The role of emotion regulation in eating disorders: a network meta-analysis approach

Running title: Emotion regulation in eating disorders

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1 Abstract

Background: Previous theoretical models and reviews have documented a strong connection between emotion dysregulation eating disorder (ED) psychopathology among the general and clinical populations. The aim of this review was to build on this previous work by conducting a network meta-analysis to explore associations between specific emotion regulation strategies and ED psychopathology trans-diagnostically across the ED spectrum to identify areas of emotion dysregulation that have the strongest association with symptomatology.

Methodology: A total of 105 studies were included in the meta-analysis and correlation coefficient representing the associations between specific emotion regulation strategies and ED symptomatology were extracted. We ran a Bayesian random effects network meta-analysis and the initial network was well connected with each emotion regulation strategy being linked to at least one other strategy. We also conducted a network meta-regression to explore whether between-study differences in body mass index (BMI), age, and whether the sample consisted of solely female participants explained any possible network inconsistency.

Results: The network meta-analysis revealed that ruminations and non-acceptance of emotions were most closely associated with ED psychopathology. There was no significant network inconsistency but two comparisons approached significance and thus meta-regressions were conducted. The meta-regressions revealed a significant effect of BMI such that the associations between different emotion regulation strategies and ED symptomatology were weaker among those with low BMI.

Discussion: The present findings build on previous work and highlight the role of rumination and difficulties with accepting emotions as key emotion regulation difficulties in EDs. Additionally, the finding that the associations were weaker among ED patients with low BMI may point towards a complex relationship between ED behaviours and emotion regulation. Taken together, our findings call for interventions that target emotion regulation, specifically rumination and difficulties accepting emotions, in the treatment of EDs.

2 Introduction

Emotion regulation refers to strategies used to identify, initiate and modify the course of emotions (Gross, 1998, 2002; Gross & Thompson, 2006). Emotion regulation strategies can be automated or controlled methods used to cope with or modify the external expression and/or internal experience when the emotional state has unwanted impact on a desired outcome (Gross, 1998, 2002; Gross & Thompson, 2006). For example, a young person might suppress their feelings of sadness when moving away from their childhood home in an attempt to not upset their parents thus reducing the external expression of negative emotions. They might then remind themselves they can still visit their parents in an attempt to gain more perspective, reappraise, and reduce the internal experience of sadness. Emotion regulation strategies can be broadly divided into adaptive strategies, including emotional awareness, acceptance and cognitive reappraisal, and maladaptive strategies, such as avoidance and suppression of emotions (Aldao, Nolen-Hoeksema, & Schweizer, 2010b; Gross, 2015). Although the maladaptive strategies can be useful in some scenarios, excessive reliance on these methods to manage emotions has been linked to various psychiatric conditions including eating disorders (EDs) (Aldao, Nolen-Hoeksema, & Schweizer, 2010a; Mason et al., 2021; Oldershaw, Lavender, Sallis, Stahl, & Schmidt, 2015; Trompeter, Bussey, Forbes, & Mitchison, 2021). Thus, further investigation of the role of emotions regulation in EDs is of interest.

Over the years there has been a great deal of interest in exploring emotion regulation within EDs; it has been proposed that difficulties in emotion regulation is one of the social-emotional factors contributing to the development and maintenance of disordered eating (Dingemans, Danner, & Parks, 2017; Oldershaw et al., 2015; Prefit, Cîndea, & Szentagotai-Tătar, 2019; Puttevils, Vanderhasselt, Horczak, & Vervaet, 2021). Large scale systematic reviews and meta-analyses have reported links between ED symptomatology and difficulties in emotion regulation among people with anorexia nervosa (AN), bulimia nervosa (BN), and binge eating disorder (BED), both when assessed under laboratory conditions and under naturalistic conditions in studies using ecological

momentary assessments (EMAs) (Dingemans et al., 2017; Oldershaw et al., 2015; Puttevils et al., 2021). Recently a meta-analytic review by Prefit et al. (2019) examined correlations between the use of various emotion regulation strategies and ED psychopathology across all ED diagnoses. The authors focused on examining individual adaptive strategies, including emotional awareness, clarity about emotions, acceptance of emotions, cognitive reappraisal, and problem solving, as well as maladaptive strategies, such as avoidance rumination and suppression of emotions. The findings showed that maladaptive emotion regulation strategies were positively associated with ED symptoms while the use of adaptive strategies was negatively associated with ED psychopathology. Interestingly, this was the case across ED diagnoses and the authors found no significant evidence of group differences in the analyses. Additionally, no particular strategy came out as more closely associated with ED psychopathology, instead it appeared that all adaptive strategies were equally negatively associated and all maladaptive strategies were equally positively associated with ED symptomatology.

Although the findings from previous reviews highlight the interesting associations between emotion regulation difficulties and ED psychopathology, whether there is a particular aspect of emotion regulation that has a most important role in EDs remains unclear. This question could be approached using the network meta-analysis technique, which explores comparative associations of several emotion regulation strategies by utilising existing direct evidence to estimate indirect evidence. This approach has been previously used to compare different interventions to identify most effective treatments (Cuijpers et al., 2020; Davies et al., 2018; Landoni et al., 2013; Padwal et al., 2011). More recently the network meta-analysis approach has also been used to compare associations in the field of educations (Saha & Cutting, 2019). The authors demonstrated a method of applying network meta-analysis to investigate which test was the most closely associated with pupils reading fluency, in an attempt to identify the most useful reading test to be used in school setting. Such a methods could also be applied to emotion regulation in EDs to identify if there is a

particular strategy that is most closely associated with ED symptomatology. This approach could inform the development of novel interventions for EDs rather than aiming to generally increase the use of adaptive strategies and reduce reliance on maladaptive strategies.

The aim of this meta-analytic review was to build on and synthesise previous literature by comparing findings from previous work examining the association between different aspects of emotion regulation and ED psychopathology among people with a diagnosis of an ED. Thus, this review aimed to build on the recent work by (Prefit et al., 2019) and conduct a network meta-analysis. We compared the use of adaptive emotion regulation strategies, including acceptance of emotions, awareness of emotions, problem solving, and cognitive reappraisal, as well as maladaptive emotion regulation strategies, such as avoidance, rumination, and emotion suppression. The objective was to identify aspects of emotion regulation that have closest association with ED symptomatology to identify useful targets for therapeutic interventions. As previous work has suggested that difficulties in emotion regulation may be trans-diagnostic (Prefit et al., 2019; Puttevils et al., 2021), we assessed the associations between the use of different emotion regulation strategies and ED symptomatology across ED diagnoses. Because findings from previous meta-analyses have reported very similar associations between different emotion regulation strategies and ED symptomatology, we did not have *a priori* expectations regarding which one or more emotion regulation strategies would emerge as being most closely associated with ED psychopathology.

