.20, 0.10)	-.05
Ros et al	2017	175		0.23 (0.08, 0.38)	.23
Smets et al	2014	65		0.16 (-0.09, 0.41)	.16
Smets et al	2014	37		0.13 (-0.21, 0.47)	.13
Sumner et al	2014	164		0.31 (0.16, 0.46)	.3
Sumner et al	2014	275		-0.10 (-0.22, 0.02)	-.1
Overall (I-squared = 76.4%, p = 0.000)				0.01 (-0.09, 0.10)	
with estimated predictive interval				(-0.35, 0.36)	

NOTE: Weights are from random effects analysis

Higher Brooding, Lower Specificity   Higher Brooding, Higher Specificity

Note. Forest plot of effect sizes (ES; Zr), with confidence intervals (CI), of the relation between brooding and memory specificity.

Figure 5. Forest plot – reflection.

Author	Year	N		ES (95% CI)	r
Brennan et al	2015	276		0.18 (0.06, 0.30)	.18
Deboer et al	2009	153		0.06 (-0.10, 0.22)	.06
Deboer et al	2009	161		-0.17 (-0.33, -0.02)	-.17
Ricarte et al	2014	31		0.02 (-0.35, 0.39)	.02
Ricarte et al	2014	31		0.18 (-0.19, 0.55)	.18
Ricarte et al	2016a	101		0.21 (0.02, 0.41)	.21
Ricarte et al	2016a	101		-0.01 (-0.21, 0.19)	-.01
Ricarte et al	2016b	210		-0.16 (-0.30, -0.03)	-.16
Overall (I-squared = 71.4%, p = 0.001)				0.03 (-0.09, 0.15)	
with estimated predictive interval				(-0.35, 0.41)	

NOTE: Weights are from random effects analysis

-1   -.75   -.5   -.25   0   .25   .5   .75   1

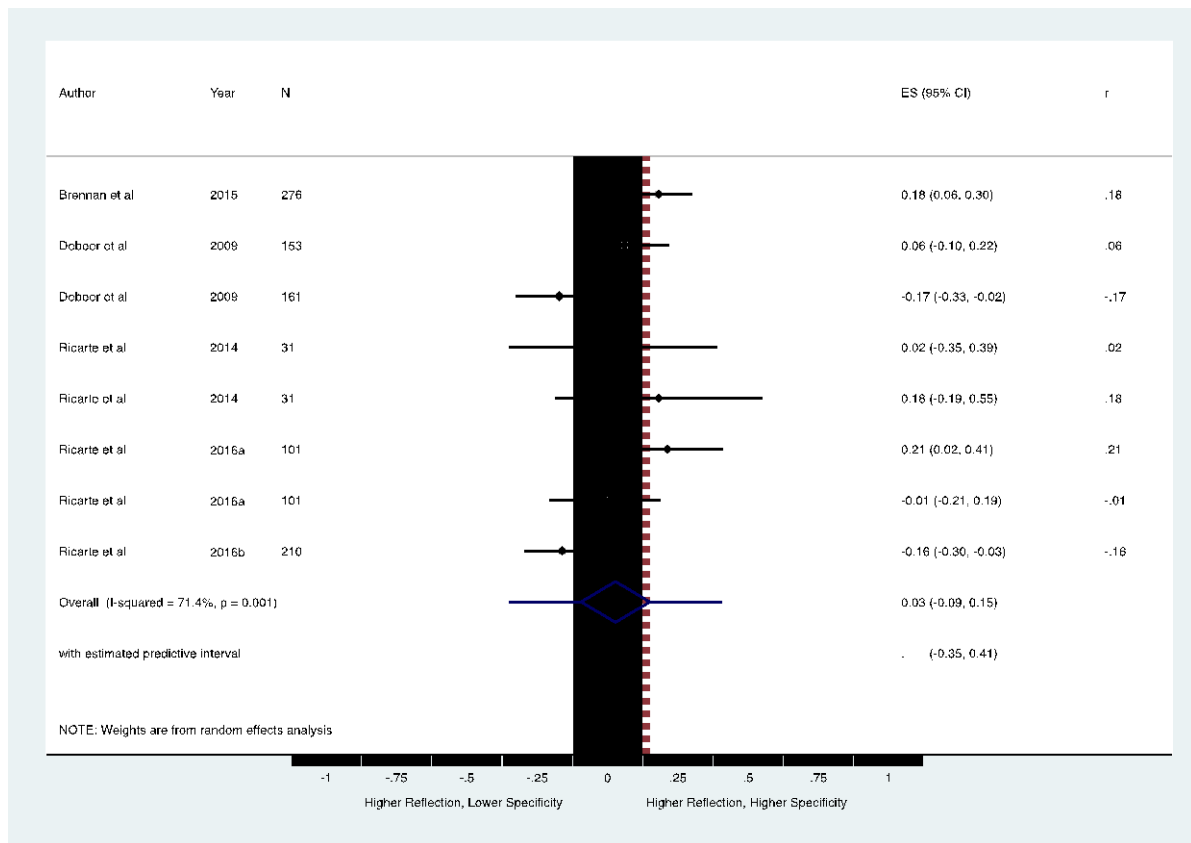Higher Reflection, Lower Specificity   Higher Reflection, Higher Specificity

Note. Forest plot of effect sizes (ES; *Zr*), with confidence intervals (CI), of the relation between reflection and memory specificity.