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Rumination and Eating Disorder Psychopathology: A Meta-Analysis

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Abstract

Rumination is a cognitive process involving repetitive thoughts about negative experiences and emotions and is associated with psychopathology. Rumination has been implicated in mood and anxiety disorders, and there is a growing body of research on rumination in relation to eating disorder (ED) psychopathology. The current meta-analytic review focused on the literature addressing rumination and ED psychopathology. A comprehensive search process identified 38 studies, which primarily used cross-sectional designs with non-clinical samples. Results demonstrated that rumination was concurrently (r=.33) and prospectively (r=.22-.23) associated with ED psychopathology, and that groups with ED psychopathology evidenced higher levels of rumination compared to non-ED control groups (g=.95), though no significant differences in rumination were observed when comparing anorexia nervosa to bulimia nervosa groups (g=.09). In addition, a narrative review of five experimental studies suggested that rumination in response to ED-related stimuli was related to increased negative affect and negative body-related cognitions across clinical and non-clinical samples. The type of rumination and sample population emerged as moderators of effect sizes, such that larger effects were observed among samples using ED-specific measures of rumination and heterogeneous samples compared to only non-clinical samples. Taken together, this literature demonstrates that rumination is a salient process in ED psychopathology, though the literature is characterized by methodological limitations and the need for more fully elaborated theories on the role of rumination in EDs. Findings are discussed in the

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Contributors

Authors KS, TM, and JL collaboratively conceptualized and designed this meta-analysis. Authors KS and TM conducted the literature search and screening. Authors KS and JL independently coded all studies. Primary analyses were conducted by author KS and reliability analyses were conducted by author TM. Authors KS and JL wrote the first draft of the manuscript, and all authors contributed to and have approved the final manuscript.

Conflict of Interest

All authors declare that they have no conflicts of interest.

context of existing models of rumination and ED psychopathology, with suggestions for future research in this area.

Keywords

Rumination; eating disorders; anorexia nervosa; bulimia nervosa; binge eating; body dissatisfaction

1. Introduction

Eating disorders (EDs) are serious mental illnesses that are characterized by disturbances in eating-related behavior. Three primary EDs are specified in the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5; American Psychiatric Association [APA], 2013). Anorexia Nervosa (AN) is defined by significantly low body weight and body image disturbances. Bulimia Nervosa (BN) is characterized by recurrent episodes of binge eating (i.e., consuming an unusually large amount of food with a concurrent sense of loss of control over eating) and inappropriate compensatory behaviors (e.g., purging, excessive exercise), as well as body shape/weight overvaluation. Binge Eating Disorder (BED) is defined by recurrent episodes of binge eating associated with marked distress in the absence of recurrent inappropriate compensatory behaviors. Importantly, EDs are associated with a number of medical complications, elevated mortality, and various psychiatric comorbidities, as well as elevated functional impairment and reduced quality of life (e.g., Crow et al., 2009; Hudson, Hiripi, Pope, & Kessler, 2007; Jenkins, Hoste, Meyer, & Blissett, 2011; Mitchell & Crow, 2006; Tchanturia et al., 2013).

Of note, evidence suggests that many individuals with clinically significant ED psychopathology do not meet formal criteria for a specific ED, though individuals with subthreshold EDs often exhibit a degree of severity that is comparable to those will full threshold EDs (Thomas, Vartanian, & Brownell, 2009). It is also notable that many of the cognitive and behavioral features of ED psychopathology, such as body dissatisfaction and binge eating, are not uncommon among non-clinical and community samples (Hudson et al., 2007; Luce, Crowther, & Pole, 2008; Lavender, De Young, & Anderson, 2011).

A number of factors have been examined in research on the development and/or maintenance of ED psychopathology, which have been described in several recent reviews. For example, in a review and synthesis of biopsychosocial variables in relation to EDs, Culbert, Racine, and Klump (2015) found that sociocultural factors (e.g., thin-ideal internalization, thinness expectancies) and personality variables (e.g., perfectionism, negative emotionality, negative urgency) emerged as risk factors for the onset of disordered eating. Additional variables were identified as correlates of disordered eating and/or EDs, such as hormonal influences, neurocognitive functioning, and neurobiological factors. Furthermore, recently proposed models of ED psychopathology incorporate many of these variables. For instance, Pearson, Wonderlich, and Smith (2015) describe a risk and maintenance model of BN emphasizing interactions between trait-oriented factors (e.g., negative urgency) and state-oriented factors (e.g., self-control depletion).

Notably, many existing psychological interventions for ED psychopathology are based on theoretical or treatment models that incorporate one or more of these identified risk and/or maintenance factors. However, despite ongoing advances in understanding the nature, onset, and maintenance of EDs, even those treatments with the strongest empirical support are only partially effective (Mitchell, Agras, & Wonderlich, 2007; Watson & Bulik, 2013). Thus, there remains a need for additional research on other constructs, and in particular those which are modifiable, that may play an important role in ED psychopathology. One such variable that has received extensive attention in research on other forms of psychopathology, but has received comparatively limited attention in the ED literature, is rumination.

1.1. Rumination

Rumination refers to the cognitive process in which one repetitively and passively focuses on the meaning, causes, and consequences of negative emotions (Nolen-Hoeksema 1991, Nolen-Hoeksema et al., 2008). Perhaps most importantly, ruminative processes demonstrate a pernicious, amplifying cycle in which negative affect and rumination reciprocally aggravate each other over time (Moberly & Watkins, 2008). That is, rumination leads to negative mood states, which in turn lead to increases in mood-congruent cognitions and repetitive thought (i.e., rumination), which further exacerbates negative mood. In addition, rumination has been conceptualized as a form of maladaptive emotion regulation (Aldao, Nolen-Hoeksema, & Schweizer, 2010; McLaughlin et al., 2011). That is, although rumination is negatively related to effective problem-solving (Hong, 2007), individuals often have positive beliefs about rumination (i.e., that repetitive focus on the causes and consequences of emotions will help one to understand and solve problems; Papageorgiou & Wells, 2003).

While rumination is often conceptualized as a unidimensional construct, several subtypes have been identified by previous research (Olatunji, Naragon-Gainey, & Wolitzky-Taylor, 2013), most notably the two subtypes based on factor analysis of the Ruminative Response Scale (RRS; Nolen-Hoeksema & Morrow, 1991): brooding and reflection (Treynor, Gonzalez, & Nolen-Hoeksema, 2003). Brooding refers to passive, abstract thought about negative themes, whereas reflection refers to contemplative, intentional pondering with a focus on problem-solving. In general, ruminative brooding has been implicated as the more maladaptive form of rumination, as it is associated with increased risk of the development of depression (e.g., Burwell & Shirk, 2007; Schoofs, Hermans, & Raes, 2010).

Although rumination is often correlated with other perseverative cognitions, such as worry and obsessions, it is distinct from worry in time orientation (i.e., past vs. future), content themes (i.e., loss, meaning, and self-worth vs. threat), degree of certainty and control (i.e., certain and uncontrollable vs. uncertain and controllable), and motives (i.e., gaining insight vs. threat anticipation; Nolen-Hoeksema et al. 2008). In addition, obsessions are typically resisted, future-oriented, and perceived as unacceptable (Turner, Beidel, & Stanley, 1992), whereas ruminative thoughts are often perceived as rational and may be associated with positive beliefs.

1.2. Correlates and Sequelae of Rumination

Rumination is broadly associated with a range of negative psychosocial outcomes and several forms of psychopathology. There is evidence that individuals who ruminate have difficulty problem-solving (Lyubomirsky & Nolen-Hoeksema, 1995; Lyubomirsky, Tucker, Caldwell, & Berg, 1999) and engaging in instrumental behavior (Lyubomirsky & Nolen-Hoeksema, 1993). Rumination is also associated with reduced social support (Nolen-Hoeksema & Davis 1999) and higher levels of interpersonal problems (Spasojevic & Alloy, 2001), which may be related to isolative tendencies or repeated discussion of negative feelings with others.

While rumination has been studied most extensively in the onset, maintenance, and exacerbation of depressive symptomatology, it has been implicated in several other types of psychopathology (see Aldao et al., 2010; Ehring & Watkins, 2008). In particular, there has been a growing body of research examining rumination in the context of anxiety and substance use, and most recently in EDs (Aldao et al., 2010). Similar to studies of rumination in depression, evidence suggests that rumination has an amplifying effect on negative emotions and maladaptive behaviors in other diagnostic groups (Caselli et al., 2010; Nolen-Hoeksema, Stice, Wade, & Bohon, 2007; Selby, Kranzler, Panza, & Fehling, 2016). This was supported by a previous meta-analysis that examined associations between emotion regulation strategies and four types of psychopathology (i.e., depression, anxiety, substance use disorders, and EDs), which found the association between psychopathology and rumination was strongest compared to other emotion regulation strategies (Aldao et al., 2010). Furthermore, rumination was significantly correlated with each type of psychopathology (depression: r=.55; anxiety: r=.42; substance use: r=.21; EDs: r=.26), though the latter two effects were based on a smaller number of studies (k=7, k=3, respectively; Aldao et al., 2010).