3 Materials and Methods

3.1 Literature search

The following keywords were used to search electronic databases including PsychINFO, PsychARTICLES, Medline, Scopus, Pubmed, and Web of Knowledge: (*'eating disorder' OR 'anorexia nervosa' OR 'bulimia nervosa' OR 'binge eating disorder'*) AND (*'emotion regulation' OR 'emotion dysregulation' OR 'affect regulation' OR 'affect dysregulation' OR 'avoidance' OR 'suppression' OR 'rumination' OR 'problem solving' OR 'problem coping' OR 'awareness' OR 'mindfulness' OR 'acceptance' OR 'clarity' OR 'appraisal' OR 'reappraisal'*). Where possible filters were used to exclude animal studies, case reports, reviews, and studies not published in English. The initial search was conducted in April 2021 and was updated in August 2021. Bibliographies of included papers and the previous review by (Prefit et al., 2019) were searched to identify any studies missed in the initial search.

3.2 Inclusion criteria

To be included in the review the studies were required to meet the following inclusion criteria: 1.) include a group of adults or adolescents with a diagnosis of an ED, 2.) measure some aspect of emotion regulation, 3.) measure ED symptomatology, 4.) be published in English, and 5.) be published in a peer reviewed journal. In the case of longitudinal or interventional studies, only emotion regulation and ED symptomatology measures taken at baseline or pre-treatment were included. Additionally, studies that only assessed emotion regulation and/or ED symptomatology at a later stage, post-intervention or at treatment follow-up, were excluded. As we were interested in comparing different emotion regulation strategies, any studies that reported only overall measures and did not assess a specific aspects of emotion regulation were not included. Studies that instructed

participants to use specific emotion regulation strategies or assessed regulation of eating or other aspects of food intake, or emotion regulation related behaviours that were to do with food, eating or bodies, such as food avoidance, or body image acceptance, were also excluded. Finally, studies that included young children or clinical populations with diagnoses other than an ED were excluded.

3.3 Study selection

This review was conducted in accordance with the PRISMA guidelines and the flow diagram detailing the literature search and study selection is presented in Figure 1. The initial search and screening based on title and abstract was conducted by J.L. along with H.M. The included full text articles were then assessed for eligibility and decisions about final inclusion or exclusion of articles was made initially by the first author. All excluded papers were screened again based on title and abstract by H.M. to ensure no relevant studies were missed. In case uncertainty regarding whether a given study should be included or excluded, the full text article was brought to the rest of the team for consensus meeting and team discussion.

Figure 1. Flow diagram

-----FIGURE 1-----

ED = Eating disorder; EMA = ecological momentary assessment

3.4 Data collection and synthesis

To conduct the network meta-analysis, we took a similar approach to a recent review investigating associations between oral reading fluency and text complexity measures to identify an assessment method most closely correlated with reading fluency (Saha & Cutting, 2019). Thus, correlation coefficient between an emotion regulation measure and ED symptomatology was extracted from all

included papers along with the ED group sample size, the aspect of emotion regulation assessed, and the type of ED symptomatology measure used. Only correlation analysis conducted within the ED group were included. If only correlations for the whole sample which included healthy participants or participants with other diagnoses were reported, the corresponding author was contacted to obtain access to a within ED group correlation coefficient. If a study included more than one ED group separate correlation coefficients for each diagnostic group or one correlation coefficient for the whole mixed ED group were included depending on what was reported. We did not favour separate correlation coefficients as the meta-analysis included all ED diagnoses. The relevant data was not reported in the main text or supplementary materials of 267 studies and the corresponding authors were contacted by D.B. to gain access to the data. Correlation coefficients which were not reported in 29 of the included manuscripts, were obtained through personal correspondence. Additional data regarding the age of the ED group, body mass index (BMI), and percentage of female participants was also extracted where available.

3.5 Methods used to assess emotion regulation

We included studies that assessed the use of adaptive emotion regulation strategies, including reappraisal, acceptance of emotions, emotional awareness, and problem solving, as well as the use of maladaptive emotion regulation strategies, such as avoidance, suppression, and rumination.

3.5.1 Adaptive emotion regulation measures

Thirty-one studies assessed the association between acceptance of emotions and ED symptomatology. Four different methods were used to assess acceptance of emotions (see Table 1 for details), all of which were self-report questionnaire measures. The most commonly used measure was the Difficulties in Emotion Regulation Scale (DERS; (Gratz & Roemer, 2004)) non-acceptance subscale (N = 24). For the purposes of the meta-analysis all correlation coefficients had

to have the same direction, with positive correlations indicating that a greater level of ED symptomatology was associated with more difficulties in emotion regulation. Therefore, the correlations that included measures of acceptance of emotions were reversed, while correlation that included measures of non-acceptance or difficulties in accepting emotions were not reversed. This was done to reflect reverse scoring of adaptive emotion regulation, whereby higher scores indicate less acceptance and, thus, this review assessed associations between non-acceptance of emotions and ED symptomatology.

Thirty-eight studies examined associations between emotional awareness and ED symptomatology. Nine different measures were used to assess awareness of emotions (Table 1), eight of which were self-report questionnaire measures. The most commonly used measure was the DERS lack of emotional awareness subscale (N = 24). One of the measures used, the Levels of Emotional Awareness, is a performance based measure assessing participants' awareness of their own and other's emotions. Although this review builds on the previous meta-analytic review by (Prefit et al., 2019) we did not include emotional clarity as a separate category. We found that the methods used to assess emotional clarity were very similar to those used to evaluate emotional awareness and thus these two categories were combined. Studies assessing mindfulness were also combined with those investigating emotional awareness and clarity as the measures used were deemed to be very similar, examining similar underlying construct. As above, the correlations that included measures of emotional awareness, were reversed, while those that included measures of lack of awareness or difficulties in emotional awareness were kept as is. Therefore, this review ended up assessing associations between lack of emotional awareness and ED symptomatology.

Thirty-four studies examined associations between the impact of emotions on participant's problem solving abilities and ED symptomatology (Table 1). Six different measures were used to assess problem solving, four of which were self-report questionnaires and the most commonly used

measure of problem solving was the DERS difficulties with goal directed behaviours subscale (N = 24). One of the measures, the Means-Ends Problem-Solving Test (MEPS; (Platt & Spivack, 1975)), was a performance-based measure used to evaluate the effectiveness of participants problem solving strategies. In this task participants are given the beginning and end of four different scenarios and they are then asked to provide the middle part connecting the beginning and ending. In all but two of the measures a higher score indicated better problem solving and thus, the correlation coefficients were reversed for the meta-analysis to assess association between problem solving difficulties and ED symptomatology. The Social Problem-Solving Inventory-Revised (SPSI-R; (D’Zurilla, Nezu, & Maydeu-Olivares, 2002)) includes the negative problem orientation subscale and the DERS includes difficulties with goal directed behaviours subscale, both of which assess negative approach that prevents effective problem solving. This subscale was used in the present review.

Eight studies examined associations between cognitive reappraisal of emotions and ED symptomatology (Table 1). Two different measures were used to assess cognitive reappraisal, both of which were self-report questionnaires and the most commonly used measure was the Emotion Regulation Questionnaire (ERQ; (Gross & John, 2003)) reappraisal subscale (N = 5). In both questionnaires, higher scores indicated greater use of cognitive reappraisal and thus, the correlation coefficients were reversed to assess associations between lack of cognitive reappraisal and ED symptomatology.

