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# **Comprehensive Psychiatry**



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# Differences in the use of emotion regulation strategies between anorexia and bulimia nervosa: A systematic review and meta-analysis

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ARTICLE INFO	A B S T R A C T
Keywords: Eating disorders Anorexia nervosa Bulimia nervosa Emotion regulation	Objective: Research has identified abnormal emotion regulation (ER) as an underlying mechanism in the onset and maintenance of eating disorders. Yet, it still remains unclear whether different forms of ER, adaptive and maladaptive strategies, are similar across categories of eating disorders. <i>Method:</i> A systematic review and meta-analysis were carried out to look at ER differences between anorexia nervosa (AN) and bulimia nervosa (BN), two common eating disorder pathologies with different eating patterns. <i>Results:</i> 41 studies were included in the meta-analysis. The results revealed no differences in the use of mal- adaptive ER strategies between individuals with AN and BN, however patients with AN tend to use less adaptive ER strategies as compared to patients with BN. <i>Conclusions:</i> Making less use of adaptive strategies in AN might be due to low body weight and high levels of alexithymia which define AN. In order to improve treatment outcome in individuals suffering from AN, these findings suggest to focus more on improving the use of adaptive ER strategies.

### 1. Introduction

During the last decade, there has emerged a growing literature on affective dysfunction in eating disorders [1]. A key finding in most conceptual models of eating disorders (EDs) is the inability to downregulate negative affect [2-5]. Disordered eating behaviour in EDs has been considered as an attempt to regulate these undesired mood states [6-8]. Besides behavioural strategies, also cognitive strategies have been addressed such as emotion regulation (ER), a multidimensional concept that refers to processes –either consciously or unconsciously- to initiate, modulate or terminate the course of an emotion [9,10]. According to [11], there is no need for constant ER, but ER strategies are applied when an emotional state is overwhelming and interferes with the desired outcome [12,13]. According to the ER framework of [14,15], cognitive ER strategies in psychopathology can be divided into adaptive and maladaptive strategies [14-16] [14-16]. Putatively adaptive ER, such as acceptance (allowing the experience of emotions without trying to change or control them), reappraisal (positive interpretation of a stressful or emotional situation) and problem solving (finding solutions to deal with a negative emotion or context), intend to reduce the intensity or duration of certain negative emotions in order to obtain a beneficial long-term outcome [10] [10]. Conversely ER strategies such as rumination (excessive focus on negative self-referential thoughts), suppression (attempting to stop thinking about a negative emotion) and avoidance (trying to avoid negative thoughts and emotions), are rather maladaptive ER strategies in order to change or eliminate a negative emotion, which may lead to an advantageous outcome in the short term but are associated with negative long-term outcomes [17] [17]. Recent findings outlined that emotion dysregulation is a central feature within EDs [4] [4], and ED patients reported higher levels of global difficulties with effectively regulating their emotional experiences, compared to healthy controls [6,8,18]. Moreover, the implementation of maladaptive ER strategies plays an important role in the development and maintenance of EDs [16,19,20]. A meta-analysis of [16] found a positive association between eating disorders and the habitual use of maladaptive ER strategies. On the other hand, a negative relationship was observed between ED symptoms and problem solving (an adaptive ER strategy), but not with reappraisal and acceptance.

Although all ED patients have difficulties in dealing with negative affect [21] and lack the flexibility in applying adaptive ER strategies compared to healthy controls [19,22,23], differences between ED categories can be observed. For example, ED patients of the binge-purge

https://doi.org/10.1016/j.comppsych.2021.152262

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type (AN-BP and BN) report less use of cognitive reappraisal (an adaptive strategy) in comparison to AN patients with the restrictive subtype [24] and the scores of reappraisal were higher in AN-BP than in women with BN [22]. Furthermore, AN patients (AN-R and AN-BP) reported significantly more maladaptive suppression of emotions compared to BN patients. Conversely, it was found that BN patients displayed higher levels of emotional inhibition (similar to suppression) than AN patients [25]. Taken together, even though (global) ER difficulties can be seen as a central feature over ED subtypes, it remains important to distinguish between the use of adaptive and maladaptive ER strategies used by patients with different ED subtypes in order to steer treatment interventions.

Most of the studies so far have focused on ER difficulties in both AN and BN patients [6,18,20,22,26,27], as well as on conceptually reviewing the existing literature on ER in AN and BN [28] [28].<sup>1</sup> To date, only one recent meta-analysis has examined global and specific ER abilities and strategies between ED patients [3]. However, this study only examined differences in the relationship between ER strategies and eating pathology, without looking at differences in the use of ER strategies between ED subtypes. Furthermore, the current study not only aims to look into ER differences on a meta-analytic level, but also aspires to provide a substantial overview of the literature by means of a systematic review.

Hence, the objective of this study is a systematic review and metaanalysis of the available literature to investigate whether AN versus BN patients differ in their use of adaptive and maladaptive emotion regulation strategies. Furthermore, we will also examine potential differences in the use of adaptive and maladaptive ER with a control group without an ED. More specifically, as outlined by [14], we will focus on three adaptive (reappraisal, acceptance, problem solving) and three maladaptive (suppression, avoidance, rumination) strategies [16]. In order to optimize treatment in EDs, the aim of the current review will be to gain more insight into ER strategies because: 1) it is known that ER difficulties are associated with ED symptoms [29], 2) the use of ER strategies can be modified with targeted treatment, and 3) rapid improvement of accessing adaptive ER strategies is associated with better treatment outcome [8,30].

# 2. Methods

The current review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement ([31], see supplementary materials).

## 2.1. Eligibility criteria

Studies were included if they contained at least one of the six selected ER strategies [14,16] in a sample of individuals with a clinical ED (both AN and BN patients should be included in their sample). ED diagnoses should be assessed by a clinically validated tool such as DSM-V [32] or an older version of DSM (depending on publication date of the study). Additionally, the inclusion criteria of this study are: all studies had to be journal articles published in English and in a peer-reviewed journal, with availability of the full text.

#### 2.2. Information sources and search

Four electronic databases were used to conduct searches: PubMed, Embase, PsychArticles and Web of Science, from the first data available up to and including the 31st of December 2020. The following search terms were used: (anorexia nervosa AND bulimia nervosa) AND (emotion regulation OR avoidance OR rumination OR suppression OR reappraisal OR Problem solving OR acceptance).

#### 2.3. Study selection

A flowchart of the systematic review process is shown in Fig. 1. First, articles were screened for eligibility based on their title and abstract, the full texts of those who were relevant for the current review were subsequently retrieved. Whenever full texts of articles did not meet all eligibility criteria, they were excluded from the review.

#### 2.4. Data collection and data extraction

Search outputs from the four selected databases were crossreferenced and all duplicate articles were removed before the screening of all records was done. Two authors - L.P. and P.H. - first screened independently the title and abstract of each article on inclusion criteria and records that did not meet these criteria were excluded. Next, the full text was reviewed on eligibility criteria. Whenever the reviewers were uncertain about an article's eligibility, the full report was obtained and discrepancies were discussed. Subsequently, all studies were screened for inclusion in the meta-analysis, and records got excluded when they were not able to provide data to calculate effect sizes (we attempted to contact the authors of those papers with missing data in order to still include them in the meta analysis). The following relevant information was extracted from each selected article (if available, and authors were contacted whenever a study did not report data in a form that we could use, in order to ask them whether they could provide the requested information): number of female participants, mean age, Body Mass Index (BMI), percentage of female participants, type of task/ questionnaire, outcome measures and key findings. For a detailed overview, see Table 1.

#### 2.5. Synthesis of results

In the first part of the review, a qualitative review will give an overview of possible differences in ER strategies between AN and BN. Subsequently, a quantitative overview (meta-analysis) will be conducted, with studies grouped by the type of ER strategy (adaptive/ maladaptive). As for the meta-analysis, we extracted mean, standard deviation (SD) and sample size of a study to calculate Hedges g's standard mean difference. Subsequently, the effect sizes were grouped into two categories depending on their ER strategy: adaptive (acceptance, reappraisal and problem solving) and maladaptive ER strategies (avoidance, suppression and rumination), and we included the type of strategy as a subgroup within the adaptive/maladaptive analysis.

Findings are summarized with respect to differences between AN and BN on the selected outcome measures.