1.3. Models of Rumination

Theoretical models have adopted both trait- and state-based conceptualizations of rumination. Response Styles Theory (Nolen-Hoeksema, 1991, Nolen-Hoeksema et al., 2008) conceptualize rumination as a stable, trait-like pattern of maladaptive responding to emotional distress. In an extension of this theory, Nolen-Hoeksema and Watkins (2011) developed a transdiagnostic model that identifies rumination as a proximal risk factor that may lead to multiple disorders (i.e., multifinality), as well as other moderating factors that influence the development of a specific set of symptoms over others (i.e., divergent trajectories). Alternatively, Control Theory (Martin & Tesser, 1989, 1996) offers a state-based account of rumination, in that discrepancies between one's actual situation and desired goals trigger negative self-focus and repetitive thought (i.e., state rumination) that persists until one resolves the discrepancy or abandons the goal.

While informed by Nolen-Hoeksema's (1991) model, the Emotional Cascade Model (Selby et al, 2008; Selby & Joiner, 2009) elucidates momentary processes by which state rumination contributes to dysregulated behaviors, specifically among impulsive individuals. Via the process of an "emotional cascade," momentary negative affect and rumination lead to progressive, exponential, and reciprocal increases in each other over time; ultimately,

individuals may engage in dysregulated, maladaptive behaviors as a means of distraction from emotional distress in order to “short-circuit” the cascade (Selby et al., 2008; Selby & Joiner, 2009).

Finally, drawing from the habit-goal literature, a more recent conceptualization by Watkins and Nolen-Hoeksema (2014) proposed rumination as a mental habit, bridging state- and trait-based conceptualizations. That is, if one consistently engages in passive abstract, repetitive thought in response to goal discrepancies, an association is formed between negative affect and rumination. Thus, via classical conditioning processes, over time negative affect can trigger rumination even in the absence of a goal discrepancy, and thus rumination can evolve into a trait-like habitual response to negative affect. This model also suggests that developmental risk factors may predispose one to develop habitual rumination, including learned passivity and exposure to stressful events (Watkins & Nolen-Hoeksema, 2014).

1.4. ED-Specific Rumination

Several studies have also focused on rumination in which the content of thoughts are specific to ED-related psychopathology (Cowdrey & Park, 2011, 2012; Mezulis, Abramson, & Hyde, 2002; Seidel et al., 2016), and a measure has been developed assessing the construct of ED-specific rumination. Based on the original RRS, the Ruminative Response Scale for Eating Disorders (RRS-ED; Cowdrey & Park, 2011) contains two subscales (i.e., brooding and reflection; similar to the RRS) that aim to capture distinct qualities of rumination among individuals with EDs. Specifically, the measure asks participants to indicate what they would generally do when they are concerned about controlling their eating, weight and shape, such as “think ‘why can’t I handle my eating better?’” and “think about a recent meal time wishing it had gone better.” The RRS-ED, particularly the brooding subscale, has demonstrated adequate internal consistency (brooding: α=.89; reflection: α=.63), test-retest reliability (brooding: r=.65; reflection: r=.48), and convergent validity, as evidenced by significant positive correlations with the Eating Disorder Examination-Questionnaire (EDE-Q; Fairburn & Cooper, 1993) and ED-related functional impairment (Cowdrey & Park, 2011). Notably, the RRS-ED brooding subscale was a better predictor of global ED symptoms than the original RRS, and demonstrated non-overlapping content with the EDE-Q.

1.5. The Present Meta-Analysis

Taken together, there is substantial theoretical and empirical evidence suggesting that rumination is a maladaptive cognitive process of relevance to various forms of psychopathology. Although an extensive body of literature has examined rumination in relationship to depression and anxiety (e.g., Olatunji, Naragon-Gainey, & Wolitzky-Taylor, 2013), relatively fewer studies have examined rumination in relation to ED psychopathology (Aldao et al., 2010). Nevertheless, extant theoretical (Nolen-Hoeksema & Watkins, 2011) and empirical evidence (Aldo et al., 2010) suggests rumination is a salient phenomenon among individuals with ED psychopathology and may have relevant clinical implications for this population. While there has been a growing number of studies of rumination in

relationship to ED psychopathology since the publication of Aldao et al. (2010), to date there has not been a systematic synthesis of this literature.

Therefore, the purpose of this meta-analysis is to provide a comprehensive quantitative review of existing research that has examined relationships between rumination and ED psychopathology, with the aim of informing future theoretical and empirical work in this area. To review this literature we conducted a meta-analysis of empirical studies assessing (1) cross-sectional and prospective relationships between rumination and ED psychopathology, (2) levels of rumination in groups with and without ED psychopathology, and (3) experimental designs assessing the influence of rumination on affect or ED-related constructs (e.g., body dissatisfaction). Based on prior research, we expected that rumination would be broadly related to ED psychopathology, both concurrently and prospectively, and that individuals with ED psychopathology would evidence higher levels of rumination compared to those without ED psychopathology. Given previous literature indicating there are important distinctions between rumination subtypes (i.e., brooding vs. reflection) and the potential relevance of disorder-specific measurement (i.e., general vs. ED-specific rumination constructs), we also sought to examine whether different rumination constructs and subtypes moderated the magnitude of effect sizes, with the expectation that brooding (conceptualized as more maladaptive form of rumination) and ED-specific rumination would be related to greater effect sizes.

2. Methods

2.1. Search Strategy

To conduct the meta-analytic review, PsycInfo and PubMed electronic databases were queried in January 2017 using the following search terms: “rumination” or “ruminat*”[1] adjacent to “eating disorder,” “disordered eating,” “anorexia,” “bulimia,” “binge,” “body image,” or “body dissatisfaction.” The search included all empirical articles as well as accessible unpublished theses/dissertations. Reference sections of identified articles were also searched for possible additional studies to include.

2.2. Study Selection

Figure 1 summarizes study selection. Inclusion criteria included availability of the study in the English language, inclusion of a measurement of rumination, and inclusion of a measurement of at least one domain related to ED psychopathology (including studies of body image dissatisfaction/overvaluation of weight/shape, as well as comparisons of groups with ED psychopathology compared to groups without ED psychopathology). Additional inclusion criteria for experimental studies were the inclusion of a control group and assessment of dependent variables following experimental inductions.[2] Review articles and case studies were excluded, as were articles that addressed the ED behavior of rumination (i.e., regurgitation).

[1]The “*” allows for the identification of terms that begin with the same stem but have multiple endings in the PsycINFO search engine.

[2]If experimental studies did not meet these criteria but reported correlation or group difference effects, these data were coded and included in the present meta-analysis.

Four unpublished dissertations were inaccessible and thus were not able to be screened. Notably, some studies appeared to have identical or overlapping samples (i.e., Cowdrey & Park, 2011, 2012; Kelly, 2012; Kelly, Lydeker, & Mazzeo, 2012). However, given that each of these studies were unique in at least one respect (e.g., differences in outcomes measures, statistical analyses, or subsamples), we included the unique data from each article. As depicted in Figure 1, the study selection process resulted in 38 articles that were included in the present review, four of which were unpublished theses/dissertations. Of these, 32 articles reported cross-sectional or prospective associations between rumination and ED psychopathology, 10 reported differences in rumination between groups with and without ED psychopathology, and 5 employed experimental designs.[3] However, the high degree of variability in methodology and outcome measures across the experimental studies precluded meta-analytic review; as such, we provide a narrative review of findings from these studies.

2.3. Data Collection

A coding form was created to extract descriptive and quantitative information from each study. Key coded variables are summarized in Table 1, which included (1) study level descriptors and sample characteristics and (2) required information to compute effect sizes, including specific measures of rumination, ED constructs, and groups. Authors KS and JL independently coded all studies, and reliability analyses were conducted by author TM. Acceptable agreement was found between the coders on categorical variables (κ=.84) and continuous variables (intra-class correlation coefficient = .99). Coders resolved any disagreements by discussion. We contacted authors of 21 articles when there was insufficient data to calculate some or all effect sizes from the study. Authors of 16 of these articles provided the necessary additional data.

2.4. Statistical Analyses

2.4.1. Overall Effect Sizes—First, overall effect sizes were computed for correlations and group differences. Effects for cross-sectional and prospective associations between ED psychopathology and rumination were assessed by zero-order Pearson's correlation coefficients (r), the magnitude of which was interpreted as small (.10), medium (.30), or large (.50); Cohen, 1992).[4] For group comparisons on levels of rumination, effect sizes were calculated as the standardized mean difference, Hedge's g, which is appropriate for small sample sizes (Hedges, 1981). Values of g were interpreted as small (.20), medium (.50), and large (.80) effects (Hedges, 1981). In order to ensure independence for each study in the overall analyses, each study could only contribute one effect size per comparison or association (Lipsey & Wilson, 2001). Thus, when studies reported multiple measures of the same construct (e.g., two measures of body dissatisfaction), these data were aggregated in effect size calculations.