3.5.2 Maladaptive emotion regulation measures

Forty-seven studies investigated associations between emotional avoidance and ED symptomatology (Table 1). Twenty-one different measures were used to assess emotional avoidance, sixteen of which were self-report questionnaires; the most commonly used measure was

the Temperament and Character Inventory (TCI; (Garcia, Lester, Cloninger, & Robert Cloninger, 2017)) harm avoidance subscale (N = 13). One of the measures, the Anagram solution task, used a behavioural measure of avoidance of threatening words. In this task, participants were given a set of anagrams to solve and the time taken to reach the correct solution was used to measure avoidance. In all measures, higher scores indicated more avoidance.

Seven studies examined associations between rumination and ED symptomatology (Table 1). Four different measures were used to assess rumination, all of which were self-report questionnaires. The most commonly used measure to assess rumination was the Ruminative Response Scale (RSS; (Treynor, Gonzalez, & Nolen-Hoeksema, 2003)) (N= 5). One of the questionnaires used was adapted from the RSS to assess ED specific rumination (Cowdrey & Park, 2012). In all measures used, higher scores indicated more rumination.

Thirteen studies investigated association between emotion suppression and ED symptomatology (Table 1). Six different measures were used to assess emotion suppression, five of which were self-report questionnaires and the most commonly used measure was the only task-based assessment, which examined evoked facial affect (N = 5). In the Evoked facial affect task, participants were presented with emotionally provoking stimuli and their evoked facial expressions were analysed. In this task, higher scores indicated more emotion expression and less suppression, and thus, the correlation coefficients were reversed to reflect reverse scoring of the task. In all self-report measures, higher scores indicated more emotion suppression.

3.6 Quality assessment

Quality assessment was conducted by J.L. and D.B. using the JBI Quasi-Experimental Appraisal Tool to investigate study level bias and the results are shown in Supplementary Figure 1. All

included studies were deemed to be high enough quality to be included in the meta-analysis. Inter-rater reliability was good (intra-class correlation coefficient = 0.81, 95% CI [0.78, 0.83]). Any disagreements were resolved through group discussion.

3.7 Statistical analysis

We conducted a Bayesian network meta-analysis to examine which aspects of emotion regulation were most closely associated with ED symptomatology. The meta-analysis was conducted in R (R Core Team, 2020) using the packages *gemtc* (van Valkenhoef et al., 2012) and *metafor* (Viechtbauer, 2010). First, all relevant correlation coefficients of the association between an aspect of emotion regulation and ED symptomatology were extracted from the included studies. The Pearson's r coefficients were then adjusted using sample-size weights to approximate population correlation and Fisher's r -to- z transformed was conducted using the function *escalc* from the package *metafor*. We converted the correlation coefficients to z -scores for the purposes of the network meta-analysis as z -scores are not bounded and come from a normal distribution. We then calculated standard error for each study from the sample size adjusted variance using the following steps

$$\sigma = \sqrt{v}$$

$$SE = \frac{\sigma}{\sqrt{n}}$$

where v is the estimated, sample size adjusted variance, σ is the standard deviation, and n is the sample size. The sample size adjusted correlation coefficients and standard errors were then taken forward to conduct the network meta-analysis.

First, we generated an initial network of the data where edge thickness represents the number of studies that reported that correlation. The generated network object was then taken forward to

specify and compile the random effects model with four Markov chains and a normal likelihood function with an identity link. Next, a Markov Chain Monte Carlo (MCMC) simulation was conducted to estimate the posterior probabilities. To ensure convergence we specified 100000 iterations with 5000 burn-in iterations. The Gelman-Rubin plots are presented in Supplementary Figure 2. The parameter estimation is conducted by utilising Just Another Gibbs Sampler (JAGS). We then generated rank probability and forest plots to visualise the direct comparisons between different aspects of emotion regulation and to examine which aspect was the most closely associated with ED symptomatology. Additionally, we also calculated Surface Under the Cumulative Ranking (SUCRA) score to evaluate which aspect of emotion regulation is most relevant in terms of ED symptomatology and might serve a useful target for interventions.

Network inconsistency was examined using a network splitting method and node comparisons with Bayesian $p < 0.05$ were considered to be indicating inconsistency in the network. As we included studies with adolescent and adult participants of any gender who had any ED diagnosis, meta-regressions were conducted to explore if any possible network inconsistency could be explained by between-study heterogeneity in age, BMI, and whether the studies had female only or mixed samples. The meta-regressions were conducted by taking the above steps with a specified regressor.

This review has been registered on PROSPERO (ID: CRD42021249996) and the code and data used to conduct the meta-analysis is available on the Open Science Framework online repository (https://osf.io/gz3kt/?view_only=6fe361c208e04817b820c1f3fb2fd2b5).

4 Results

4.1 Study characteristics

The characteristics of each study included in the review are summarised in Table 1. Altogether, data from 19 734 participants were included in the meta-analysis, with average study sample size of 181 (range = 6 – 2405). Majority, 72, of the studies included only female participants and three studies did not report the participants’ gender. Additionally, most studies included a mixed ED sample and assessed emotion regulation across ED diagnoses while 50 studies examined emotion regulation within one diagnostic group. The mean age across studies was 27.7 (range = 15.0 – 49.3); most studies included adults and only eight studies included a sample of adolescents with sample mean age below 18. The mean BMI across studies was 22.25 (range = 14.6 – 39.7), with most studies including people who were of healthy weight, and 29 studies including underweight participants with sample mean BMI below 18.5 and 15 studies including overweight participants with sample mean BMI above 25.

Table 1. Study characteristics

-----TABLE 1-----

ED = eating disorder; AN = anorexia nervosa; BN = bulimia nervosa; BED = binge eating disorder; ARFID = avoidant restrictive food intake disorder; OSFED = other specified feeding and eating disorder; EDNOS = eating disorder not otherwise specified; BMI = body mass index; SVF120 = Coping and Stress Questionnaire (Stressverarbeitungsfragenbogen); DERS = difficulties in emotion regulation scale; AAQ-II = acceptance and avoidance questionnaire (version 2); AAQ-W = acceptance and avoidance questionnaire (weight-related); PHLMS = Philadelphia mindfulness scale; ACF = Attention and Clarity of One’s Feelings and the Feelings of Others; LEAS = levels of emotional awareness; CAMS-R = cognitive and affective mindfulness scale; EPS = emotional

processing scale; MAAS = mindful attention awareness scale; FFQM = five facet mindfulness scale; SMQ = Southampton mindfulness questionnaire; KIMS = Kentucky inventory of mindfulness skills; SPSI-R = social problem solving inventory (revised); COPE = coping orientation to problem experienced inventory; CISS = coping inventory for stressful situations; MEPS = Means-Ends Problem-Solving Test; UCL = Utrecht coping list; DTS = distress tolerance scale; ERQ = emotion regulation questionnaire; EAQ = experiential avoidance questionnaire; BEAQ = brief experiential avoidance questionnaire; BSBS = brief safety behaviours scale; DAPP-BQ = dimensional assessment of personality pathology (basic questionnaire); DB = decisional balance; DSI = differentiation of self inventory; DSI-R = differentiation of self inventory (revised); YRAI = Young-Rygh avoidance inventory; CET = compulsive exercise test; REI = reasons for exercise; MANQ = meanings of anorexia nervosa questionnaire; AFQ-Y = avoidance and fusion questionnaire for youth; PCL-5 = post-traumatic stress disorder checklist; TCI = temperament and character inventory; TPQ = temperament and personality questionnaire; PCT-Q = pre-morbid childhood traits questionnaire; DIDS = dimensions of identity development scale; RRS = ruminative response scale; RRS-ED = ruminative response scale (eating disorder version); PTQ = perseverative thinking questionnaire; STSS = silencing the self scale; YSQ = Young's schema questionnaire; STAXI-1 = state-trait anger expression inventory (version 2); BES = binge eating scale; EDI = eating disorder inventory; ELOC = eating loss of control scale; EDE = eating disorder examination; EDEQ = eating disorder examination questionnaire; EDQOL = eating disorder quality of life questionnaire; RS = restraint scale; DEBQ = Dutch eating behaviour questionnaire; PMT = progress monitoring tool; EAT = eating attitudes test; EDDS = eating disorder diagnostic scale; EEQ = emotional eating questionnaire; BITE = bulimic inventory test; YEDE-Q = youth eating disorder examination questionnaire; EPSI = eating pathology symptom inventory;