### 2.6. Defining and measuring emotion regulation

In accordance with the meta-analysis of [16], we selected six ER strategies, three adaptive (acceptance, reappraisal, problem solving) and three maladaptive (rumination, avoidance, suppression) based on the ER theory of [14]. Acceptance can be seen as an adaptive ER strategy that aims to allow the experience of an emotion without attempting to alter or suppress the emotion [33,34]. Reappraisal is an ER strategy that alters the underlying meaning of an emotional situation as a way of reducing distress [35]. Problem solving is another adaptive ER strategy that involves the conscious attempt to change a stressful situation by assessing an orientation or specific actions directed at solving a problem [16]. Rumination is one of the selected maladaptive ER strategies and is defined as the process of repetitively thinking about negative feelings and their causes and consequences [36]. Avoidance refers to the unwillingness to experience feelings and thoughts, as well as to the

<sup>&</sup>lt;sup>1</sup> Because the use of ER strategies is associated with age [174,175], we selected AN and BN patients because they are similar in age and age of onset [176], and decided not to include Binge Eating Disorder (BED), whereas mean onset of patients is on later age [177].



Fig. 1. Flow chart study selection process.

attempts to alter them [37,38]. Finally, the third selected maladaptive ER strategy is suppression and is defined as a strategy directed toward inhibiting behaviours and thoughts that can elicit an emotional response [35].

For the current study, in line with [16], we will merely focus on selfreport measures to assess the use of ER strategies. These strategies can be measured by specific questionnaires that aim to examine one ER strategy in particular (e.g. Ruminative Response Scale for rumination or Emotional Avoidance Questionnaire for avoidance) or general questionnaires measuring several ER constructs or strategies (e.g. the Cognitive Emotion Regulation Questionnaire or the Difficulties with Emotion Regulation Scale). If one study contains more than one included ER strategy, different strategies from the same study will be included in the current analysis (except when two or more different questionnaires examine the same ER strategy; in this case the most relevant questionnaire will be selected).

# 2.7. Data analysis

The meta-analysis was carried out with R version 3.6.1 in R studio [39] using the meta and metafor package [40] for the calculation of effect sizes, and for the meta regression and assessment of publication bias. Random effects models were used to estimate all effects to take heterogeneity between the effect sizes of the individual studies into account. A random effects model takes the random variability of different studies with different populations into account, and this is reflected by a random sample of studies that are distributed around the mean effect size for a population. Effect sizes were calculated to reveal ER differences between AN and BN, represented by Hedge's g, a measure of effect sizes that controls for potential biases in small sample sizes. An effect size of 0.2 is considered as small, 0.5 is interpreted as a medium and effect size and 0.8 is seen as a large effect size [41]. For the current meta-analysis, the Q statistic and the I<sup>2</sup> statistic were used to assess heterogeneity. The Q statistic is distributed as a chi-square statistic with accompanying *p*-value and its power depends on the number of studies included in the analysis. It is calculated as the weighted sum of squared differences between individual study effects and the pooled effect across

studies. The I<sup>2</sup> statistic describes the percentage of total variation across studies that is due to heterogeneity rather than chance and ranges from 0 to 100%, where 50% or higher was considered to suggest a marked inconsistency in effect between studies [42]. Unlike the Q statistic, its power does not rely on the number of included studies. In order to account for heterogeneity, we used ER strategy as a subgroup. We conducted another subgroup analysis to examine potential differences between both ED and a healthy control group (HC), i.e. whether differences in the use of ER strategies between AN and HC vary substantially from differences between BN and HC. Additionally, we also conducted a separate meta-regression analysis with age as a continuous moderator using a mixed-effects regression model. Finally, a funnel plot was generated to check for the existence of publication bias, with the yaxis representing the standard error of the effect estimate (studies that hold more power will be placed higher on the graph) and the x-axis displaying the effect sizes (standard mean difference) of all individual studies. An asymmetric funnel plot is commonly equated with the presence of publication bias. When asymmetry could be visually inspected, Egger's test of the intercept was used to assess risk of publication bias [43]. When Egger's test indicated the presence of publication bias, the trim and fill procedure of [44] was applied. This procedure "trims" extreme effect sizes from the asymmetrical side of the funnel plot until the distribution of effect sizes is symmetrical, and subsequently "fills" the trimmed effect sizes back on the opposite side of the funnel plot (with imputed effect sizes) to obtain a symmetrical distribution.

# 3. Results

#### 3.1. Study selection

An overview of the study selection process is displayed in Fig. 1. After applying the search strategy to all selected databases, a total of 1397 articles were identified. Another three articles were identified through additional sources. After removing duplicate articles (n = 294), 1106 articles were screened based on the title and abstract, and the full text of 159 articles. 947 articles were excluded based on the title/abstract and following full-text evaluation, another 84 articles got

### Table 1

Characteristics of included studies for each ER strategy [22,45,51,58,66,67,82,106,107,109,110,115-117,119-120].

Author	Year	N group	Mean (SD)	Mean (SD)	%	ER strategy	Type questionnaire	Outcome
Agijara at al	2010	140 AN	age	BMI	female	Accentance	DEDS: non accontance	17 69 (7 96)
Aguera et al.	2019	236 BN			100	Acceptance	онко: поп-ассертансе	17.02 (7.26) 20.99 (6.42)
Anderson et al.	2018	176 AN-R 62 AN-BP 121 BN	21.71 (9.25)		94	Acceptance	DERS: non-acceptance	15.92 (0.53) 18.79 (0.88) 18.38 (0.64)
Andrews et al. Ban Porath Fadarici Wisniewski &	2013	22 AN	34.8 (11.1)	16 53	97 100	Avoidance	DEDC: non accentance	18 00 (5 08)
Warren	2014	ZZ AN	22.82 (4.94)	(1.27)	100	Acceptance	DERS. IIOII-acceptance	18.09 (3.98)
		43 BN	23.79 (7.47)	22.17 (3.84)				17 (6.03)
Bloks, Van Furth, Callewaert, & Hoek	2004	72 AN 47 BN 27 EDNOS	27.5 (8.0)		100	Avoidance	UCL: avoidance	
Branley-Bell & Talbot	2020	05 AN D	06.06.00.000	14.61	100	Rumination	RRS-ED	
Brockmeyer et al.	2014	35 AN-R	26.06 (8.32)	14.61 (1.85)	100	Acceptance	DERS: non-acceptance	19.37 (7.67)
		22 AN-BP	25.73 (6.21)	15.12 (1.71)				19.27 (6.05)
		34 BN	26.85 (9.89)	21.73				19.26 (5.84)
		29 BED	39.17	33.00				17.20 (6.65)
		60 NWC	(13.22) 25.90 (5.16)	(4.68) 21.76				12.28 (4.50)
		29 OWC	36.38	(1.88) 34 40				11.72 (4.43)
Durante al	0010	54 AN D	(10.50)	(4.18)	02.0	A	DEDC	17.11 (5.05)
brown et al.	2018	54 AN-K	23.83 (8.43)	(1.96)	93,9	Acceptance	DERS: non-acceptance	17.11 (5.95)
		60 BN	27.27 (9.42)	24.79 (5.63)				19.73 (6.57)
Brown, Cusack, Anderson, et al.	2019	56 AN	22.86 (5.87)	17.84 (1.79)	93	Acceptance	DERS: non-acceptance	17.29 (6.73)
		58 BN	26.93 (8.98)	24.21				19.96 (6.72)
Brown, Cusack, Berner, et al.	2019	77 AN-R	24.3 (9.16)	17.45	95	Acceptance	DERS: non-acceptance	13.6 (0.55)
		46 AN-BP	26.51 (9.67)	(2.00) 18.65				16.14 (0.71)
		118 BN	28.19 (9.99)	(1.46) 24.26				15.42 (0.46)
Brytek-Matera & Schiltz	2013	52 ED	19.63 (2.56)	(4.62) 18.08	100	Avoidance	SCO: avoidance	
		55 HC	20.10 (1.03)	(2.48)		Pumination	SCO: rumination	
		55 110	20.19 (1.03)	(2.40)		Rummation		
Bussolotti et al.	2002	134 AN 198 BN	22.4 (5.3) 23.3 (5.7)	16.4 (1.8) 21.8 (3.8)	100	Avoidance	SADS: avoidance	14.5 (8.3) 8.8 (0.8)
Butryn et al.	2013	35 AN	25.8 (11.2)		100	Avoidance	EAQ: avoidance of positive/ negative emotion	
		29 BN 24 EDNOS					-	
Byrne, Eichen, Fitzsimmons-craft,	2016	107 ED	20.7 (1.97)		100	Acceptance	DERS: non-acceptance	
Claes et al.	2009	26 AN			100	Problem	UCL: active problem solving	
		21 BN				solving		
		17 EDNOS	27.3 (9.1)			Avoidance	UCL: avoidant coping	
Corstorphine, Mountford, Tomlinson,	2006	19 AN	30.45 (9.28)	15.56	100	Acceptance	DTS: Accepting and managing	2.76 (0.57)
waner, a weyer		24 BN	25.92 (4.98)	(1.01) 23.7 (4.49)			енюцон	2.61 (0.54)
		28 EDNOS				Avoidance	DTS: Avoidance of affect	2.96 (0.78)
Crino, Touvz, & Rieger	2019	35 AN	25,23 (8.33)	17.39	100	Reappraisal	Thought control questionnaire	2.65 (0.71) 13.80 (3.93)
	2017	20 PN	10.100 (0.000)	(1.92)	100	reappraisa		14.02 (4.44)
		29 DIN		(2.16)				14.03 (4.44)
		12 BED 14 OSFED						
						Rumination	Thought control questionnaire	12.17 (3.88) 12.34 (3.88)
Dakanalis et al.	2016	212 AN	adolescents	15.52 (1.24)		Avoidance	SADS: avoidance	12.01 (0.00)