For effects comprised of at least five studies, a random effects model was applied, which assumes that the variability in effects is due to both within-study sampling error and between-study variance (Hedges & Pigott, 2004; Lipsey & Wilson, 2001). The random

[3]Some studies included multiple types of effect sizes.
[4]If studies reported partial correlation coefficients, authors were contacted to obtain zero-order correlation coefficients. If no response was received or data were unavailable, these effects were not coded.

effects takes into account possible variations in study procedures and settings, and therefore findings are considered more generalizable (Lipsey & Wilson, 2001; Rosenthal, 1995). However, for effects consisting of less than five studies, a fixed effect model was applied due to considerations of statistical power (Jackson & Turner, 2017).

2.4.2. Heterogeneity—The Q and the I^2 statistics were used to assess the heterogeneity of overall effect size distributions. The Q statistic assesses the statistical significance of heterogeneity, while the I^2 statistic indicates the proportion of total variability in a set of effect sizes that is due to true between-study differences (Huedo-Medina, Sanchez-Meca, Marin-Martinez, & Botella, 2006). The I^2 statistic can be interpreted such that percentages of 25, 50, and 75 represent low, medium, and high degrees of between-study variability, respectively.

2.4.3. Meta-Regression—If the overall effect size was significant and showed large and significant heterogeneity in the observed effect size distribution (i.e., significant Q value and I^2 statistic ≥ 75%), random effects meta-regression using maximum likelihood procedures was considered to assess relationships between covariates (moderators) and effect sizes. Given that previous research has suggested at least ten studies for each covariate in meta-regression models (Bornstein, Hedges, Higgins, & Rothstein, 2009), meta-regression was only conducted for (1) overall correlations between rumination and any measure of ED psychopathology, and (2) overall group differences in rumination between ED groups compared to non-ED groups.

A two-step approach was applied to determine the most parsimonious meta-regression models. The following methodological variables and sample characteristics were first assessed as covariates at the univariate level: age, sex (percentage of female participants), ethnicity (percentage of Caucasian participants), body mass index (BMI), population (i.e., community, college/university, psychiatric, or mixed/other), publication status (i.e., published vs. not published). Those that were significant predictors of effect the size ($p<.05$) at the univariate level were retained and added to the final model along with the two a-priori hypothesized moderators of effect sizes: rumination construct (i.e., general vs. ED-specific) and subtype[5] (i.e., overall composite measure, brooding, or reflection). Comprehensive Meta-Analysis Version 3.0 (Borenstein, Hedges, Higgins, & Rothstein, 2014) and SPSS version 24.0 were used to conduct statistical analyses.

2.5. Publication Bias

To minimize possible publication bias (i.e., the file drawer problem) we included both published articles and unpublished theses/dissertations in our literature search. The presence of publication bias was also evaluated quantitatively to determine whether it was likely that the publication of only significant results accounted for the observed findings. This was done by calculating the fail-safe N for each overall effect size, which is the number of studies with an effect of 0 that would reduce an observed effect to a non-significant level (Rosenthal, 1979).

[5]Other subtypes (e.g., co-rumination) were excluded due to the small number of effects.

3. Results

3.1. Sample Characteristics

The 38 studies consisted of 42 unique samples. Of these, 17 were college/university samples, 10 were community samples, 12 were other/mixed (e.g., comprised of both psychiatric and community samples), and 3 were drawn from psychiatric settings. Sample sizes ranged from 18 to 780 (M=236.88, SD=197.29). The mean sample age was 22.17 years (SD=7.56), and the mean sample BMI was 24.00 (SD=4.89). Samples were mostly female (87.70%) and Caucasian (70.87%). Ten samples included groups with current ED diagnoses. There was wide variability in self-report measures used to assess rumination in the reviewed studies, but the Ruminative Responses Scale (Nolen-Hoeksema & Morrow, 1991) was the most common.

3.2. Associations between Rumination and ED Psychopathology

3.2.1. Cross-Sectional Associations—Table 2 displays results for cross-sectional and prospective associations between rumination and ED psychopathology (see Supplementary Table 1 for full list of the individual effects). The overall effect size for concurrent relationships between rumination and measures of ED psychopathology was medium (r=.33), with large and significant heterogeneity in the effect size distribution. With respect to specific ED constructs, effect sizes were small to medium for restraint/restriction (r=.17) and binge eating/bulimic symptoms (r=.22), and medium to large for body dissatisfaction/overvaluation of shape/weight (r=.31), eating concerns (r=.34), and general ED psychopathology (r=.45). With the exception of the effects for restraint/restriction and eating concerns, which were comprised of fewer studies, each subconstruct evidenced large and significant heterogeneity in the effect size distribution. Notably, each overall effect was also highly robust, as indicated by fail-safe N's exceeding 100 in all categories.

Additionally, a number of studies reported concurrent relationships between rumination and other ED-related constructs that were too few in number to submit to meta-analysis but were coded and are displayed in Supplementary Table 4. Descriptively, these results indicated that there were significant positive relationships between rumination and body surveillance (r=.25-.34; Grabe et al., 2007), weight bias internalization (r=.20-.56; Wang et al., 2017), and the rigid weight regulation and self-control subscales of the Mizes Anorectic Cognitions Questionnaire-Revised (r=.22-29; Rawana & Kohut, 2012). Among individuals with BED but not non-ED controls, brooding rumination was related to emotional eating (r=.40) and expectancies that eating helps manage negative affect (r=.35; Sitnikov, 2014). In addition, body-related co-rumination (i.e., a phenomenon in which close friends mutually share negative thoughts and feelings related to their body or appearance) was related to greater body image cognitive distortions (i.e., problematic thought patterns when processing information about appearance; r=.26), but the relationship between body-related co-rumination and overall appearance investment was not significant (r=.11; Rudiger & Winstead, 2013).

3.2.2. Prospective Associations—As shown in Table 2, three studies assessed prospective relationships between rumination and subsequent binge eating/bulimic

symptoms, as well as between binge eating/bulimic symptoms and subsequent rumination (see Supplementary Table 2 for full list of the individual effects). The effect was significant and similar in magnitude for both directions (r=.22-.23, p's<0.001), though there was not substantial heterogeneity in the effect size distributions, and effects were relatively less robust (fail-safe N's=20-28). Given the limited heterogeneity and small number of studies contributing to these effect sizes, moderation analyses were not pursued for these prospective associations.

3.3. Group Differences in Rumination

Summary effect sizes for group differences in rumination are displayed in Table 4 (see Supplementary Table 3 for full list of the individual effects). The overall effect size for the difference in rumination between groups characterized by current ED psychopathology (i.e., ED diagnosis, binge eating, or extreme dieting groups) compared to groups without ED psychopathology was large in magnitude (g=.95), with large and significant heterogeneity in the effect size distribution. The effect was large for differences between groups with ED diagnoses (g=1.18) compared to non-ED groups, and medium for differences between groups with binge eating compared to non-binge eating groups (g=.46). Only one study included an extreme dieting group and therefore this independent effect, while large in magnitude (g=1.60), is considered tentative. Similarly, one study compared a group with a history of AN to a non-ED control group, finding a medium and significant difference (g=.55), though this finding is in need of further replication. With respect to differences in rumination between EDs, two studies compared AN and BN groups, finding a non-significant difference (g=.09). Lastly, the fail-safe N for all categories for which this statistic was able to be calculated indicated that the effects for comparisons of any ED group, ED diagnostic group, or binge eating group compared to non-ED control groups were fairly robust (N's=50-313).

3.4. Meta-Regression

3.4.1. Moderators of Cross-Sectional Associations—As shown in Table 5, at the univariate level, sample population emerged as a significant predictor of the concurrent correlation between rumination and ED psychopathology (Q=13.01, p=.001; R^2 analog=.12), such that larger associations were observed among mixed/other samples compared to non-clinical samples[6] (b=.14, p=.007), as well as sex, (Q=5.38, p=.020; R^2 analog=.05), such that larger associations were observed among samples with higher proportions of females. The final model (Table 6) explained 50% of the total between-study variance (Q=70.74, p<.001, R^2 analog=.50). In addition to sex and population, the rumination construct assessed emerged as a significant predictor of the effect size, in that the association between rumination and ED psychopathology was stronger when ED-specific measures of rumination were used (b=.75, p<.001).