4.2 Network characteristics

The initial network graph, in Figure 2, shows the eligible comparisons to identify emotion regulation strategy most strongly linked to ED symptomatology. The thickness of the edges indicates the number of studies that evaluated a given association or comparison. In the present review most of the studies ($N = 50$) examined the association between avoidance and ED symptomatology. Across the 105 included studies, 294 correlations contributed to the network. All emotion regulation strategies were compared with at least one other emotion regulation method in addition to the association with ED symptoms resulting in a well connected network, which is more likely to produce reliable results (Mills, Thorlund, & Ioannidis, 2013).

Figure 2. Initial network plot

-----FIGURE 2-----

Line thickness represents the number of studies reporting the association.

4.3 Forest plot

The forest and SUCRA plots from the Bayesian random effects network meta-analysis are shown in Figure 3. Each emotion regulation strategy represents a unit of analysis and is thus presented on the rows. Larger positive effect sizes indicate a stronger association between a given emotion regulation strategy and ED symptomatology. The meta-analysis showed that the emotion regulation strategies vary in their relationship with ED symptomatology, with two methods showing the strongest association: rumination ($ES = 0.51$, 95% CrI [0.33,0.69]) and non-acceptance of

emotions (ES = 0.43, 95% CrI [0.35,0.51]). Lack of cognitive reappraisal had the weakest association with ED psychopathology (ES = 0.17, 95% CrI [0.02,0.34]).

Figure 3. Forest and SUCRA plots

-----FIGURE 3-----

A. Forest plot showing the associations between the emotion regulation strategies and ED symptoms. B. Bar plot showing the surface under the cumulative ranking (SUCRA) for each emotion regulation method. ES = effect size; CrI = Credible Interval.

4.4 Meta-regressions

Network inconsistency was evaluated using the node-split method (Supplementary Figure 3). Although there was no evidence of significant inconsistency, the comparisons between problem solving difficulties and lack of emotional awareness ($p = 0.076$) and rumination and non-acceptance of emotions ($p = 0.084$) approached significance. Therefore, three meta-regressions were conducted to examine whether these slight inconsistencies could be explained between-study differences in BMI, age, or whether the study included only female participants or a mixed sample of participants. The meta-regressions revealed a significant effect of BMI ($b = -0.09$ CrI [-0.18,-0.01]) such that the associations between different emotion regulation strategies and ED psychopathology were weaker among those with low BMI. There was no significant effect of age ($b = -0.04$, CrI [-0.14,0.06]) or whether the studies included of only female or mixed participants ($b = 0.02$, CrI [-0.12,0.32]).

5 Discussion

The aim of the present review was to examine associations between various emotion regulation strategies and ED psychopathology trans-diagnostically to identify strategies that were most closely linked with psychopathology. We used network meta-analysis approach with a well-connected network, which identified rumination and non-acceptance of emotions to be most closely associated with ED symptomatology. Difficulties in cognitive reappraisal was found to be the least connected with ED symptomatology of all emotion regulation strategies examined in this review. There was some evidence of network inconsistency which approached significance and two meta-regressions were performed to examine if this could be explained by the between-study variability in BMI or age. The meta-regressions were non-significant suggesting the findings were consistent across age groups and BMI.

The present review adds to the steady accumulation of evidence highlighting the relationship between maladaptive emotion regulation based on rumination and ED symptomatology (Palmieri et al., 2021; Smith, Mason, & Lavender, 2018). Over the recent years, studies using ecological momentary assessments (EMAs) have reported that rumination and repetitive negative thinking predicts engagement in ED behaviour, including body checking and binge eating (Sala, Brosf, & Levinson, 2019; Smith et al., 2021; Svaldi, Werle, Naumann, Eichler, & Berking, 2019). One EMA study also reported that excessive rumination also predicted higher levels of ED psychopathology at a one month follow-up assessment (Sala et al., 2019). Moreover, it has been suggested that some ED symptoms, such as excessive focus on food, eating, and body weight and shape, are forms of illness specific rumination (Cowdrey & Park, 2011). Indeed, a longitudinal study using EMA and biological assessments found that food-related rumination was linked to BMI status and leptin levels among people in treatment for anorexia nervosa (Fürtjes et al., 2018). This suggest that at least certain aspects of illness-specific rumination may be linked to under-nutrition and

physiological signalling, explaining why weight restoration can have a positive impact on this type of rumination. Overall, it appears that rumination, whether general repetitive negative thinking or illness-specific, is a key characteristic of the acute stage of an ED.

It is important to note that most of the studies included in the present review used the RRS questionnaire, which assesses brooding, depressive rumination, and reflection. Therefore, it is possible that the observed strong association between rumination and ED psychopathology may be partially explained by known links between depression and ED symptoms (Ridout et al., 2021; Spindler & Milos, 2007). Indeed, one study reported that although food-related rumination was linked to stage of illness and under-nutrition, other aspects of illness-specific rumination including, body weight and shape, were more associated with negative mood than not ED symptoms (Fürtjes et al., 2018). Additionally, an experimental study has reported that induction of body shape related rumination had a direct negative impact on mood but not on ED cognitions among people with BED (Svaldi & Naumann, 2014). Another interpretation is that the above findings may reflect the mechanism through which rumination influences EDs: due to its repetitive nature of rumination forms a habitual relationship with depressive mood which in turn fuels ED symptomatology (Smith & Juarascio, 2019). In support of this hypothesis, one longitudinal EMA study documented a bidirectional mediation between rumination, negative mood, and ED symptoms (Smith et al., 2021). The authors found that rumination mediated the association between low mood and ED symptomatology and low mood in turn mediated the association between rumination and ED symptomatology. Taken together these findings highlight the need to further examine the underlying processes through which rumination impacts EDs and how rumination may impact illness progression and recovery.