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Author	Year	N group	Mean (SD) age	Mean (SD) BMI	% female	ER strategy	Type questionnaire	Outcome
		131 BN		21.18 (2.07)				
Danner et al.	2012	360 EDNOS 20 AN-R 17 AN-BP 13 BN	21.63 (2.66)		100	Reappraisal	ERQ: reappraisal	
Danner et al.	2014	32 AN-R	23.09 (6.51)	17.23 (1.80)	100	Suppression	ERQ: expressive suppression	4.57 (1.13)
		32 AN-BP	27.41 (9.25)	16.98 (1.94)				4.43 (1.40)
		30 BN	25.37 (6.15)	23.44 (3.29)				3.59 (1.17)
		29 BED	38.48 (10.68)	37.45 (5.10)				3.55 (1.37)
						Reappraisal	ERQ: cognitive reappraisal	4.02 (1.13) 4.18 (1.05) 3.52 (1.44) 3.88 (1.30)
Davies, Swan, Schmidt, & Tchanturia	2012	42 AN 26 BN 34 HC	25.6 (6.5) 25.9 (8.0) 26.3 (8.4)	14.8 (1.8) 21.5 (2.0) 21.6 (1.4)		Suppression	ERQ: suppression	16.1 (5.3) 14.5 (5.0) 10.8 (5.0)
						Reappraisal	ERQ: reappraisal	25.6 (8.3) 24.3 (9.5)
Dittmer et al.	2018	19 AN-R 7 AN-BP	22.66 (8.25)	15.41 (2.54)	100	Acceptance	ERSQ: acceptance	29.1 (6.0)
Espel, Goldstein, Manasse, Adrienne, & Hall	2016	2 BN 27 AN	30.17 (12.10)			Acceptance	AAQ: acceptance	
Espel-Huynh Muratore Virzi Brooks	2019	13 BN 11 EDNOS 268 AN	24.36	17.79	100	Avoidance	BEAO: avoidance	58 99 (13 24)
& Zandberg	2019	180 BN	(10.35) 24.76 (9.24)	(2.34) 25.64	100			60.71 (13.20)
Fassino et al.	2005	28 AN	25.58 (6.11)	(7.31) 16.33 (1.51)	100	Suppression	STAXI: anger expression	
	0010	29 BN	01 70 (4 00)	22.85 (4.46)	100			
Fitzsimmons & Bardone-Cone	2010	17% AN 6% BN	21.78 (4.28)		100	Avoidance	subscale	
Fitzsimmons & Bardone-Cone	2011	77% EDNOS 17% AN 6% BN 77% EDNOS	23.64 (4.74)			Avoidance	CISS: avoidance	
Flament, Godart, Fermanian, &	2001	29 AN 34 BN	17.9 (4.3) 26 6 (6 5)			Avoidance	SPS: avoidance	24 (14) 26 (16)
Gagliardini et al.	2020	44 AN-R 20 AN BP	30.88 (11.95)		94,9	Acceptance	DERS: non-acceptance	20 (10)
		41 BN 27 BED 12 OSFED						
Gagnon-Girouard, Chenel-Beaulieu, Aimé, Ratté, & Bégin	2019	46 AN	18–65		100	Avoidance	psychological meanings of ED: avoidance	2.59 (1.73)
Garke, Sorman, Jayaram-Lindstrom, Hellner, & Birgegard	2019	35 BN 432 AN-R 156 AN-BP 630 BNP 307 BN-P 251 BED	26.47 (8.43)		97	Acceptance	DERS: non-acceptance	4.00 (2.47)
Ghaderi & Scott	2000	1383 EDNOS 23 ED				Avoidance Problem	WCQ: escape avoidance WCQ: purposeful problem	
Gilboa-Schechtman, Avnon, Zubery, & Jeczmien	2006	20 AN 20 BN	16.60 (2.48) 19.65 (5.01)		100	Rumination	RSQ: rumination	3.70 (0.70) 3.76 (0.53)
Harrison, Sullivan, Tchanturia, & Treasure	2010	20 HC 50 AN	19.65 (5.01) 26.7 (9.82)	15.38 (1.83)	100	Acceptance	DERS: non-acceptance	2.78 (0.66) 23 (10)
		50 BN	27.54 (8.82)	20.98 (2.35)				20 (9)
		90 HC	28.50 (9.93)					11 (8.5)

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Author	Year	N group	Mean (SD) age	Mean (SD) BMI	% female	ER strategy	Type questionnaire	Outcome
				21.61				
Humbel et al.	2018	58 AN	22.45 (4.18)	(1.89) 17.22	100	Acceptance	DERS: non-acceptance	19.30 (5.77)
		54 BN	23.13 (4.10)	(1.61) 22.73				18.80 (6.44)
Juarascio et al.	2013	66 AN	26.74 (9.19)	(2.52)	100	Acceptance	DERS: non-acceptance	
Kanakam, Krug, Raoult, Collier, &	2013	24 AN twins			100	Acceptance	DERS: non-acceptance	
Kollei, Brunhoeber, Rauh, de Zwaan, & Martin	2012	32 AN	26.94 (9.15)	15.62 (1.63)	86,9	Reappraisal	CITQ: reappraisal	12.95 (3.18)
		34 BN	25.94 (8.25)	21.00 (2.69)				12.42 (3.44)
		33 HC	26.91 (8.48)	22.68 (3.11)				11.84 (4.40)
Krug et al.	2008	21 AN	24.43 (6.55)	16.27 (1.33)	100	Suppression	STAXI 2: suppression	44.29 (22.76)
		75 BN	26.68 (6.59)	23.19 (4.54)				62.55 (27.67)
		39 EDNOS				Avoidance	SAD: avoidance	13.78 (8.38)
Lawson, Waller, & Lockwood	2007	14 AN-R	28.5 (8.70)	21.9 (9.74)	100	Avoidance	YRAI: avoidance	15.85 (8.55)
	2007	8 AN-BP 21 BN	2010 (017 0)	2119 (517 1)	100	inolulie		
Lee, Ong, Twohig, Lensegrav-Benson,	2018	19 EDNOS 48 AN			100	Acceptance	AAO-II: acceptance	
& Quakenbush-Roberts	2009	20 BN 58 AN				Problem	CSI: problem solving	
Bautista, & Garrido	2009	35 BN				solving Avoidance	con problem solving	
Luck, Waller, Meyer, Ussher, & Lacey	2006	43 AN-R 28 AN-BP	24.7 (7.51)	16.3 (3.47) 16 4 (2.81)	100	Avoidance	YRAI: avoidance	3.07 (0.93) 3.45 (1.11)
		50 BN	29.7 (8.54)	22.8 (6.40)				3.17 (0.78)
Mallorquí-Bagué et al.	2018	57 AN-R 44 AN-BP			100	Acceptance	DERS: non-acceptance	16.83 (7.74) 17.83 (7.09)
		168 BN						20.77 (6.39)
		62 BED 107 OSFED						19.28 (6.31) 19.88 (6.71)
Merwin, Zucker, Lacy, & Elliott	2010	15 AN	22.53 (5.21)	18.21 (1.75)	94	Acceptance	DERS: non-acceptance	17.60 (5.45)
		13 BN	22.85 (6.43)	23.10 (4.58)				16.50 (8.25)
		20 EDNOS	28.60 (8.63)	25.76 (6.02)				15.11 (6.97)
Meule et al.	2019	53 AN	23.83 (8.78)	16.02 (1.95)	100	Suppression	ERQ: suppression	4.25 (1.33)
		45 BN	25.40 (9.57)	22.56 (4.12)				4.06 (1.29)
						Reappraisal	ERQ: reappraisal	3.56 (1.11) 3.25 (1.20)
Monell et al.	2018	172 AN-R	21.8 (7.0)	16.0 (1.5)	100	Acceptance	DERS: non-acceptance	16.0 (6.0)
		64 AN-BP 350 BN	26.2 (8.4)	16.3 (1.3) 24.8 (5.4)				17.4 (6.6) 16.2 (6.2)
		40 BED	32.3 (11.3)	34.2 (6.8)				17.7 (6.8)
Monell Clinton & Birgegard	2020	373 OSFED	24.1 (8.3) 24.8 (8.4)	21.4 (4.1)		Acceptance	DFRS: non-accentance	16.2 (6.2)
Monen, emiton, e Dirgegard	2020	350 BN 40 BED	24.0 (0.4)			Acceptance	DERO. non-acceptance	
		373 OSFED						
Nagata, Matsuyama, Kiriike, Iketani, & Oshima	2000	43 AN-R 42 AN-BP	21.2 (4.8) 24.5 (4.8)	13.8 (2.0) 15.3 (3.0)	100	Avoidance	CISS: social diversion	12.3 (3.8) 12.4 (4.2)
		73 BN	22.6 (4.0)	20.5 (2.6)				12.3 (4.5)
		97 HC	23.4 (5.2)	21.3 (2.8)		Avoidance	CISS: distraction	14.6 (4.7)
						Avoidance	CI35. distraction	21.9 (4.9)
								22.2 (4.6)
Nakahara	2000	11 AN-R	21.6 (5.5)		100	Problem	SCI: problem solving	21.5 (5.6) 7.2 (3.8)
						solving		
		11 AN-BP 20 BN-P	22.4 (5.7) 22.1 (4.8)					6.0 (2.5) 5.1 (3.4)
		6 BN-NP	22.3 (4.0)					4.0 (4.0)
						Avoidance	SCI: avoidance	5.6 (1.9)