3.4.2. Moderators of Group Differences—Univariate tests of covariates (Table 7) also identified sex and sample population (i.e., other/mixed samples) as predictors of larger effect sizes for differences in rumination between ED and non-ED control groups. Due to

[6]Non-clinical groups included samples coded as either college/university or community.

collinearity between sex and population, two final models were evaluated to assess these variables along with rumination construct and subtypes. The final model (Table 8) including sex accounted for 72% of the between-study variance (Q=20.06, p<.001; R^2 analog=.72); the model including population was significant (Q=78.64, p<.001) but due to sampling error the R^2 analog value exceeded 1. Both sex and population remained significant in the final models, in addition to the rumination construct assessed. Similar to the first meta-regression model, group differences were larger among studies that used ED-specific measures of rumination.

3.5. Experimental Studies

Five studies manipulated state rumination in response to eating- or body-related inductions using laboratory paradigms, which we summarize narratively. In a clinical sample, Naumann, Tuschen-Caffier, Voderholzer, Schaefer, and Svaldi (2016) instructed participants with AN or BN to either ruminate or use emotional acceptance strategies after “media-induced body dissatisfaction” (i.e., viewing pictures of thin models). Rumination was associated with decreases in mood and body satisfaction in both AN and BN groups, and changes in body satisfaction were significant after covarying for mood. Similarly, Svaldi and Naumann (2014) induced body dissatisfaction among individuals with BED, after which they were instructed to ruminate or use acceptance strategies. Results indicated that participants in the rumination condition demonstrated decreases in mood, yet no changes in body satisfaction were observed in either the rumination or acceptance conditions. Thus, the use of ruminative coping in response to body dissatisfaction inductions is related to increased negative affect across ED diagnostic groups, though effects on body satisfaction may be specific to AN and BN.

Rawal, Williams, and Park (2011) manipulated self-focus (i.e., analytical vs. experiential) following an ED-specific stressor (i.e., imagining eating fattening food) in a sample of individuals high and low in ED psychopathology (Study 1), and in a weight-restored AN sample (Study 2). Results of Study 1 indicated that analytical focus, which was thought to resemble ruminative processing, was followed by higher weight estimates in both groups, and lower estimates of likelihood of weight/shape change in the high ED psychopathology group only. Study 2 results indicated that analytic self-focus was related to higher weight estimates and efforts to neutralize stress (e.g., imagining exercise) compared to the experiential self-focus in the weight-restored AN sample. Additionally, a study of obese individuals found that those who were assigned to ruminate after a body dissatisfaction induction evidenced increased body-related distress and lower mood compared to those who were assigned to use acceptance strategies (Svaldi, Naumann, Trentowka, Lackner, & Tuschen-Caffier, 2013).

Wade and colleagues (2009) also examined weight and appearance satisfaction among undergraduate females who underwent a body dissatisfaction induction (i.e., exposure to images of thin models), after which they were randomized to use different coping methods. Compared to the use of acceptance, distraction, and cognitive dissonance (i.e., listing positive attributes about oneself; writing down the costs and consequences of pursuing the thin ideal) methods, the ruminative coping condition was associated with significantly lower

weight and appearance satisfaction. In summary, results of these experimental studies in non-clinical samples suggest that compared to more adaptive coping methods, rumination in response to eating- or body-related stressors are generally related to greater negative affect, lower body satisfaction, and more negative cognitions about one's shape and weight.

4. Discussion

Taken together, based on the 38 empirical studies identified in this review, there is clear evidence supporting rumination as a salient process involved in ED-related psychopathology. Overall, results suggest (1) rumination is related to elevated ED psychopathology; (2) the direction of influence between rumination and ED psychopathology may be reciprocal in nature; (3) groups with ED psychopathology evidence higher levels of rumination compared to groups without ED psychopathology; and (4) experimental manipulation of rumination in response to ED-related stimuli is related to increased negative affect and/or negative body-related cognitions across the spectrum of ED symptoms. The results also point to a substantial increase in this body of research since the publication of Aldao et al. (2010). The majority of studies reviewed here utilized cross-sectional designs with non-clinical samples, most of which assessed trait rumination as opposed to state rumination using experimental paradigms. Though most studies assessed general rumination, there were several that examined ED-specific rumination or response to ED-specific stimuli.

4.1. Overall Effects

In line with expectations, there was a medium positive concurrent correlation between rumination and ED psychopathology. However the magnitude of the effect varied across ED constructs, with relationships between rumination and restraint/restriction evidencing the smallest (albeit still significant) magnitude of association, and relationships between rumination and general ED psychopathology evidencing the largest magnitude. In contrast to the growing body of cross-sectional research in this area, it was notable that only three studies examined prospective relationships between rumination and ED psychopathology, specifically bulimic symptoms. Although causal inferences cannot be made, the similar magnitude of effects in both directions nevertheless suggest that there may be bidirectional influences between these domains. This is also consistent with research outside of EDs demonstrating reciprocal longitudinal relationships between rumination and symptoms over time (e.g., Jose & Weir, 2013). Regarding state rumination, across clinical and non-clinical experimental studies, individuals who experienced rumination in response to sad mood or body dissatisfaction inductions evidenced increases in negative affect and ED/body-related cognitions, lending further support for temporal and possibly causal relationships between rumination and ED psychopathology. This is consistent with the Emotional Cascade model (Selby et al., 2008; Selby & Joiner, 2009), which posits bidirectional exacerbating influences between aversive affective states and rumination, prompting behavioral dysregulation.

With respect to group differences, we also found support for the hypothesis that groups characterized by ED psychopathology report greater levels of rumination compared to non-ED control groups. This was true across varying types of ED psychopathology, including groups defined by ED diagnoses, binge eating, and extreme dieting. While only two studies

compared ED diagnoses to each other, the non-significant differences in rumination between AN and BN lends support for the tenet that rumination is a transdiagnostic phenomenon across psychopathology, including ED diagnoses.

4.2. Moderation Effects

Furthermore, meta-regression results revealed that the magnitude of association depended on the rumination construct assessed, the proportion of females in the sample, and the sample population. Specifically, the effect sizes for both correlations and group differences were largest when studies employed ED-specific measures of rumination (e.g., RRS-ED). While this may be due in part to similarities in ED-related content assessed by these measures, the RRS-ED has also shown to be distinct from other ED measures (Cowdrey & Park, 2011), suggesting that this measure taps a unique construct related to the repetitive abstract nature of thought processes in EDs. Sample population also emerged as a moderator across effect types, such that effects were largest among studies including mixed or “other” samples compared to studies that included only non-clinical samples. It is important to note that many of the mixed/other samples included both ED diagnostic groups as well as non-ED controls. Thus, the inclusion of groups with greater ED symptom severity, who may evidence greater ruminative tendencies, could in part account for these findings. Moreover, the small number of psychiatric samples likely limited statistical power to detect moderation effects for this category, which also highlights the need for future studies to examine rumination in clinical ED populations.

In addition, higher percentages of female participants in samples were related to greater effect sizes at the univariate level for both effect types, though sex was only a significant predictor of the group difference effect in the final meta-regression models. We interpret the latter finding with caution given that only one group difference effect was based on a sample that included male participants (Goosens et al., 2016). Clearly further study is warranted to assess rumination among males with ED psychopathology to assess the generalizability of the observed findings across sexes. Nevertheless, the observed univariate findings are in line with prior research outside of EDs demonstrating that women report higher levels of rumination than men across rumination subtypes (Johnson & Whisman, 2013).

Contrary to the expectation that the brooding subtype of rumination would be related to the greatest magnitude of effects, effect sizes did not vary significantly across rumination subtypes. While there is considerable research supporting the tenet that brooding is the more maladaptive form of rumination, characterized by abstract and passive negative cognitions, some research has suggested that whether reflection is maladaptive depends on the nature of the coping response (Marroquin, Fontes, Scilletta, & Miranda, 2010). That is, individuals who were higher in reflection but low in active coping tendencies evidenced higher levels of depressive symptomatology, whereas this relationship was not found among individuals high in reflection who employed active, adaptive coping methods, suggesting that the correlates of reflection may depend on other self-regulatory strategies (Marroquin et al., 2010). Given that individuals with ED psychopathology evidence a range of emotion regulation deficits (e.g., Lavender et al., 2015; Kittel, Brauhardt, & Hilbert, 2015) and maladaptive coping tendencies (e.g., Koff & Sagani, 1997; Troop, Holbrey, & Treasure, 1998), it may be that

reflection, via repeated processing of negative cognitions without accompanying capacity or skills to engage in adaptive response behaviors, has a similar influence on ED symptomatology as brooding.