Difficulties accepting emotions was another emotion regulation domain that was highly associated with ED psychopathology in the present review. This is in line with findings from the general population showing that reduced use of adaptive emotion regulation strategies, such as acceptance, and increased reliance on maladaptive methods, including suppression and avoidance, are associated with daily habit of food restriction (Mikhail & Kring, 2019). Similarly, people who report objective binge eating episodes and loss of control over eating also report more difficulties accepting emotions than those who do not engage in disorder eating behaviours (Racine & Horvath, 2018). Additionally, a recent longitudinal study reported that a poor response to CBT-based ED treatment was associated with lack of change in the patients' self-reported ability to accept emotions and limited access to other effective emotion regulation strategies (Mallorqui-Bague et al., 2018). Moreover, another interventional study found that irrespective of treatment condition, changes in acceptance of emotions were associated with greater improvements in ED-related quality of life post-intervention (Juarascio, Schumacher, Shaw, Forman, & Herbert, 2015). These findings have led some authors to suggest that emotion regulation in general and acceptance of unwanted emotions in particular should be added to current standard ED treatments (Juarascio, Manasse, Schumacher, Espel, & Forman, 2017; Mallorqui-Bague et al., 2018). While it seems that acceptance of emotions may have a strong role in disordered eating and the progression of EDs, further investigation of the underlying mechanism would be of interest to aid the development of evidence-based interventions.

Interestingly, difficulties accepting emotions has also been proposed to be linked to excessive reliance on other maladaptive emotion regulation strategies, including avoidance and suppression (Hayes et al., 2004; Hofmann & Asmundson, 2008). If unwanted emotions are deemed unacceptable, a person might put great effort in avoiding situations that give rise to such emotions or, if the emotions are already present, engage in suppression in an attempt to manage the unwanted emotions. Findings from a review of experimental and self-report studies support this notion

reporting links between suppression and non-acceptance of emotion among people with AN and BN (Lavender et al., 2015). Further, difficulties in emotion regulation, including non-acceptance of emotions, have been found to mediate the association between experiential avoidance and ED psychopathology among people with a range of ED diagnoses (Wolz et al., 2015). Similar findings have been reported in the general population with reduced access to adaptive emotion regulation strategies, including acceptance of emotions and reappraisal, and increased reliance on maladaptive strategies based on suppression being associated with greater tendency to engage in ED-related behaviours (Mikhail & Kring, 2019). Thus, further investigation of the mechanisms that might underlie this connection as well as examination of the impact of acceptance-focused interventions on the use of other emotion regulation strategies among people with EDs may be of interest.

Interestingly, our meta-regression also found a significant effect of BMI, such that the associations were generally weaker among those with lower BMI. This is somewhat in contrast with previous reviews suggesting that there are no significant differences in the associations between emotion regulation methods and ED psychopathology between different ED diagnostic groups characterised by low and high BMI (Prefit et al., 2019; Puttevils et al., 2021). However, some studies have reported that starvation impacts emotion regulation in such a way that those with very low BMI in the acute stage of AN report fewer difficulties (Brockmeyer et al., 2012). Indeed, it has been suggested that self-starvation itself works as an emotion regulation strategy which reduces both the internal experience and external expression of emotions through (Haynos & Fruzzetti, 2011). By suppressing physiological responses and arousal, starvation can help the person escape and avoid unwanted emotions (Haynos & Fruzzetti, 2011; Henderson, Fox, Trayner, & Wittkowski, 2019). If no alternative methods are available, the person may over time become reliant on starvation as their sole emotion regulation strategy due to its numbing effect (Oldershaw, Startup, & Lavender, 2019; Schmidt & Treasure, 2006). This mechanism could be one of the factors contributing to the present finding and it further highlights the complex relationship between emotion regulation and EDs.

5.1 Clinical implications

Over the recent years, several reviews have recommended the use of interventions aimed at reducing rumination and repetitive negative thinking, Metacognitive Therapy (MCT) and Rumination-Focused Cognitive Behavioural Therapy (RFCBT), such as in the treatment of EDs (Palmieri et al., 2021; Prefit et al., 2019; Smith et al., 2018; Trompeter et al., 2021). MCT and RFCBT have been successfully used to treat anxiety and depression among other psychiatric disorders, and there is some evidence suggesting that rumination-focused treatments may help reduce the risk of relapse in depression (Normann, van Emmerik, & Morina, 2014; Spinhoven et al., 2018; Watkins et al., 2011). Furthermore, one of the meta-analytic reviews found a very high correlation between rumination and ED symptomatology among the general population, which led the authors to suggest that rumination may be a useful target for interventions aiming to prevent EDs and other forms of disordered eating (Palmieri et al., 2021). To date, very few studies examining the impact of interventional designed to target rumination in EDs have been conducted. To our knowledge only one case series has explored the effects of MCT on binge eating behaviour among three people with BED (Robertson & Strodl, 2020). MCT aims to alleviate repetitive negative cognitions by increasing awareness and mindfulness, and modifying the metacognitions that underlie maladaptive behaviours, such as binge eating (Papageorgiou, 2015; Wells et al., 2009). The Robertson & Strodl (2020) found that MCT intervention significantly reduced binge eating frequency and improved cognitions related worry and rumination. There improvements were maintained at a 2-month follow-up assessment. Together, these findings highlight the need to develop new interventions or adapt existing treatments to target rumination and repetitive negative thinking in EDs.

Acceptance and mindfulness based interventions, such as Acceptance and Commitment Therapy (ACT), have been proposed to target difficulties in coping with unwanted emotions in EDs (Juarascio et al., 2017; Manlick, Cochran, & Koon, 2013). The purpose of ACT is to encourage people to accept and experience unwanted emotions without attempts to modify them, thus reducing avoidance and suppression of difficult emotions and embracing the use of adaptive emotion regulation strategies (Manlick et al., 2013). A number of small case series have reported that ACT can be effective in reducing ED symptomatology and behaviours among people with AN and BED (Berman, Boutelle, & Crow, 2009; Hill, Masuda, Melcher, Morgan, & Twohig, 2015; Wildes & Marcus, 2011). Another larger longitudinal treatment study found that ACT was more effective than treatment as usual in reducing residual ED symptoms and risk of relapse following standard ED treatment and the effects were maintained at a 2-year follow-up (Fogelkvist, Gustafsson, Kjellin, & Parling, 2020). However, another interventional study found that ACT did not lead to greater improvements in ED related quality of life than treatment as usual (Juarascio et al., 2015). Furthermore, a systematic review examining the use of ACT to treat body image disturbance and weight dissatisfaction reported that they could not determine the effectiveness of ACT due to the poor quality of current evidence (Griffiths, Williamson, Zucchelli, Paraskeva, & Moss, 2018). These findings suggest that acceptance and mindfulness based interventions may be promising in the treatment of EDs, but more research into the mechanisms that underlie the relationship between emotion acceptance and ED psychopathology is needed to create evidence-based treatment strategies.

5.2 Limitations

The main limitation of this review was the use of the network meta-analysis due to its use of indirect evidence, which relies on the assumption of transitivity (Ioannidis, 2006). According to the transitivity assumption, a given association is exchangeable between studies even if a given study did not assess that association. This assumption can be violated by individual differences in the

samples between studies, which can be difficult to control resulting in network inconsistency. Although we did not observe significant network inconsistency, there was evidence of near significant inconsistency in two comparisons. Another limitation of this review is that majority of the studies included adult women with normal BMI. Although the meta-regressions indicated that BMI and age did not have a significant impact on the results, findings from the present review may not be fully generalisable to young people at the extreme ends of the BMI spectrum. Additionally, the findings may not be fully generalisable to other genders. Gender identity can impact a person's experiences with the world around them and thus influence their emotion regulation habits (Gillikin, Manasse, & Seager van Dyk, 2021; Katz-Wise, Rosario, & Tsappis, 2016). Thus, further exploration of the impact of gender and particularly minority gender identity on emotion regulation in EDs is needed. Finally, it is also important to note that we did not have equal number of studies examining each association. Indeed, only eight studies reported correlations involving difficulties with cognitive reappraisal and this method was found to be most weakly associated with ED psychopathology with largest between study variance. It is possible that this finding may have been impacted by the small number of studies included. However, only seven studies reported correlations involving rumination and this maladaptive strategy was found to be most strongly associated with ED psychopathology. Still, equal and large number of studies examining each association would enable us to draw stronger conclusions.