(continued on next page)

#### Author Year N group Mean (SD) Mean (SD) % ER strategy Type questionnaire Outcome BMI age female 6.8 (2.3) 6.6 (2.4) 6.8 (3.4) Reappraisal SCI: reappraisal 6.5 (4.1) 6.4 (2.3) 5.2 (2.7) 3.8 (2.3) 2015 38 AN 100 Naumann, Tuschen-Caffier, & Rumination RSQ: rumination 37 BN Voderholzer Naumann, Tuschen-Caffier, 2016 42 AN 25.71 15.23Acceptance 59.53 Voderholzer, & Svaldi (10.65) (1.87) 40 BN 25.78 (8.49) 22.14 63.42 (4.95) Reappraisal 37.75 31.95 Rumination 68.89 64.39 Suppression 44.61 38.43 Navarro-Haro et al. 2018 18 AN 100 Suppression ERQ: suppression 24 BN 76 EDNOS Reappraisal ERQ: reappraisal Nordgren, Monell, Birgegard, 2020 272 AN 24.24 (7.38) 18.75 96 Acceptance DERS: non-acceptance 16.15 (6.10) Bjureberg, & Hesser (3.83) 319 BN 27.09 (8.19) 25.32 16.17 (6.34) (5.57)41 BED 23 OSFED Pisetsky, Haynos, Lavendere, Crow, & 2017 33.5 (12.2) 93,6 Acceptance DERS: non-acceptance Peterson Portzky, van Heeringen, & Vervaet 2014 562 AN 24.2 95,4 Avoidance UCL: avoidant coping 371 BN 120 BED 307 EDNOS Rumination UCL: passive reaction Rothschild-Yakar, Peled, Enoch-levy, 100 2018 13 AN-R Suppression ERQ: suppression 7 AN-BP Gur. & Stein 5 BN Reappraisal ERQ: reappraisal Ruscitti et al. 2016 28 AN Acceptance DERS: non-acceptance 19.54 (6.45) 18.95 (7.30) 21 BN 18 BED 22.17 (5.77) 119 EDNOS 19.76 (6.94) Segura-Serralta et al. 2019 16 AN-R 100 Acceptance DERS: non-acceptance 4 AN-BP 8 BN 2020 Sagiv & Gvion 55 AN 23.98 (5.46) Rumination RRS 26 BN 12 EDNOS/ OSFED 26.9 (8.11) Sheffield, Waller, Emanuelli, Murray, 2009 40 AN 15.95 100 Avoidance YRAI: avoidance 7.52 (1.56) & Meyer (1.68) 37 BN 27.93 (7.44) 24.39 7.44 (1.43) (8.64) Smith, Feldman, Nasserbakhy, & 1993 Acceptance CRI: acceptance/resignation Steiner Problem CRI: problem solving solving Reappraisal CRI: positive reappraisal CRI: cognitive avoidance Avoidance Smith, Forrest, & Velkoff 2018 26.92 (7.96) 100 Acceptance Svaldi, Griepenstroh, Tuschen-Caffier, 20 AN 22.85 (4.38) 16.28 100 ERQ: suppression 4.20 (1.59) 2012 Suppression & Ehring (1.82)25.89 (7.84) 18 BN 22.25 3.89 (1.17) (2.77) 25 BED 43.46 37.55 3.54 (1.54) (11.95) (6.72) Reappraisal ERQ: reappraisal 3 64 (0 95) 3.73 (1.12) 3.89 (1.51) Thew, Gregory, Roberts, & Rimes 2017 16 AN 28.6 (7.2) 17.1 (2.4) 100 Rumination RRQ: rumination 3.24 (0.66) 29.2 (9.0) 6 BN 28.5 (12.7) 3.35 (0.54) Thompson-Brenner et al. 2019 230 AN 25.59 100 Avoidance MEAQ: experiential avoidance (10.76)

(continued on next page)

201 BN

Author	Year	N group	Mean (SD) age	Mean (SD) BMI	% female	ER strategy	Type questionnaire	Outcome
		25 BED 160 OSFED						
Troop, Holbrey, & Treasure	1998	12 AN	23.6 (5.6)	15.7 (3.2)	100	Avoidance	CSinterview: cognitive avoidance	2/12
		21 BN	29.7 (8.4)	24.8 (7.9)				7/21
						Rumination	CSinterview: cognitive rumination	3/10
Troop Holbrey Trowler & Treasure	1994	24 AN	26.1 (7.8)	165(20)	100	Avoidance	WCC: avoidance	7/17
	1001	66 BN	26.7 (5.2)	22.0 (3.1)	100	Tronunce		20.4 (4.7)
								Mean
-								percentage
Troop & Treasure	1997	11 AN onset	23.3 (5.0)	15.3 (2.3)	100	Avoidance	CSinterview: cognitive avoidance	7/11
		10 BN onset	25.4 (10.8)	23.8 (1.6)		Pumination	Ceinterview: cognitive	0/10
		10 PN opset				Kullillatioli	rumination	2/11
Vieira Bamalho Brandão & Saraiva	2016	28 AN-R	22.93 (9.82)	16 71	92.4	Acceptance	DERS: non-acceptance	779 15.71 (4.94)
	2010	201211	22190 (9102)	(2.79)	,	neceptance		100/1 (10/1)
		15 AN-BP	29.8 (11.42)	16.37				21.57 (7.47)
				(2.97)				
		17 BN	26.29 (9.07)	21.44 (2.29)				17.69 (7.26)
		2 BED						
Vieira et al	2020	4 EDNO3 75 AN	25.72 (11.2)		94.2	Acceptance	DERS: non-acceptance	13.12 (7.5)
	2020	41 BN	31.12 (9.86)		,	neceptance		8.59 (7.08)
		20 BED	16.85 (2.01)					
		35 OSFED	23.95 (4.99)					
Villa et al.	2009	29 AN	32.93	15.69	100	Avoidance	COPE: avoidance	33.05 (5.17)
		28 BN	31.86 (9.21)	(2.07)				33 (6.69)
				(2.67)				,
Wang & Borders	2018	67 AN	25.7 (10.46)	16.49	87,1	Rumination	ARS: rumination	2.08 (0.73)
				(3.14)				
		8 BN	20.6 (6.66)	23.24 (5.4)				2.92 (0.54)
		10 OSI-ED				Rumination	RRS: rumination	
Weinbach et al.	2018	32 AN-R				Acceptance	DERS: non-acceptance	13 (5.96)
		19 AN-BP						16.46 (5.87)
		22 BN						14.2 (5.45)
Wolz et al.	2015	30 AN	28.20	16.84	90,3	Acceptance	DERS: non-acceptance	16.39 (7.52)
		54 BN	(11.21)	(1.83)				19.61 (6.00)
		01211	2,100 (0120)	(5.96)				19101 (0100)
		20 BED	36.65	39.54				17.99 (6.46)
			(10.86)	(10.33)				
		30 OSFED	26.07 (9.82)	22.80				19.36 (7.59)
Wyssen et al.	2019	61 AN	22.87 (4.57)	17.05		Acceptance	DERS: non-acceptance	
				(1.63)		F		
		58 BN	23.16 (3.96)	22.64				
				(2.56)				