4.3. Limitations

Although the present review found consistent support for relationships between ruminative processes and ED-related psychopathology, the limitations of existing studies raise several questions and suggest areas in need of future research. As previously stated, the majority of these studies utilized cross-sectional designs and non-clinical samples of predominantly Caucasian women, which limits conclusions that can be drawn regarding temporal relationships and raises concerns about generalizability to clinical samples and other demographic groups. However, one study found that rumination was similarly predictive of binge eating among both African American and Caucasian women (Mason & Lewis, 2016), and two studies have assessed rumination in relation to ED symptoms in sexual minority samples (Mason & Lewis, 2015; Wang & Borders, 2016). While some of the cross-sectional studies reviewed employed mediational designs, the methodology of such studies precludes causal inferences. As such, it will be imperative for future research to employ longitudinal designs to further clarify the prospective nature of associations between rumination and a range of ED symptoms, as only bulimic symptoms have been assessed in prospective studies thus far. Additionally, samples were relatively homogenous with respect to age, in that the majority were adults and drawn from college/university settings. Given that EDs commonly onset in late adolescence (e.g., Favaro, Caregaro, Tenconi, Bosello, & Santonastaso, 2009), more work is needed to determine the role of rumination in the developmental course of ED psychopathology. In addition to research on mechanisms of onset, research using momentary, naturalistic designs (e.g., ecological momentary assessment [EMA]) may help to clarify the role of state rumination in the maintenance of ED behaviors.

In addition, few of the reviewed studies included more than one ED group, with only two studies comparing AN and BN groups in rumination. There is a need for additional comparisons between types of EDs to evaluate the extent to which rumination varies across EDs, and the mechanisms by which rumination may result in differing behavioral manifestations across EDs. Additionally, due to the lack of studies including a psychiatric control group, it is not clear whether the phenomenology and consequences of rumination are similar across ED diagnoses and other forms of psychopathology. It would be beneficial for future research to include transdiagnostic samples to examine possible differences in the content and correlates of rumination across EDs and other diagnoses (e.g., depression, anxiety, substance use).

4.4. Future Directions

4.4.1. The Roles of ED-Specific vs. General Rumination—Although the present meta-analysis indicated stronger concurrent relationships between ED psychopathology and ED-specific rumination compared to general rumination, the potential differential influences of general versus ED-specific rumination in the development versus maintenance of ED-related symptomatology remain unclear. While the transdiagnostic model suggests that rumination, regardless of content, serves as a risk factor for psychopathology (Nolen-

Hoeksema & Watkins, 2011), it has been proposed that ruminative thinking related to ED-specific themes may be a particularly important maintenance factor for ED psychopathology. For instance, Park, Dunn, and Barnard (2011, 2012) suggest that repetitive thought about ED-related concerns in AN serves to increase feelings of control and alleviate fears of weight gain, but ultimately serves as a maintenance factor for restrictive eating. In addition, some have suggested that this type of ED-specific cognitive process serves as an avoidance strategy among individuals with EDs, given that they are likely to avoid or have difficulty tolerating the emotional content that is typically the focus of ruminative thoughts (Cowdrey & Park, 2012). Thus, it is unclear whether ED-specific rumination functions as a more general risk factor and/or symptom that maintains and exacerbates the psychopathology. Future research using prospective designs may help address the possibly differential salience of general versus ED-specific rumination to the onset and maintenance of ED psychopathology, and studies using momentary assessment methods such as EMA may provide data relevant to understanding potential differential antecedents and consequences of general and ED-specific rumination at the momentary level.

4.4.2. Neurocognitive Correlates—There also remains a lack of data on related neurocognitive processes that have been studied in the broader rumination literature. For instance, extensive research has examined executive functioning in relationship to ruminative processes in other forms of psychopathology (see Whitmer & Gotlib, 2013 for a review). In brief, rumination is associated with deficits in various elements of cognitive control, including attentional processes, response inhibition, and cognitive flexibility. Such deficits may be proximal risk factors for various forms of psychopathology, including EDs. Future studies of these mechanisms could lend insight into possible underlying neurocognitive risk factors, and also identify which individuals with EDs are most prone to have ruminative tendencies.

4.4.3. The Role of Rumination in ED Models—While informative, the results of the present review highlight several areas in need of further investigation. Perhaps most importantly, this literature demonstrates that the construct of rumination has generally not been considered in existing theoretical models of EDs. Two prominent models of EDs are cognitive behavioral (e.g., Fairburn, Cooper, & Shafran, 2003; Fairburn, Marcus, & Wilson, 1993) and affect regulation (e.g., Hawkins & Clement, 1984; Haynos & Fruzzetti, 2011; Heatherton & Baumeister, 1991; Wonderlich et al., 2008) models. First, cognitive behavioral models suggest that EDs arise from dysfunctional schemas of self-evaluation, particularly the overvaluation of shape, weight, and eating, which in turn promote ED symptoms such as dietary restraint, binge eating, compensatory behaviors, and preoccupations with body image and eating. However, as previously mentioned, there are important distinctions between rumination and other forms of perseverative cognitions; while it may be the case that perseverative thoughts in ED can become ruminative in nature, not all preoccupation about eating, weight, and shape should be considered rumination, which is characterized by an *abstract* focus on the *meaning*, *causes*, and *consequences* of present or past negative experiences. That is, despite the theoretical importance of ED-related preoccupations and cognitions in ED research, thus far there is little research characterizing the nature of these cognitive processes.

Second, affect regulation models posit that ED behaviors function as maladaptive strategies to escape from or regulate negative affective states, which is consistent with an extensive body of literature demonstrating emotion regulation difficulties among individuals with EDs (e.g., Lavender et al., 2015; Kittel et al., 2015). While rumination has been conceptualized as one form of maladaptive emotion regulation (Aldao et al., 2010; McLaughlin et al., 2011), this construct has not been considered in affect regulation models of EDs. Additionally, in line with Control Theory (Martin & Tesser, 1989, 1996), which suggests that goal discrepancies are proximal triggers of rumination, the theoretical model underlying Integrative Cognitive-Affective Therapy (ICAT; Wonderlich et al., 2015) suggests that momentary self-discrepancies are precursors of negative affect, which in turn prompts binge eating; however, rumination has not been studied as a potential mechanism linking self-discrepancy, negative affect, and binge eating in the context of this model. Taken together, while rumination is a construct that is largely *consistent* with existing conceptualizations and models of EDs, this factor has been relatively understudied from a theoretical perspective.

4.4.4. Integration of Rumination Models in ED Theory and Research—In addition to the lack of integration of rumination in ED models, studies of rumination in EDs have generally not integrated broader models of rumination. Importantly, considering models of rumination in future empirical and theoretical work may help clarify if and how rumination uniquely contributes to existing ED models. Broadly, theories of rumination suggest that it is not only the *content* of thought but also the *ways* in which individuals process these thoughts that creates a particularly potent context for the development of psychopathology. ED theory and research generally focuses on the content of thoughts (i.e., fear of weight gain, overvaluation of shape and weight, preoccupation with eating), but has lacked meaningful consideration of the ways in which such thoughts may lead to ED behaviors and affective disturbance. That is, the mere occurrence of particular thoughts may not be the only or most important factor when considering the relevance of cognitive ED symptoms; rather, it may be that the repetitive, abstract, and negative way in which individuals experience these thoughts is the more influential feature of cognitions that potentiates dysregulated affect and behaviors.

It is also unknown how state-based and trait-based rumination may interrelate and interact to promote ED psychopathology. While the Habit-Goal Framework proposes that state and trait ruminative processes can influence each other, no studies in the present review examined the influence of trait-based ruminative tendencies on state rumination, which could lend insight into whether individual differences increase sensitivities to triggers of state rumination. As suggested by previous research, those higher in trait rumination are likely to exhibit higher levels of state rumination in response to triggers (Roberts, Watkins, & Wills, 2013), and possibly subsequent ED behaviors among individuals who are also predisposed to ED psychopathology. Furthermore, although the Emotional Cascade Model posits that momentary negative affect and state rumination have an additive, synergistic effect on ED behaviors, thus far no studies have examined momentary relationships with binge eating or other ED behaviors.

4.4.5. Extending and Testing Models—In sum, while rumination is not an explicit element within existing ED models, integrating this construct in risk and maintenance models may be helpful in understanding the mechanisms by which ED-related cognitions and negative affect together potentiate ED behaviors. While it is well-established that individuals with ED psychopathology experience heightened levels of negative affect, self-discrepancy, and ED-specific cognitions, each of which have been implicated in existing theoretical models of EDs, research is needed to assess whether the unique form and qualities of repetitive thinking that characterize rumination offer additive explanatory power in understanding how these factors interact and exacerbate each other to promote ED psychopathology. However, there are limited data to answer the question of whether rumination accounts for ED symptoms beyond other well-established factors in ED models (e.g., negative affect, restraint, personality), although some research has shown rumination has unique predictive utility over other risk factors (e.g., Cowdrey & Park, 2012; Mason & Lewis, 2016).