6 Conclusions

This review aimed to build on previous work by conducting a trans-diagnostic network meta-analysis to identify emotion regulation strategies most closely associated with psychopathology among those with ED. The meta-analysis revealed that rumination and difficulties accepting emotions were most closely associated with ED symptoms, while the weakest association was between difficulties with cognitive reappraisal and ED symptoms. The meta-regressions showed that BMI had significant impact such that the associations between various emotion regulation strategies and ED psychopathology were weaker among those with low BMI. The present findings add to the steady accumulation of evidence highlighting the relationship between ED psychopathology and reliance on maladaptive emotion regulation strategies based on rumination and non-acceptance of emotions. Together with previous longitudinal observational studies and ecological momentary assessments, these findings suggest that these two maladaptive strategies may have a key role in maintaining and perpetuating ED. The meta-regression finding also emphasises the complex relationship between ED symptoms and emotion regulation. It is possible that some people with ED may use starvation and malnutrition to escape and avoid unwanted emotions. Thus, there is pressing need to explore and develop interventions targetting emotion regulation difficulties in ED with particular focus on rumination and non-acceptance of emotions.

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8 References

- Aldao, A., Nolen-Hoeksema, S., & Schweizer, S. (2010a). Emotion-regulation strategies across psychopathology: A meta-analytic review. *Clinical Psychology Review*, 30(2), 217–237.
- Aldao, A., Nolen-Hoeksema, S., & Schweizer, S. (2010b, March). Emotion-regulation strategies across psychopathology: A meta-analytic review. *Clinical Psychology Review*. <https://doi.org/10.1016/j.cpr.2009.11.004>
- Berman, M. I., Boutelle, K. N., & Crow, S. J. (2009). A case series investigating acceptance and commitment therapy as a treatment for previously treated, unremitted patients with anorexia nervosa. *European Eating Disorders Review*, 17(6), 426–434. <https://doi.org/10.1002/erv.962>
- Brockmeyer, T., Holtforth, M. G., Bents, H., Kämmerer, A., Herzog, W., & Friederich, H. C. (2012). Starvation and emotion regulation in anorexia nervosa. *Comprehensive Psychiatry*, 53(5), 496–501. <https://doi.org/10.1016/j.comppsy.2011.09.003>
- Cowdrey, F. A., & Park, R. J. (2011). Assessing rumination in eating disorders: Principal component analysis of a minimally modified ruminative response scale. *Eating Behaviors*, 12(4), 321–324. <https://doi.org/10.1016/j.eatbeh.2011.08.001>
- Cowdrey, F. A., & Park, R. J. (2012). The role of experiential avoidance, rumination and mindfulness in eating disorders. *Eating Behaviors*, 13(2), 100–105. <https://doi.org/10.1016/j.eatbeh.2012.01.001>
- Cuijpers, P., Noma, H., Karyotaki, E., Vinkers, C. H., Cipriani, Andrea, & Furukawa, T. A. (2020). A network meta-analysis of the effects of psychotherapies, pharmacotherapies and their combination in the treatment of adult depression. *World Psychiatry*, 19(1), 92–107. <https://doi.org/https://doi.org/10.1002/wps.20701>
- D’Zurilla, T. J., Nezu, A. M., & Maydeu-Olivares, A. (2002). Social problem-solving inventory-revised.
- Davies, C., Cipriani, A., Ioannidis, J. P. A., Radua, J., Stahl, D., Provenzani, U., ... Fusar-Poli, P. (2018). Lack of evidence to favor specific preventive interventions in psychosis: a network meta-analysis. *World Psychiatry*, 17(2), 196–209. <https://doi.org/https://doi.org/10.1002/wps.20526>
- Dingemans, A., Danner, U., & Parks, M. (2017). Emotion Regulation in Binge Eating Disorder: A Review. *Nutrients* . <https://doi.org/10.3390/nu911274>
- Fogelkvist, M., Gustafsson, S. A., Kjellin, L., & Parling, T. (2020). Acceptance and commitment therapy to reduce eating disorder symptoms and body image problems in patients with residual eating disorder symptoms: A randomized controlled trial. *Body Image*, 32, 155–166. <https://doi.org/http://dx.doi.org/10.1016/j.bodyim.2020.01.002>

- Fürtjes, S., Seidel, M., King, J. A., Biemann, R., Roessner, V., & Ehrlich, S. (2018). Rumination in anorexia nervosa: Cognitive-affective and neuroendocrinological aspects. *Behaviour Research and Therapy*, 111, 92–98. <https://doi.org/10.1016/j.brat.2018.10.001>
- Garcia, D., Lester, N., Cloninger, K. M., & Robert Cloninger, C. (2017). Temperament and Character Inventory (TCI) BT - Encyclopedia of Personality and Individual Differences. In V. Zeigler-Hill & T. K. Shackelford (Eds.) (pp. 1–3). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-28099-8_91-1
- Gillikin, L. M., Manasse, S. M., & Seager van Dyk, I. (2021). An examination of emotion regulation as a mechanism underlying eating disorder pathology in lesbian, gay, and bisexual individuals. *Eating Behaviors*, 41, 101508. <https://doi.org/10.1016/j.eatbeh.2021.101508>
- Gratz, K. L., & Roemer, L. (2004). Multidimensional Assessment of Emotion Regulation and Dysregulation: Development, Factor Structure, and Initial Validation of the Difficulties in Emotion Regulation Scale. *Journal of Psychopathology and Behavioral Assessment*, 26(1), 41–54. <https://doi.org/10.1023/B:JOBA.0000007455.08539.94>
- Griffiths, C., Williamson, H., Zucchelli, F., Paraskeva, N., & Moss, T. (2018). A Systematic Review of the Effectiveness of Acceptance and Commitment Therapy (ACT) for Body Image Dissatisfaction and Weight Self-Stigma in Adults. *Journal of Contemporary Psychotherapy*, 48(4), 189–204. <https://doi.org/10.1007/s10879-018-9384-0>
- Gross, J. J. (1998). The emerging field of emotion regulation: An integrative review. *Review of General Psychology*, 2(3), 271–299.
- Gross, J. J. (2002). Emotion regulation: Affective, cognitive, and social consequences. *Psychophysiology*. Cambridge University Press. <https://doi.org/10.1017/S0048577201393198>
- Gross, J. J. (2015). Emotion regulation: Current status and future prospects. *Psychological Inquiry*, 26(1), 1–26.
- Gross, J. J., & John, O. P. (2003). Individual Differences in Two Emotion Regulation Processes: Implications for Affect, Relationships, and Well-Being. *Journal of Personality and Social Psychology*, 85(2), 348–362. <https://doi.org/10.1037/0022-3514.85.2.348>
- Gross, J. J., & Thompson, R. A. (2006). Emotion regulation: Conceptual foundations. *Handbook of Emotion Regulation*.
- Hayes, S. C., Strosahl, K., Wilson, K. G., Bissett, R. T., Pistorello, J., Toarmino, D., ... McCurry, S. M. (2004). Measuring experiential avoidance: A preliminary test of a working model. *The Psychological Record*, 54(4), 553–578. <https://doi.org/10.1007/BF03395492>
- Haynos, A. F., & Fruzzetti, A. E. (2011). Anorexia Nervosa as a Disorder of Emotion Dysregulation: Evidence and Treatment Implications. *Clinical Psychology: Science and Practice*, 18(3), 183–202. <https://doi.org/10.1111/j.1468-2850.2011.01250.x>
- Henderson, Z. B., Fox, J. R. E., Trayner, P., & Wittkowski, A. (2019). Emotional development in eating disorders: A qualitative metasynthesis. *Clinical Psychology & Psychotherapy*, 26(4), 440–457. <https://doi.org/10.1002/cpp.2365>