Notes: DERS: Difficulties in Emotion Regulation Scale; UCL: Utrecht Coping List; SCQ: Stress Coping Questionnaire; SAD: Social Avoidance and Distress Scale; EAQ: Emotional Avoidance Questionnaire; DTS: Distress Tolerance Scale; ERQ: Emotion Regulation Questionnaire; ERSQ: Emotion Regulation Skills Questionnaire; AAQ-II: Acceptance and Action Questionnaire-II; BEAQ: Brief Experiental Avoidance Questionnaire; STAXI: State-Trait Anger Expression Inventory; CISS: Coping Inventory for Stressful Situations; SPS: Social Phobia Scale; WCQ: Ways of Coping Questionnaire; RSQ: Response Styles Questionnaire; CITQ: Control of Intrusive Thoughts Questionnaire; STAXI-2: State-Trait Anger Expression Inventory 2; YRAI: Young–Rygh Avoidance Inventory; CSI: Coping Strategies Inventory; SCI: Stress Coping Inventory; RRQ: Rumination Reflection Questionnaire; CSInterview: Coping Strategies Interview; WCC: Ways of Coping Checklist; COPE: Coping Orientation to Problem Experienced Inventory; ARS: Anger Rumination Scale; RRS: Ruminative Response Scale.

excluded after reading the full text. In sum, 75 articles were included in the review, and 41 studies were included in the meta-analysis. All samples included an AN and a BN group, and at least one measure examining one of the six predefined ER strategies.

# 3.2. Study characteristics

Table 1 presents details of all studies included in the systematic review and meta-analysis. 70% of the studies were published in the past 10 years. A total of 5868 participants were included in the meta-

analysis, and both adolescents and adults were included. At least 98% of the participants in all included studies were females. Of the 75 studies identified, we did not have sufficient data on 34 studies for mean and SD on ER strategies for AN and BN separately, and these studies were therefore excluded from the meta-analysis due to missing data. After contacting the authors, data were labelled as missing when the authors did not reply or when they stated the requested data was no longer available. Twenty-seven different questionnaires were employed, the most common ones being Difficulties in Emotion Regulation Scale (subscale Non-Acceptance, n = 26) and Emotion Regulation

Questionnaire (n = 7). The mean age across studies included in the metaanalysis is 25.26 (SD = 2.52). One study (Svaldi et al., 2012) made use of multiple measures to assess acceptance, so we only included the most frequently used questionnaire (DERS) in the analysis.

# 3.3. Qualitative review

#### 3.3.1. Acceptance

Of the 33 studies reporting the use of (non-)acceptance between AN and BN patients, 8 studies found no differences in the use of this adaptive ER strategy between AN and BN patients [6,23,26,45-48] or between restrictive and binging/purging ED subtypes [27]. However, some studies did find differences on the use of acceptance: higher scores on the non-acceptance scale were found in BN (and AN-BP) patients compared to AN(-R) [8,49-52]. One study compared gender-related differences in ER and found more use of non-acceptance in BN compared to AN in a female sample, however this difference was not found in male participants [53]. Additionally, ED patients that understand people rather on a cognitive level than an affective one seems to display more acceptance [54]. ED patients with a history of non-suicidal self-injury (NSSI) showed more use of non-acceptance compared to a group with no history of NSSI [55], however another study found no differences between these groups [56]. Presence of NSSI was also associated with higher ED severity. When ED patients were compared with a control group, eight studies found that ED patients made less use of acceptance strategies to regulate emotions compared to healthy controls [6,8,48,52,53,23,26,58]. Three studies examined the effect of Dialectic Behaviour Therapy (DBT) on ER in ED patients and found a significant decrease in the use of non-acceptance and an increase in weight gain [51,60,61]. Higher levels of acceptance at the start of the treatment predicted significantly greater symptom reduction during treatment [62], and the more they start to make use of acceptance, the more psychologically flexible they become [63].

#### 3.3.2. Problem solving

Five studies assessed the adaptive ER strategy problem solving in EDs [64–68]. The study of [67] found that BN patients tend to use less problem solving compared to AN, but this result was not significant. The anorexia nervosa binge-eating/purging-type group tended to use less planful problem solving than the control group. Another study also found more use of problem solving strategies in a control group, but no differences between AN and BN, and these two ED groups also did not differ from other mental disorders [66]. [65] found similar results, they revealed less use of problem solving in individuals with a current ED compared to a healthy control group.

### 3.3.3. Reappraisal

Twelve studies examined the use of the adaptive ER strategy reappraisal in AN and BN. Four studies found no significant differences in the use of reappraisal between AN and BN patients [67,69–71]. Two studies found differences in the use of this adaptive strategy; one study indicated that AN-BP patients scored higher on reappraisal compared to BN patients [22], and another study revealed lower cognitive reappraisal scores in a binging/purging ED group compared to a restrictive ED group [24], and this group also reported higher levels of eating pathology. In comparison with a healthy control group, six studies found lower reappraisal scores in AN and BN compared to a control group [22,26,67,69,71,73], while two studies found no differences in the use of reappraisal compared to healthy controls [70,74]. In terms of effectiveness of using a reappraisal strategy, healthy controls found reappraisal strategies more effective than AN [74]. In BN patients, less functional emotion regulation strategies such as reappraisal tended to relate to eating less when feeling happy [71]. Another study examined levels of alexithymia, ER strategies and depressive symptoms and found that greater reported alexithymia was correlated with reduced cognitive reappraisal in ED patients and also found a negative correlation between

cognitive reappraisal and depressive symptoms [75]. Although most studies look at trait ER strategies, one study examined state reappraisal and found no group differences with regard to the use of spontaneous reappraisal [76]. However, reappraisal scores were low in all groups, suggesting that neither the ED groups nor controls intensely engaged in spontaneous reappraisal. One study looked into the use of dialectical behaviour therapy and found that an increase in the use of reappraisal strategies in ED patients in the DBT group compared to treatment as usual [77].

# 3.3.4. Rumination

Of the 13 studies that included the ER strategy rumination in their research, two studies examining rumination could not find any differences between the AN and BN group on the maladaptive ER strategy rumination [78,79]. Compared to a control group without an ED, women with an ED were more likely to use rumination and displayed higher levels of rumination compared to those not suffering from an ED [74,78,80–82]. [83] could not detect significant differences in the use of rumination between individuals with a current ED and those in recovery. Rumination is also positively associated with symptom severity and ED pathology [74,78,84], as well as with the onset of bulimic symptoms [85]. Women reported more use of ruminative thoughts compared to men [84], and higher rumination levels are associated with an increased risk of attempted suicide and higher probability of self-injury attempts [86,87].