To address these issues, future research is needed to develop and test models that integrate ED-specific and transdiagnostic risk factors (i.e., rumination) across multiple levels of analysis, as discussed recently by Culbert et al. (2015). Such research will also allow for the evaluation and refinement of the transdiagnostic model proposed by Nolen-Hoeksema and Watkins (2011), which called for the study of mechanisms and moderators that predispose individuals who ruminate to be more vulnerable to developing EDs as opposed to other forms of psychopathology. As one such example of an integrative risk model, Pearson et al. (2015) proposed both state-based and trait-based pathways for BN, which included transdiagnostic (i.e., negative urgency) and ED-specific risk factors (i.e., expectancies for reinforcement from eating). In brief, the state-based pathway suggests that negative affect, periods of dietary restriction, and other stressful experiences deplete self-control resources and increase the likelihood of ED behaviors at a momentary level. The trait-based pathway is based on individual (i.e., between-person) differences and suggests that those high in negative urgency are more likely to engage in ED behaviors when they experience momentary negative affect and depletion in self-control.

Similar to negative urgency, rumination can be conceptualized as a transdiagnostic factor that is closely related to emotion dysregulation and a salient phenomenon in EDs. In line with the results of this review, it is possible that rumination serves as a between-person *risk factor* for ED psychopathology, a *symptom* or correlate of EDs, as well as a within-person, state-like *mechanism* by which maladaptive ED-related cognitions and negative affect reciprocally exacerbate and maintain each other over time, eventually leading individuals to resort to ineffective and maladaptive coping responses (i.e., ED behaviors). It will be important for future research to consider how both trait- and state-level rumination may potentiate ED symptoms. Thus, rumination is a construct that is particularly well-suited to examine within the context of theoretical frameworks incorporating both momentary and between-person factors (e.g., Pearson et al., 2015).

For example, at the momentary level, individuals with EDs are at risk of engaging in ruminative thoughts in response to negative affect, self-discrepancies, or stressful events. In turn, momentary perseverative thoughts occupy cognitive resources and distract from task-

relevant processing, increase negative self-focused attention, and exacerbate emotional distress, all of which deplete one's capacity for adaptive self-regulation and increase risk of engaging in subsequent ED behaviors. However, additional research is needed to evaluate how these processes (i.e., resource depletion, negative self-awareness, and negative affect) are linked to rumination in EDs.

With regard to trait-level factors, transdiagnostic and ED-specific individual difference factors may function as moderators of these momentary relationships. For example, the momentary relationship between negative affect and rumination may be stronger among individuals with underlying deficits in neurocognitive domains that are linked to rumination, such as cognitive flexibility, working memory, and inhibitory control (Whitmer & Gotlib, 2013), all of which have been shown to be present in varying degrees across EDs (e.g., Wu et al., 2013, 2014; Zakzanis et al., 2010). Second, in line with Pearson et al. (2015), individual differences in learning histories (i.e., expectancy of reinforcement from eating or dieting), dispositional tendencies to engage in impulsive behaviors in the context of negative affect (i.e., negative urgency), as well as trait-level ruminative tendencies, may moderate momentary relationships between self-control depletion and ED behaviors.

4.5. Clinical Implications

The aforementioned findings also have relevant clinical implications. As suggested by Watkins and Nolen Hoeksema (2014), habit reversal and counterconditioning approaches that utilize stimulus control and functional analysis may be effective in reducing habitual ruminative tendencies. This is consistent with recent suggestions that addressing habits may be important in the treatment of EDs, particularly AN (e.g., Park, Godier, & Cowdrey, 2014; Walsh, 2013) but has also been acknowledged in the treatment of BN (e.g., ICAT, Wonderlich et al, 2015). In addition, cognitive deficits and attentional biases associated with rumination could be targeted via cognitive bias modification and interventions that improve inhibitory control and working memory functioning (Watkins & Nolen-Hoeksema, 2014). This is also consistent with the application of Cognitive Remediation Therapy as an ED treatment (e.g., Tchanturia, Lounes, Holttum, 2014).

Rumination-Focused Cognitive Behavioral Therapy (RFCBT) is an intervention that has been developed to specifically target rumination among individuals with depression. Rather than modifying thought *content* (a typical focus of CBT), RFCT focuses on changing thought *processes* (i.e., shifting from unconstructive rumination to constructive thinking styles) and decreasing avoidance (Watkins et al., 2007). Evidence thus far suggests that RFCBT leads to decreases in depression and lower relapse rates compared to antidepressant medication treatment among adults; furthermore, treatment effects were mediated by changes in rumination (Watkins et al., 2011). Given the apparent relevance of ruminative processes to ED psychopathology, as well as the common co-occurrence of depressive symptomatology in EDs, incorporating aspects of these rumination-focused interventions may have value in ED treatment, particularly for patients who exhibit high levels of rumination. However, additional research will be needed to evaluate whether the addition of such techniques would improve the efficacy of ED treatments.

4.6. Conclusion

The present meta-analysis demonstrated that rumination appears to be a salient cognitive process that is broadly associated with ED psychopathology. Despite the growing body of research in this area, there nevertheless is a clear need for additional studies that employ prospective methods, assess clinical ED samples, and directly evaluate the unique explanatory contribution of rumination within the frameworks of existing ED theories. Several questions remain to be answered, particularly with regard to how rumination may interact with other factors to promote the development and/or maintenance of ED psychopathology. Future research that examines both proximal risk factors, such as underlying cognitive deficits, and ED-specific risk factors (e.g., eating expectancies) may help to elucidate the mechanisms by which rumination predisposes some individuals to engage in ED behaviors versus symptoms of other forms of psychopathology. Finally, such research may inform the development or refinement of clinical interventions to address ruminative processes among individuals with EDs.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- We conducted a meta-analysis of rumination in eating disorder (ED) psychopathology
- A total of 38 studies were identified
- Greater rumination was found in those with ED symptoms versus non-ED controls
- Rumination was concurrently and prospectively associated with ED symptoms
- We discuss limitations and future directions for research in this area

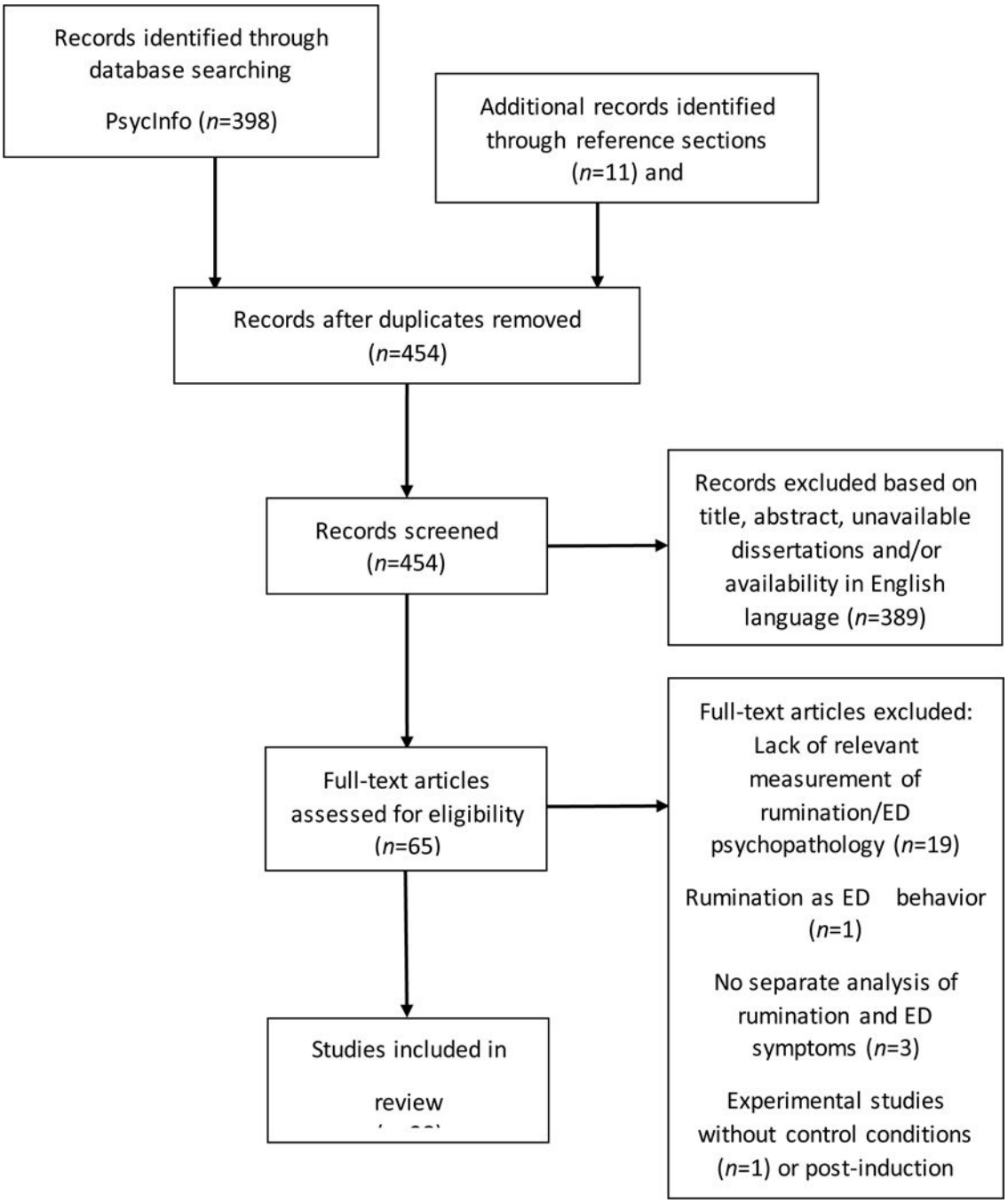

Figure 1.
PRISMA flow diagram of study selection.