- Hill, M. L., Masuda, A., Melcher, H., Morgan, J. R., & Twohig, M. P. (2015). Acceptance and commitment therapy for women diagnosed with binge eating disorder: A case-series study. *Cognitive and Behavioral Practice*, 22(3), 367–378. <https://doi.org/http://dx.doi.org/10.1016/j.cbpra.2014.02.005>
- Hofmann, S. G., & Asmundson, G. J. G. (2008). Acceptance and mindfulness-based therapy: New wave or old hat? *Clinical Psychology Review*, 28(1), 1–16. <https://doi.org/https://doi.org/10.1016/j.cpr.2007.09.003>
- Ioannidis, J. P. A. (2006). Indirect comparisons: the mesh and mess of clinical trials. *Lancet (London, England)*, 368(9546), 1470–1472. [https://doi.org/10.1016/S0140-6736\(06\)69615-3](https://doi.org/10.1016/S0140-6736(06)69615-3)
- Juarascio, A. S., Manasse, S. M., Schumacher, L., Espel, H., & Forman, E. M. (2017). Developing an Acceptance-Based Behavioral Treatment for Binge Eating Disorder: Rationale and Challenges. *Cognitive and Behavioral Practice*, 24(1), 1–13. <https://doi.org/http://dx.doi.org/10.1016/j.cbpra.2015.12.005>
- Juarascio, A. S., Schumacher, L. M., Shaw, J., Forman, E. M., & Herbert, J. D. (2015). Acceptance-based treatment and quality of life among patients with an eating disorder. *Journal of Contextual Behavioral Science*, 4(1), 42–47. <https://doi.org/10.1016/j.jcbs.2014.11.002>
- Katz-Wise, S. L., Rosario, M., & Tsappis, M. (2016). Lesbian, Gay, Bisexual, and Transgender Youth and Family Acceptance. *Pediatric Clinics*, 63(6), 1011–1025. <https://doi.org/10.1016/j.pcl.2016.07.005>
- Landoni, G., Greco, T., Biondi-Zoccai, G., Nigro Neto, C., Febres, D., Pintaudi, M., ... Zangrillo, A. (2013). Anaesthetic drugs and survival: a Bayesian network meta-analysis of randomized trials in cardiac surgery. *BJA: British Journal of Anaesthesia*, 111(6), 886–896. <https://doi.org/10.1093/bja/aet231>
- Lavender, J. M., Wonderlich, S. A., Engel, S. G., Gordon, K. H., Kaye, W. H., & Mitchell, J. E. (2015). Dimensions of emotion dysregulation in anorexia nervosa and bulimia nervosa: A conceptual review of the empirical literature. *Clinical Psychology Review*, 40, 111–122. <https://doi.org/10.1016/j.cpr.2015.05.010>
- Mallorqui-Bague, N., Vintro-Alcaraz, C., Sanchez, I., Riesco, N., Aguera, Z., Granero, R., ... Treasure Zaida; ORCID: <http://orcid.org/0000-0003-4453-4939> AO - Fernandez-Aranda, Fernando; ORCID: <http://orcid.org/0000-0002-2968-9898> AO - Treasure, Janet; ORCID: <http://orcid.org/0000-0003-0871-4596>, J. A. O.-A. (2018). Emotion Regulation as a Transdiagnostic Feature Among Eating Disorders: Cross-sectional and Longitudinal Approach. *European Eating Disorders Review*, 26(1), 53–61. <https://doi.org/http://dx.doi.org/10.1002/erv.2570>
- Manlick, C. F., Cochran, S. V, & Koon, J. (2013). Acceptance and Commitment Therapy for Eating Disorders: Rationale and Literature Review. *Journal of Contemporary Psychotherapy*, 43(2), 115–122. <https://doi.org/10.1007/s10879-012-9223-7>
- Mason, T. B., Smith, K. E., Anderson, L. M., Tyler, H., Smith, K. E., Anderson, L. M., & Mason, V. M. A. O.-. (2021). Anhedonia, positive affect dysregulation, and risk and maintenance of

binge-eating disorder. *International Journal of Eating Disorders*, 54(3), 287–292. <https://doi.org/http://dx.doi.org/10.1002/eat.23433>

Mikhail, M. E., & Kring, A. M. (2019). Emotion regulation strategy use and eating disorder symptoms in daily life. *Eating Behaviors*, 34. <https://doi.org/10.1016/j.eatbeh.2019.101315>

Mills, E. J., Thorlund, K., & Ioannidis, J. P. A. (2013). Demystifying trial networks and network meta-analysis. *BMJ*, 346. <https://doi.org/10.1136/bmj.f2914>

Normann, N., van Emmerik, A. A. P., & Morina, N. (2014). THE EFFICACY OF METACOGNITIVE THERAPY FOR ANXIETY AND DEPRESSION: A META-ANALYTIC REVIEW. *Depression and Anxiety*, 31(5), 402–411. <https://doi.org/https://doi.org/10.1002/da.22273>

Oldershaw, A., Lavender, T., Sallis, H., Stahl, D., & Schmidt, U. (2015, July 1). Emotion generation and regulation in anorexia nervosa: A systematic review and meta-analysis of self-report data. *Clinical Psychology Review*. Elsevier Inc. <https://doi.org/10.1016/j.cpr.2015.04.005>

Oldershaw, A., Startup, H., & Lavender, T. (2019). Anorexia Nervosa and a lost emotional self: A psychological formulation of the development, maintenance, and treatment of Anorexia Nervosa. *Frontiers in Psychology*, 10, 1–22. <https://doi.org/10.3389/fpsyg.2019.00219>

Padwal, R., Klarenbach, S., Wiebe, N., Birch, D., Karmali, S., Manns, B., ... Tonelli, M. (2011). Bariatric surgery: a systematic review and network meta-analysis of randomized trials. *Obesity Reviews*, 12(8), 602–621. <https://doi.org/https://doi.org/10.1111/j.1467-789X.2011.00866.x>

Palmieri, S., Mansueto, G., Scaini, S., Caselli, G., Sapuppo, W., Spada, M. M., ... Ruggiero, G. M. (2021). Repetitive Negative Thinking and Eating Disorders: A Meta-Analysis of the Role of Worry and Rumination. *Journal of Clinical Medicine* . <https://doi.org/10.3390/jcm10112448>