#### 3.3.5. Avoidance

Of the 28 studies that were included in the qualitative review to examine avoidance, only one study found that BN patients made significantly more use of avoidance [88], while other studies were not able to reveal a significant difference in the use of the maladaptive ER strategy avoidance between AN and BN [89-94]. When looking into differences between ED patients and a control group, results are inconclusive: some studies did not find any differences in the use of avoidance between both groups [66,67,91,92,95], some reported ED patients make more use of avoidance as an ER strategy [65,82,96,93], while others found the opposite, namely lower scores on avoidance questionnaires compared to a group without an ED [92,94,98]. Two studies discovered that recovered ED patients reported significantly less use of avoidance strategies after treatment [99,100]. Furthermore, a positive [101] and negative [102] association was found between ED symptomatology and emotional avoidance, which is in its turn associated with body dissatisfaction [103] and the onset of anorexic symptoms [85]. Experiential avoidance was also a mediator between anxiety sensitivity and ED psychopathology: higher social anxiety sensitivity tended to endorse greater avoidance or suppression of emotional distress, and in turn, experienced more severe ED psychopathology [104]. When looking into differences over diagnostic categories, ED patients with compulsive features did not show differences in the use of avoidance compared to an ED group with no compulsive features, and avoidances scores were higher in ED patients who had a past suicide attempt, indicating an increased risk of a suicide attempt when avoidance strategies are more frequently used [86].

#### 3.3.6. Suppression

Nine studies looked at the use of suppression between ED categories. Some studies did not detect any significant differences in the use of this maladaptive ER strategy between AN and BN patients [26,69,71], while another study found that women with AN reported more use of suppression compared to BN patients [22]. All studies who included a control group reported significantly higher suppression scores in ED patients compared to the healthy control group [22,26,69,71]. In ED patients, the maladaptive ER strategy suppression was related to a lower BMI and higher levels of depression and anxiety [24]. Higher suppression scores are also linked with the tendency to eat less than usual when being stressed in AN, but not in BN and controls [71]. Alexithymia (inability to identify and describe emotions experienced by one's self or others) is also associated with elevated levels of suppression in ED patients [75].

# 3.4. Meta-analysis

#### 3.4.1. Adaptive ER strategies

First, we looked at differences between AN and BN patients over all three adaptive strategies (acceptance, reappraisal, problem solving). A weighted, random effects meta-analysis tested for significant differences between individuals who suffer from AN and BN on the use of adaptive ER strategies across the 30 included studies. An overall significant difference in the use of adaptive strategies was found [g = 0.24 (95% CI 0.08, 0.40, z = 2.85, p = 0.004]. When examining heterogeneity, the analysis showed a high amount of between-study variance in the full sample of studies (Q = 172.56,  $l^2 = 83\%$ ,  $p \le 0.00001$ ).<sup>2</sup> Fig. 2 provides an overview and forest plot of the results. Inspection of the funnel plot (see Fig. 3) indicated some asymmetry, however Egger's test did not show any significance (p = 0.57) so the trim and fill procedure was not applied on the included studies with adaptive ER strategies.

When examining the three adaptive ER strategies acceptance, reappraisal and problem solving separately, significant differences in overall effect size across studies were found for the adaptive ER strategies acceptance [g = 0.23, (95% CI 0.03, 0.43) z = 2.02, p = 0.04] and reappraisal [g = 0.22, (95% CI 0.04, 0.41) z = 2.64, p < 0.0.01]. The model for problem solving could not be calculated due to only one included study in the analysis. For a complete overview see Table 2.

#### 3.4.2. Maladaptive ER strategies

We first examined whether there was an overall difference in maladaptive ER strategies (rumination, suppression, avoidance) between AN and BN patients. The meta-analysis with the random effects model (n = 2088; AN = 1062, BN = 1026) revealed no significant effect size across the 19 included studies [g = -0.01 (95% CI -0.24, 0.21), z =0.14, ns]. A large amount of variation across the different studies was found, which was indicated by the statistic measures examining heterogeneity (Q = 122.93,  $I^2 = 83\%$ , p < 0.00001).<sup>3</sup> The visual inspection of the funnel plot (Fig. 5) indicated the possible presence of publication bias, but Egger's test did not confirm this (p = 0.14). Fig. 4 shows a summary and forest plot of all included studies in the meta analysis.

Next, we examined the subgroups for each maladaptive ER strategy separately. The random-effects model for avoidance revealed that those with AN did not have significantly lower levels of avoidance than BN patients [g = 0.03 (95% CI -0.28, 0.34), z = 0.18, ns]. Similar effects were found for the maladaptive ER strategies rumination and suppression, indicating no significant differences between AN and BN.

For a complete overview see Table 2.

### 3.4.3. Comparison with healthy controls

To examine whether differences between each ED and a HC group alter between AN and BN patients, we looked at the effects for AN and BN and compared these to a HC group. Next, we conducted a subgroup analysis to look for potential differences (AN-HC versus BN-HC). For adaptive ER strategies, a significant difference was found when comparing AN and HC [g = -0.76 (95% CI -1.01, -0.50, z = -5.85, p < 0.0001], as well as BN and HC [g = -0.94 (95% CI -1.22, -0.67, z = -6.78, p < 0.0001], indicating less use of adaptive ER strategies in both patient groups compared to HC. We did not find any subgroup differences between AN-HC and BN-HC, indicating that the ED groups do not differ from one another when being compared to a control group (Q(1) = 2.17, p = 0.14).

When looking at maladaptive ER strategies, we found a significant difference in overall effect size between AN and HC [g = 0.63 (95% CI 0.12, 1.14, z = 2.45, p = 0.01] and BN and HC [g = 0.53 (95% CI 0.09, 0.98, z = 2.35, p = 0.02]. However, when we compared the differences with HC between AN and BN, we did not find significant differences between the two patient groups (Q(1) = 0.07, p = 0.79).

#### 3.5. Moderation analyses

We examined whether differences in specific ER strategies were associated with effect size differences between AN and BN patients. The regression model with type of strategy as a predictor does not explain any of the variability in the effect size data ( $R^2 = 0\%$ ) within both adaptive (acceptance, reappraisal, problem solving) and maladaptive (suppression, rumination, avoidance), and the type of strategy is not significantly associated with effect size differences within adaptive and maladaptive ER strategies.

A meta-regression analysis was conducted with the mean age as a continuous moderator. Age was no significant moderator within adaptive (slope  $\beta = -0.04$ , 95% CI [-0.14, 0.06], p = 0.42) and maladaptive (slope  $\beta = -0.01$ , 95% CI [-0.09, 0.07], p = 0.77) ER strategies.

#### 4. Discussion

Previous research has shown that ER is a key feature across EDs [16], with ER difficulties in both AN and BN patients. The aim of the current systematic review and meta-analysis was to examine potential differences in the use of adaptive (reappraisal, acceptance, problem solving) and maladaptive (avoidance, rumination, suppression) ER strategies between patients diagnosed with AN and BN. In order to optimize treatment outcome, more insight into possible differences in used ER strategies between these two diagnostic groups is needed. Hence, relevant research articles were selected and screened in a systematic way following the PRISMA guidelines. Subsequently, a qualitative overview of the findings and a quantitative meta-analysis across the full sample of included studies was done to explore differences between AN and BN regarding adaptive and maladaptive ER strategies, as well as differences with a healthy control group.

Based on our systematic overview of the existing literature on differences in the use of ER strategies between AN and BN, the evidence remains inconclusive. Some studies found that ED patients differed in the use of adaptive [8,52,61] and maladaptive [22] strategies, while other studies could not find significant differences in the use of ER strategies between AN and BN patients [6,48,89,91,94]. However, when looking into differences between the ED group compared with a healthy control group, most studies reported less use of adaptive and more use of maladaptive ER strategies in the ED group [53,65,69,71,96,121].

We also looked into ER differences between AN and BN patients on a quantitative level by carrying out a meta-analysis. Firstly, we have found that both ED groups differ significantly from healthy controls in the use of maladaptive ER strategies. In other words, ED patients, regardless of the specific ED diagnosis, make use of more maladaptive ER strategies as compared to individuals without an ED. In addition, even though differences between each ED subtype and a healthy control group were observed, these two patient groups did not differ from one another in the comparison with a control group. This is in line with previous research reporting that both AN and BN patients tend to make less use of adaptive ER strategies compared to healthy controls [3,28].

Secondly, when considering differences between ED subtypes, our results indicated no differences in the use of maladaptive ER strategies

<sup>&</sup>lt;sup>2</sup> We performed an outlier analysis which removed two studies from the sample (Q = 56.86,  $I^2 = 53\%$ , p = 0.001). However, since the results remained the same (significant difference between AN and BN, [g = 0.17 (95% CI 0.06, 0.28, z = 3.06, p = 0.002]), we decided to leave the studies in the meta analysis.