Table 1

Summary of key variables coded for each study

Variable coded	Levels/definition
Population	College/university[1]
(recruitment source)	Community[1]
	Psychiatric
	Mixed/other (e.g., psychiatric and community)
Publication status	Published study
	Unpublished thesis/dissertation
Sample size	Total number of participants included
Age	Mean/SD sample age (years)
BMI	Mean/SD sample BMI
Ethnicity	% Caucasian participants
Sex	% Female participants
ED diagnosis included	AN
	BN
	BED
	Mixed EDs (e.g., AN and BN)
	Other (e.g., recovered AN)
Study design/effects	Cross-sectional association
	Prospective association
	Experimental
	Group differences in rumination
Rumination construct	General (e.g., RRS)
	ED-specific (e.g., RRS-ED)
Rumination subtype	Overall composite score
	Brooding
	Reflection
	Other (e.g., co-rumination)
Rumination measure	Rumination measure and subscale name (e.g., RRS brooding)
Correlation Effects Only	
Time frame	Cross-sectional: Time 1 rumination-Time 1 ED construct
	Prospective: Time 1 rumination-Time 2 ED construct
	Prospective: Time 1 ED construct-Time 2 rumination
Time lag (if prospective)	Time in months between Time 1 and Time 2
ED construct	General ED psychopathology (e.g., EDE-Q global)
(continuous)	Bulimic/binge eating symptoms (e.g., BULIT-R)
	Body dissatisfaction/overvaluation of shape/weight (e.g., BSQ)
	Restraint/restriction (e.g., EDE-Q restraint)

Variable coded	Levels/definition
	Other[2]
ED measure	ED measure and subscale name
Group Difference Effects Only	
Comparison	AN vs. BN
	AN vs. BED
	AN vs. Non-ED control[3]
	BN vs. BED
	BN vs. Non-ED control
	BED vs. Non-ED control
	Other

Note. BMI = Body mass index; ED = Eating Disorder; AN = Anorexia Nervosa; BN = Bulimia Nervosa; BED = Binge Eating Disorder; RRS = Ruminative Response Scale; RRS-ED = RRS for Eating Disorders; EDE-Q = Eating Disorder Examination-Questionnaire. BULIT-R = Bulimia Test-Revised; BSQ = Body Shape Questionnaire.

[1] College/university and community samples were combined as a “non-clinical” group in moderation analyses.

[2] Eating concern effects (i.e., EDE/EDE-Q eating concern) were initially coded as “other” but later combined as a separate category given the number of effect sizes for this construct.

[3] Non-ED controls were defined as either healthy control groups or non-ED control groups without other specified diagnoses.

Table 2

Summary of reviewed studies (*k*=38)

				Age (years)				BMI			
Study name	**Subsamples (if any)**	**Population**	***N***	***M***	***SD***	**Sex (% female)**	**Ethnicity (% Caucasian)**	***M***	***SD***	**ED diagnoses included**	**Study effects**
Breithaupt, Rallis, Mehlenbeck, & Kleiman (2016)		College/university	353	21.93	5.78	85.00	55.00	23.86	4.66	No ED group	C
Connolly, Rieger, & Caterson (2007)		College/university	140	19.50	2.57	100.00		21.52	3.51	No ED group	C,GD
Cowdrey & Park (2011)	AN History	Other/mixed	42	24.00	8.31			19.60	2.46	History of AN	C,GD
	Overall sample, Controls	Community	275	24.13	7.49	82.90		22.13	2.81	No ED group	
Cowdrey & Park (2012)	AN History	Other/mixed	42	24.00	8.31			19.60	2.46	History of AN	C
Dixon-Gordon, Aldao, & De Los Reyes (2014)		College/university	531	19.28	1.65	73.63	69.11			No ED group	C
Dondzilo, Rieger, Palermo, Byrne, & Bell (2016)		College/university	116	19.00	1.77	100.00		21.61	3.02	No ED group	C,GD
Doyle (2013)*		College/university	441	18.71	1.01	100.00	73.20	22.39	3.73	No ED group	C
Goossens, Van Malderen, Van Durme, & Braet (2016)		Community	524	15.08	1.59	70.60				No ED group	GD
Gordon, Holm-Denoma, Troop-Gordon, & Sand (2012)		College/university	780	19.27	2.12	65.70	94.00			No ED group	C
Grabe, Hyde, & Lindberg (2007)		Community	299	11.24		52.84	89.40			No ED group	C
Harrell & Jackson (2008)		College/university	329	19.31		100.00	58.00			No ED group	C
Hilt, Roberto, & Nolen-Hoeksema (2013)		Community	101	12.70	1.14	100.00	73.00	22.13	5.68	No ED group	C

				Age (years)				BMI			
Study name	**Subsamples (if any)**	**Population**	***N***	***M***	***SD***	**Sex (% female)**	**Ethnicity (% Caucasian)**	***M***	***SD***	**ED diagnoses included**	**Study effects**
Holm-Denoma & Hankin (2010)		Community	191			100.00				No ED group	C
Jungmann, Vollmer, Selby, & Witthöft (2016)		Community	414	47.20	16.70	54.00				No ED group	C
Kelly (2012) *	Part 1	College/university	631	19.20	1.50	100.00	44.40			No ED group	C,GD
Kelly, Lydecker, & Mazzeo (2012)		College/university	419	18.95	1.33	100.00	43.00			No ED group	C
Maraldo, Zhou, Dowling, & Vander Wal (2016)		Other/mixed	609			100.00				No ED group	C
Mason & Lewis (2015)		Other/mixed	164	24.37	6.11	100.00	62.20			No ED group	C
Mason & Lewis (2016)		College/university	184	19.96	1.84	100.00	54.35	25.06	6.34	No ED group	C
Naumann, Tuschen-Caffier, Voderholzer, Caffier, & Svaldi (2015)		Other/mixed	111			100.00				Mixed ED diagnoses	GD
Naumann, Tuschen-Caffier, Volderholzer, Schafer, & Svaldi (2016)		Other/mixed	78			100.00				Mixed ED diagnoses	C,E
Naumann, Tuschen-Caffier, Volderholzer, & Svaldi (2016)		Other/mixed	123			100.00				Mixed ED diagnoses	GD
Nolen-Hoeksema, Stice, Wade, & Bohon (2007)		Community	496	15.00	0.73	100.00	68.00			No ED group	C
Opwis, Schmidt, Martin, & Salewski (2017)		Community	295			69.49		23.86	4.96	No ED group	C
Rawal, Park, & Williams (2010)	Study 1	College/university	177	22.39	5.13	68.93		21.95	2.72	No ED group	GD

				Age (years)				BMI			
Study name	**Subsamples (if any)**	**Population**	***N***	***M***	***SD***	**Sex (% female)**	**Ethnicity (% Caucasian)**	***M***	***SD***	**ED diagnoses included**	**Study effects**
	Study 2	Other/mixed	26	26.08	6.95	100.00				AN	
Rawal, Williams, & Park (2011)	Study 1	College/university	18	20.33	2.11	100.00				No ED group	E
	Study 2	Other/mixed	26	25.11	4.74	100.00				AN	
Rawana & Kohut (2012)		Community	311	15.37	0.95	56.90	72.00			No ED group	C
Rudiger & Winstead (2013)		College/university	203	20.00	3.07	100.00	61.60	23.84	5.01	No ED group	C
Seidel et al. (2016)		Other/mixed	70			100.00				AN	C,GD
Selby, Anestis, & Joiner (2008)	Study 1	College/university	200	18.60	2.36	68.50	68.00			No ED group	C
	Study 2	College/university	65	19.31	4.23	82.90	77.10			No ED group	
Sitnikov (2014) *		Other/mixed	76	24.70	10.20	100.00	88.20	25.90	4.80	BED	C,GD
Startup et al. (2013)		Psychiatric	62	26.60	7.80	93.55		16.40	1.40	AN and EDNOS-AN subtype	C
Svaldi & Naumann (2014)		Psychiatric	30			100.00				BED	C,E
Svaldi, Naumann, Trentowska, Lackner & Tuschen-Caffier (2013)		Community	37			100.00				No ED group	C,E
Tuna (2012) *	Study 2	College/university	507	23.12	3.18	72.00				No ED group	C
Wade, Man George, & Atkinson (2009)		College/university	100	24.38	9.39	100.00	100.00	23.46	4.82	No ED group	E
Wang & Borders (2016)		Other/mixed	116	24.80	5.35	40.50	90.00			No ED group	C
Wang, Lydecker, & Grilo (2017)		Psychiatric	237	47.90	10.00	70.46	76.90	39.45	5.92	BED	C

Note. ED = Eating Disorder; BMI = Body Mass Index; AN = anorexia nervosa; EDNOS = Eating Disorder Not Otherwise Specified; C = Correlation; GD = Group Difference; E = Experimental.