Papageorgiou, C. (2015). Metacognitive Theory, Therapy and Techniques: Introduction to the Special Issue. *Cognitive Therapy and Research*, 39(1), 1–3. <https://doi.org/10.1007/s10608-014-9649-1>

Platt, J. J., & Spivack, G. (1975). *Manual for the Means-Ends Problem-Solving Procedure (MEPS): A measure of interpersonal cognitive problem-solving skill*. Community Mental Health, Mental Retardation Center, Department of Mental

Prefit, A.-B., Cîndea, D. M., & Szentagotai-Tătar, A. (2019). Emotion regulation across eating pathology: A meta-analysis. *Appetite*, 143, 104438. <https://doi.org/10.1016/j.appet.2019.104438>

Puttevils, L., Vanderhasselt, M.-A., Horczak, P., & Vervaeke, M. (2021). Differences in the use of emotion regulation strategies between anorexia and bulimia nervosa: A systematic review and meta-analysis. *Comprehensive Psychiatry*, 109, 152262. <https://doi.org/https://doi.org/10.1016/j.comppsy.2021.152262>

R Core Team. (2020). R: A Language and Environment for Statistical Computing. Vienna, Austria. Retrieved from <https://www.r-project.org/>

- Racine, S. E., & Horvath, S. A. (2018). Emotion dysregulation across the spectrum of pathological eating: Comparisons among women with binge eating, overeating, and loss of control eating. *Eating Disorders*, 26(1), 13–25. <https://doi.org/http://dx.doi.org/10.1080/10640266.2018.1418381>
- Ridout, S. J., Ridout, K. K., Kole, J., Fitzgerald, K. L., Donaldson, A. A., & Alverson, B. (2021). Comparison of eating disorder characteristics and depression comorbidity in adolescent males and females: An observational study. *Psychiatry Research*, 296, 113650. <https://doi.org/https://doi.org/10.1016/j.psychres.2020.113650>
- Robertson, S., & Strodl, E. (2020). Metacognitive therapy for binge eating disorder: A case series study. *Clinical Psychologist*, 24(2), 143–154.
- Saha, N., & Cutting, L. (2019). Exploring the use of network meta-analysis in education: examining the correlation between ORF and text complexity measures. *Annals of Dyslexia*, 69(3), 335–354. <https://doi.org/10.1007/s11881-019-00180-y>
- Sala, M., Brossof, L. C., & Levinson, C. (2019). Repetitive negative thinking predicts eating disorder behaviors: A pilot ecological momentary assessment study in a treatment seeking eating disorder sample. *Behaviour Research and Therapy*, 112, 12–17. <https://doi.org/http://dx.doi.org/10.1016/j.brat.2018.11.005>
- Schmidt, U., & Treasure, J. (2006). Anorexia nervosa: Valued and visible. A cognitive-interpersonal maintenance model and its implications for research and practice. *British Journal of Clinical Psychology*, 45(3), 343–366. <https://doi.org/10.1348/014466505X53902>
- Smith, K. E., & Juarascio, A. (2019). From Ecological Momentary Assessment (EMA) to Ecological Momentary Intervention (EMI): Past and Future Directions for Ambulatory Assessment and Interventions in Eating Disorders. *Current Psychiatry Reports*, 21(7), 53. <https://doi.org/10.1007/s11920-019-1046-8>
- Smith, K. E., Mason, T. B., & Lavender, J. M. (2018). Rumination and eating disorder psychopathology: A meta-analysis. *Clinical Psychology Review*, 61, 9–23. <https://doi.org/https://doi.org/10.1016/j.cpr.2018.03.004>
- Smith, K. E., Mason, T. B., Reilly, E. E., Hazzard, V. M., Borg, S. L., Dvorak, R., ... Wonderlich, S. A. (2021). Examining prospective mediational relationships between momentary rumination, negative affect, and binge eating using ecological momentary assessment. *Journal of Affective Disorders Reports*, 5, 100138. <https://doi.org/https://doi.org/10.1016/j.jadr.2021.100138>
- Spindler, A., & Milos, G. (2007). Links between eating disorder symptom severity and psychiatric comorbidity. *Eating Behaviors*, 8(3), 364–373. <https://doi.org/https://doi.org/10.1016/j.eatbeh.2006.11.012>
- Spinhoven, P., Klein, N., Kennis, M., Cramer, A. O. J., Siegle, G., Cuijpers, P., ... Bockting, C. L. (2018). The effects of cognitive-behavior therapy for depression on repetitive negative thinking: A meta-analysis. *Behaviour Research and Therapy*, 106, 71–85. <https://doi.org/https://doi.org/10.1016/j.brat.2018.04.002>

- Svaldi, J., & Naumann, E. (2014). Effects of Rumination and Acceptance on Body Dissatisfaction in Binge Eating Disorder. *European Eating Disorders Review*, 22(5), 338–345. <https://doi.org/10.1002/erv.2312>
- Svaldi, J., Werle, D., Naumann, E., Eichler, E., & Berking, M. (2019). Prospective associations of negative mood and emotion regulation in the occurrence of binge eating in binge eating disorder. *Journal of Psychiatric Research*, 115, 61–68. <https://doi.org/10.1016/j.jpsychires.2019.05.005>
- 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>
- Trompeter, N., Bussey, K., Forbes, M. K., & Mitchison, D. (2021). Emotion Dysregulation within the CBT-E Model of Eating Disorders: A Narrative Review. *Cognitive Therapy and Research*. <https://doi.org/10.1007/s10608-021-10225-5>
- van Valkenhoef, G., Lu, G., de Brock, B., Hillege, H., Ades, A. E., & Welton, N. J. (2012). Automating network meta-analysis. *Research Synthesis Methods*, 3(4), 285–299. <https://doi.org/10.1002/jrsm.1054>
- Viechtbauer, W. (2010). Conducting meta-analyses in R with the metafor package. *Journal of Statistical Software*, 36(3), 1–48.
- 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. *The British Journal of Psychiatry: The Journal of Mental Science*, 199(4), 317–322. <https://doi.org/10.1192/bjp.bp.110.090282>
- Wells, A., Fisher, P., Myers, S., Wheatley, J., Patel, T., & Brewin, C. R. (2009). Metacognitive Therapy in Recurrent and Persistent Depression: A Multiple-Baseline Study of a New Treatment. *Cognitive Therapy and Research*, 33(3), 291–300. <https://doi.org/10.1007/s10608-007-9178-2>
- Wildes, J. E., & Marcus, M. D. (2011). Development of emotion acceptance behavior therapy for anorexia nervosa: A case series. *International Journal of Eating Disorders*, 44(5), 421–427. <https://doi.org/10.1002/eat.20826>
- Wolz, I., Agüera, Z., Granero, R., Jiménez-Murcia, S., Gratz, K. L., Menchón, J. M., & Fernández-Aranda, F. (2015). Emotion regulation in disordered eating: Psychometric properties of the Difficulties in Emotion Regulation Scale among Spanish adults and its interrelations with personality and clinical severity. *Frontiers in Psychology*, 6(JUN). <https://doi.org/10.3389/fpsyg.2015.00907>