<sup>&</sup>lt;sup>3</sup> We performed an outlier analysis and three outliers were detected and removed from the analysis, resulting in a substantial drop in heterogeneity (Q = 23.64,  $I^2 = 23.9\%$ , p = 0.16) but still resulting in no differences between AN and BN patients [g = -0.09 (95% CI -0.20, 0.03), z = -1.42, ns], therefore we have decided to leave the studies in the meta-analysis.

			AN			BN							
Author	Ν	Mean	SD	Ν	Mean	SD				g	95%	CI	weight
Strategy = acceptance	e												
Aquera 2019	140	12.38	7.26	236	9.01	6.42		- i-	-	0.50	[0.29:0.	711	4.1%
Anderson 2018	238	13.33	1.40	121	11.62	0.64				1.42	1.18:1	671	4.0%
Ben-Porath 2014	22	11.91	5.98	43	13.00	6.03	-	-		-0.18	[-0.69: 0.	341	3.1%
Brockmever 2014	57	10.67	7.03	34	10.74	5.84		-	-	-0.01	[-0 44.0	411	3.4%
Brown 2018	54	12.89	5.95	60	10.27	6.57		- T-i	+	0.41	[0.04:0	791	3.6%
Brown 2019 1	56	12.71	6.73	58	10.04	6.72			-	0.39	[0.02:0	771	3.6%
Brown 2019 2	123	15.45	1.36	118	14.58	0.46		1		0.85	[ 0.58: 1.	111	4.0%
Corstorphine 2006	19	2.76	0.57	25	2.61	0.54		-	_	0.27	[-0.33: 0.	871	2.8%
Harrison 2010	50	7.00	10.00	50	10.00	9.00	-			-0.31	[-0.71: 0.	081	3.5%
Humbel 2018	58	10.70	5.77	54	11.20	6.44				-0.08	[-0.45: 0.	291	3.6%
Mallorqui-Baqué 2018	101	12.73	7.44	168	9.23	6.39		— <b>Т</b> 2		0.51	[0.26:0	761	4.0%
Merwin 2010	15	12.40	5.45	13	13.50	8.25	_	-	_	-0.16	[-0.90: 0.	591	2.3%
Monell 2018	236	13.62	6.19	350	13.80	6.20		-		-0.03	[-0.19: 0.	141	4.2%
Nordaren 2020	272	13.85	6.10	319	13.83	6.34				0.00	[-0.16:0	161	4.2%
Ruscitti 2016	28	10.00	6 4 5	21	11.05	7.30			_	-0.09	[-0.65: 0	481	2.9%
Smith 2018	34	11 56	6.41	27	10.59	7 41				0.14	[-0.37:0	651	3.1%
Svaldi 2012	20	9 75	7 61	18	10.83	7 66	_	-	_	-0.14	[-0 78· 0	501	2.6%
Vieira 2016	43	12 25	6 45	17	12 31	7 26				-0.01	[-0.57·0	551	2.9%
Vieira 2020	75	13 12	7 50	41	8 59	7.08		Τ÷	-	0.61	[0.22.1	001	3.5%
Weinbach 2018	51	15 71	6.09	22	15.80	5 45		-	_	-0.02	[-0.52: 0	481	3.1%
Wolz 2015	30	13 61	7.52	54	10.39	6.00		<b>T</b> ÷		0.49	[0.03.0	941	3.3%
Wyssen 2019	61	11 08	5 65	58	11 29	6.25		-		-0.04	[-0.39:0	321	3.6%
Total (95% CI)	1783	11.00	0.00	1907	11.20	0.20		- T-		0.23	[0.03: 0.	431	75.4%
Prediction interval								1		0120	[-0.70:1	161	
Heterogeneity: $I^2 = 87\%$ [	[82%;	91%], τ	<sup>2</sup> = 0.18	78, p	< 0.01						[ 0.1 0, 1.	101	
Strategy = reappraisa	0.5	40.00	0.00	~~~	44.00					0.05			0.40/
Crino 2019	35	13.80	3.93	29	14.03	4.44			_	-0.05	[-0.55; 0.	44]	3.1%
Danner 2014	64	4.10	1.09	30	3.52	1.44				0.47	[0.04; 0.	91]	3.3%
Davies 2012	42	25.60	8.30	26	24.30	9.50		-		0.15	[-0.34; 0.	64]	3.2%
Kollei 2012	32	12.95	3.18	34	12.42	3.44			_	0.16	[-0.33; 0.	64]	3.2%
Meule 2019	53	3.56	1.11	45	3.25	1.20			-	0.27	[-0.13; 0.	67]	3.5%
Nakahara 2000	22	6.45	3.24	26	4.88	2.63		1		0.53	[-0.05; 1.	11]	2.8%
Svaldi 2012	20	3.64	0.95	18	3.73	1.12	-		_	-0.09	[-0.72; 0.	55]	2.6%
Total (95% CI)	268			208				-	•	0.22	[0.04; 0.	41]	21.8%
Prediction interval		2						:	-		[-0.02; 0.	46]	
Heterogeneity: $I^2 = 0\%$ [ (	0%; 7	1%], τ² =	= 0, p =	0.59									
Strategy = problem so	olvino	1											
Nakahara 2000	22	6.60	3.19	26	4.85	3.49				0.51	[-0.06: 1.	091	2.8%
Total (95% CI)	22			26				-		0.51	[-0.06: 1.	091	2.8%
Prediction interval													
Heterogeneity: not application	able												
Total (95% CI)	2073			2141						0 24	[ 0 07· 0	401	100 0%
Prediction interval	2010			- 141				-		0.24	[-0.59: 1	071	. 50.0 /8
Heterogeneity: $l^2 = 83\% l$	77%:	88%l. T	$^{2} = 0.15$	79. p	< 0.01	Г	1		1		,		
		a strong to	0.10			-2	-1	0	1	2			
							Favours	AN Fa	avours BN				

Fig. 2. Forest plot of the differences between AN and BN patients in the use of adaptive ER strategies.



Fig. 3. Funnel plot of adaptive ER strategies. Dots represent individual studies, the X-axis represents the mean result and the Y-axis shows the sample size or an index of precision (Egger et al. [43]).

### Table 2

Hedges' g: effect size; 95% CI: 95% CI of effect size; K: number of studies; N: number of participants; Z: test for overall effect; p (Z): p value for overall effect; Q: heterogeneity between studies within ER strategy; p (Q): p value for heterogeneity;  $I^2$ : percentage of heterogeneity caused by study differences (Q—degrees of freedom/Q  $\times$  100%).

Strategy	Hedges' g	95% CI	К	Ν	Z	<i>p</i> (Z)	Q	<i>p</i> (Q)	I <sup>2</sup> (%)
Suppression	0.15	[-0.31, 0.60]	5	394	0.63	0.53	17.75	0.001	77%
Rumination	-0.31	[-0.67, 0.04]	5	282	1.77	0.08	6.56	0.16	39%
Avoidance	0.03	[-0.28, 0.34]	12	1614	0.18	0.86	89.70	< 0.00001	88%
Reappraisal	0.22	[0.04, 0.41]	7	476	2.37	0.02	4.66	0.59	0%
Problem Solving	0.51	[-0.06, 1.09]	1	48	1.74	0.08	n/a	n/a	n/a
Acceptance	0.23	[0.03, 0.43]	22	3690	2.25	0.02	166.88	< 0.00001	88%