*Unpublished thesis/dissertation

Table 3

Overall effect sizes for cross-sectional and prospective associations between rumination and ED psychopathology

			Effect size and 95% confidence interval					Heterogeneity				
Correlation	**Constructs**	**Number of studies (*k*)**	***r***	**Lower**	**Upper**	***Z***	***p***	***Q***	**df**	***p***	I^2	**Fail-safe N**
Cross-sectional	Any ED psychopathology[1] and rumination	31	0.33	0.26	0.39	9.08	<0.001	286.22	30	<0.001	89.52	4,853
	General psychopatho logy and rumination	16	0.45	0.32	0.57	6.00	<0.001	209.74	15	<0.001	92.85	1,357
	Binge eating/bulimic symptoms and rumination	15	0.22	0.15	0.29	5.95	<0.001	96.27	14	<0.001	85.46	1,000
	Body dissatisfaction or overvaluation of shape/weight and rumination	12	0.31	0.23	0.39	7.14	<0.001	66.26	11	<0.001	83.40	945
	Restraint/restriction and rumination	8	0.17	0.11	0.23	5.51	<0.001	12.40	7	0.088	43.53	105
	Eating concerns and rumination	7	0.34	0.28	0.40	9.83	<0.001	11.32	6	0.079	47.00	344
Prospective	Time 1 rumination and Time 2 binge eating/bulimic symptoms	3	0.22	0.15	0.29	5.93	<0.001	0.04	2	0.982	<0.01	20
	Time 1 binge eating/bulimic symptoms and Time 2 rumination	3	0.23	0.15	0.29	6.10	<0.001	3.41	2	0.181	41.42	28

Note. ED = Eating Disorder.

[1]"Any ED psychopathology" included measures of general ED psychopathology, binge eating/bulimic symptoms, body dissatisfaction/overvaluation of shape/weight, restraint/restriction, and eating concerns.

Table 4

Overall effect sizes for group differences in rumination

		Effect size and 95% confidence interval						Heterogeneity				
Group comparison (A vs. B)[1]	**Number of studies (*k*)**	***g***	***SE***	**Lower**	**Upper**	***Z***	***p***	***Q***	**df**	***p***	I^2	**Fail-safe N**
Any ED psychopatho logy[2] vs. non-ED control group	9	0.95	0.18	0.60	1.31	5.22	<0.001	51.04	8	<0.001	84.33	313
Any ED diagnosis vs. non-ED control group	5	1.18	0.12	0.94	1.42	9.67	<0.001	4.18	4	0.382	4.33	122
Binge eating group vs. no binge eating group	4	0.46	0.07	0.32	0.61	6.20	<0.001	24.84	3	<0.001	87.92	50
AN vs. BN	2	0.09	0.16	−0.23	0.40	0.54	0.591	0.32	1	0.570	<0.001	—
Extreme dieting group vs. no extreme dieting group	1	1.60	0.37	0.87	2.32	4.32	<0.001	—	—	—	—	—
History of AN vs. non-ED control group	1	0.55	0.17	0.23	0.88	3.32	0.001	—	—	—	—	—

Note. ED = Eating Disorder; AN = anorexia nervosa; BN = Bulimia Nervosa.

[1] Positive *g* values indicate group A mean > group B mean.

[2] "Any ED psychopathology" included groups with ED diagnoses, binge eating, or extreme dieting.

Table 5

Random effects univariate meta-regression results for overall correlation between in rumination and ED psychopathology

Univariate predictors	Level	Reference group	Coefficient	*SE*	Lower	Upper	*Z*	*p*	Number of effects	*Q*	df	*p*	R^2 analog
Population	Psychiatric	Non-clinical	−0.01	0.06	−0.13	0.10	−0.19	0.851	118	13.01	2	0.001	0.12
	Other/mixed	Non-clinical	0.16	0.05	0.07	0.26	3.43	0.001					
Age	—	—	<0.01	<0.01	−0.01	<0.01	−0.93	0.352	72	0.87	1	0.352	0.01
Sex	—	—	<0.01	<0.01	<0.01	0.01	2.32	0.020	118	5.38	1	0.02	0.05
Ethnicity	—	—	<0.01	<0.01	<0.01	<0.01	0. 38	0.705	63	0.14	1	0.705	0.01
BMI	—	—	−0.01	0.01	−0.02	0.00	−1.91	0.056	38	3.66	1	0.056	0.09
Publication status	Unpublished	Published	−0.05	0.07	−0.19	0.09	0.67	0.505	118	0.44	1	0.505	<0.01

Note. ED = Eating Disorder; BMI = Body Mass Index

Table 6

Random effects meta-regression results for overall correlation between in rumination and ED psychopathology

Predictor	Level	Reference group	Coefficient	*SE*	Lower	Upper	*Z*	*p*	*Q*	df	*p*
Sex	—	—	<0.001	<0.001	<0.001	<0.001	0.47	0.639			
Population	Psychiatric	Non-clinical	0.05	0.05	−0.05	0.15	0.94	0.346	6.68	3	0.035
	Other/mixed	Non-clinical	0.11	0.05	0.03	0.20	2.52	0.012			
Rumination construct	ED-specific	General	0.75	0.11	0.54	0.96	6.99	<0.001			
Rumination subtype	Brooding	Overall	−0.02	0.04	−0.11	0.06	−0.56	0.572	2.52	2	0.283
	Refection	Overall	−0.10	0.06	−0.23	0.02	−1.58	0.113			

Note. ED = Eating Disorder; sex = percentage of female participants. Number of included effects: 112. R^2 analog=.50.

Table 7

Random effects univariate meta-regression results for differences between ED and non-ED control groups in rumination

Univariate predictors	Level	Reference group	Coefficient	*SE*	Lower	Upper	*Z*	*p*	Number of effects	*Q*	df	*p*	R^2 analog
Population	Other/mixed	Non-clinical	0.89	0.39	0.13	1.66	2.29	0.022	18	5.34	2	0.069	0.35
	Psychiatric	Non-clinical	0.83	0.40	0.04	1.62	2.06	0.039					
Age	—	—	0.05	0.05	−0.05	0.14	1.00	0.317	11	1.00	1	0.317	0.14
Sex	—	—	0.03	0.01	<.01	0.06	2.28	0.023	18	5.20	1	0.023	0.34
Publication status	Unpublished	Published	−0.25	0.37	−0.96	0.47	−0.67	0.501	18	0.45	1	0.501	0.02

Note. ED = Eating Disorder; sex = percentage of female participants. Ethnicity and body mass index were not assessed as covariates due to an insufficient number of effects for these variables (<10).

Table 8

Random effects meta-regression results for overall differences in rumination between ED and non-ED control groups

	Predictor	Level	Reference group	Coefficient	*SE*	Lower	Upper	*Z*	*p*	*Q*	df	*p*
Model 1	Population	Other/mixed	Non-clinical	0.87	0.15	0.58	1.15	5.97	<0.001	37.89	2	<0.001
		Psychiatric	Non-clinical	0.16	0.17	−0.17	0.48	0.96	0.338			
	Rumination construct	ED-specific	General	1.33	0.31	0.73	1.93	4.35	<0.001			
	Rumination subtype	Brooding	Overall	0.05	0.23	−0.40	0.49	0.20	0.839	3.83	2	0.144
		Reflection	Overall	−0.44	0.29	−1.01	0.14	−1.49	0.136			
Model 2	Sex	—	—	0.02	0.01	<0.01	0.04	2.47	0.013			
	Rumination construct	ED-specific	General	0.61	0.32	−0.01	1.23	1.92	0.055			
	Rumination subtype	Brooding	Overall	0.26	0.28	−0.29	0.81	0.93	0.354	2.81	2	0.246
		Reflection	Overall	−0.24	0.35	−0.93	0.44	−0.69	0.49			

Note. Note. ED = Eating Disorder; sex = percentage of female participants. Number of included effects: 18. Model 2 R^2 analog=.72.

Two models were run due to collinearity between sex and sample type.