Author	N Mean	AN SD	N Mean	BN SD		g	95	% CI	weight
Strategy = avoidance Bussolotti 2002 Corstorphine 2006 Espel Huynh 2019 Flament 2001 Gagnon-Girouard 2019 Krug 2008 Luck 2006 Nagata 2000 Nakahara 2000 Sheffield 2009 Troop 1994 Villa 2009 Total (95% CI) Prediction interval Heterogeneity: $I^2$ = 88% [800	134 14.50 19 2.96 268 58.99 29 24.00 46 2.59 21 13.78 85 12.35 22 6.20 40 7.52 24 19.80 29 33.05 788 	8.30 0.78 13.24 14.00 1.73 8.38 1.01 3.98 2.14 1.56 5.90 5.17	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{c} 0.80\\ 0.54\\ 13.20\\ 16.00\\ 2.47\\ 8.55\\ 0.78\\ 4.50\\ 2.59\\ 1.43\\ 4.70\\ 6.69\end{array}$		1.07 0.52 -0.13 -0.67 -0.24 0.05 0.01 -0.18 0.05 -0.12 0.01 0.03	[ 0.84; [-0.09; [-0.32; 0] [-0.32; 0] [-1.12; -1] [-0.73; 0] [-0.30; 0] [-0.75; 0] [-0.75; 0] [-0.57; 0] [-0.57; 0] [-0.28; 0] [-0.28; 0] [-1.14; 0]	1.31] 1.14] 0.06] 0.37] 0.22] 0.24] 0.24] 0.32] 0.38] 0.35] 0.35] 0.35] 0.34] 1.20]	5.5% 4.1% 5.6% 4.6% 5.1% 5.1% 4.2% 4.8% 4.7% 4.5% 57.6%
Strategy = rumination Crino 2019 Gilboa-Schechtman 2006 Sagiv 2020 Thew 2017 Wang 2018 Total (95% Cl) Prediction interval Heterogeneity: J <sup>2</sup> = 39% [ 0%	$\begin{array}{c} 35 & 12.17 \\ 20 & 3.70 \\ 55 & 60.22 \\ 16 & 3.24 \\ 67 & 2.08 \\ 193 \\ 5; 77\%], \tau^2 = 0 \end{array}$	3.88 0.70 16.33 0.66 0.73	29 12.34 20 3.76 26 65.38 6 3.35 8 2.92 89	3.88 0.53 13.24 0.54 0.54		-0.04 -0.09 -0.33 -0.17 -1.16 -0.32	[-0.54; ( [-0.71; ( [-0.80; ( [-1.11; ( [-1.92; -( [-0.67; ( [-1.30; (	0.45] 0.53] 0.14] 0.77] 0.41] 0.04] 0.66]	4.6% 4.0% 4.7% 2.9% 3.5% 19.6%
Strategy = suppression Danner 2014 Davies 2012 Krug 2008 Meule 2019 Svaldi 2012 Total (95% Cl) Prediction interval Heterogeneity: J <sup>2</sup> = 77% [460	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	1.26 5.30 22.76 1.33 1.59	30 3.59 26 14.50 75 62.55 45 4.06 18 3.89 194 $\rho < 0.01$	1.17 5.00 27.67 1.29 1.17		0.73 0.30 -0.68 0.14 0.22 0.15	[ 0.29; [-0.19; [-1.17; [-0.25; [-0.42; [-0.31; 0] [-1.48; 2]	1.18] 0.80] 0.18] 0.54] 0.85] 0.60] 1.78]	4.8% 4.6% 4.6% 4.9% 4.0% 22.8%
<b>Total (95% CI)</b> <b>Prediction interval</b> Heterogeneity: <i>I</i> <sup>2</sup> = 83% [759	<b>1181</b> %; 88%], τ <sup>2</sup> =	0.2199,	<b>1109</b> p < 0.01	-	2 -1 0 1 Favours AN Favours BN	-0.02	[-0.24;( [-1.02;(	0.21] 0.99]	100.0%

Fig. 4. Forest plot of the differences between AN and BN patients in the use of maladaptive ER strategies.

between AN and BN. Both EDs have been associated with the use of maladaptive ER strategies [3,28]. Actually, more avoidance, rumination and suppression is often associated with higher symptom severity and higher levels of ED psychopathology, suggesting that disordered eating behaviour might serve as a form of maladaptive ER to regulate emotionally stressful situations or mental states [3,122].

Thirdly, results from our meta-analysis reveal that even though AN and BN patients report to use more maladaptive but less adaptive cognitive emotion regulation strategies, AN patients are specifically impaired in applying adaptive emotion regulation strategies. This is particularly the case for two adaptive ER strategies, namely reappraisal and acceptance. This is an innovative and important finding, given that most studies report that ER difficulties are common in EDs, and – in line with the seminal transdiagnostic framework in eating disorders - generally report that ED subtypes do not differ from one another [23,47,66,71,74].

There are different tentative explanations for this innovative finding that AN patients are specifically impaired in using adaptive ER strategies. *First*, this latter finding could be explained by the impairment of mental flexibility as a key characteristic in AN patients [123,124]. Indeed, AN patients are found to have problems in set shifting (i.e., adapting behaviour in response to changing task demands; [125,126], and this cognitive rigidity has been related to an inability to use ER strategies in a flexible way (i.e., not being able to flexibly use an adaptive ER strategy in different situations [127]). Moreover, AN is also characterized by high levels of inhibition and overcontrolling [128,129]. As suggested by a fMRI study of [130], AN patients could benefit by focusing more on adaptive ER strategies instead of their 'overcontrolling', a key feature in AN which depletes patients' cognitive resources [131]. According to the model of [128], individuals with AN develop ER strategies to prevent or reduce the intensity of the emotion, resulting in a brief decrease in emotional experience. On the short term, this can be beneficial as opposed to longer-term avoidance. Nevertheless, it should be noted that other studies have shown that cognitive rigidity is also present in BN patients and might serve as a transdiagnostic feature in ED as well [124,133,135]. Second, a feature that particularly occurs in individuals who suffer from AN, is alexithymia referring to impaired emotional awareness and emotion recognition.



Fig. 5. Funnel plot of maladaptive ER strategies. Dots represent individual studies, the X-axis represents the mean result and the Y-axis shows the sample size or an index of precision (Egger et al., [43]).

Indeed, some studies suggested that individuals with a diagnosis of AN experience higher levels of alexithymia compared to individuals with other ED [136,137]. This alexithymia might possibly result in the fact that these patients have a lower need to apply adaptive ER strategies [138–140], and a lack of emotional awareness limits the capacity to engage in sophisticated and adaptive ER strategies [141]. This interpretation is in line with results of a recent study, reporting that a high level of alexithymia is associated with less frequent use of adaptive ER strategies in AN patients [142]. A third possible explanation can be found in the perseverant dietary restraint and starvation effects seen in AN [129,143], in contrast to BN patients in which normal BMI values have been found [144,145]. Due to this starvation, AN patients show on a variety of tasks reduced activity in the prefrontal cortex, a brain region involved in ER [146-150]. A neuroimaging study revealed less activation in the dorsolateral prefrontal cortex (dlPFC) when using cognitive reappraisal, suggesting dlPFC hypoactivity when processing affective stimuli might be a vulnerability factor for AN [132]. Furthermore, this study also found that fronto-amygdalar connectivity was negatively associated with overall eating disorder severity and endorsed difficulties in emotion regulation in patients with AN. [151,152] found that low body weight is also associated with limited access to physiological experience of emotions, moreover these emotions are experienced as vague and overwhelming. A recent study found that lower BMI was associated with less ER difficulties in women who suffer from acute AN [138]. A later study of this group has shown that being underweight was associated with attenuated emotional reactivity which seems to fade with weight gain [153]. In line with this notion, low body weight can be seen as a maladaptive mechanism of ER leading to an impairment in emotional awareness and limited capacity to engage in adaptive ER strategies [128,141].

These findings have important implications for treatment outcomes. Our results concerning the use of maladaptive ER strategies are in line with the finding that ER can be seen as a transdiagnostic construct as dysfunctional emotional processing is related to the etiology and maintenance of EDs [6,52] and also psychopathology in general [16,154,155] and less ER difficulties are associated with a decrease in psychopathology symptoms [8,155,156]. Although there are differences as to how different EDs display distinct disordered eating patterns, they might share the same underlying clinical dimensions. Given the fact that emotion dysregulation is a central feature within ED [4] and these study results with overall ER difficulties compared to a healthy control group, there is large potential in interventions that focus on ER. Since many ED patients stay symptomatic or only show partial improvement after Cognitive-Behavioural Therapy (CBT; [157]) that mainly focuses on changing cognitions and emotions [158], CBT can be extended or even replaced by valuable treatment strategies such as Emotion-Focused Therapy (EFT; [159]) and Young's Schema Therapy (ST; [160]) or focus more on contextual methods such as Mindfulness Self Compassion Training (MSC [161]). Those approaches focus on emotional awareness, emotion recognition and emotion regulation in order to enable primary emotional experience in ED patients [129].

For AN patients in particular, it is also very important to not only focus on global improvements in ER but also to make use of treatment protocols that aim to increase the use of adaptive ER strategies. For example, research has shown that Acceptance and Commitment Therapy (ACT [162]) improves emotional awareness and provides increased access to adaptive ER strategies as well as less disordered eating patterns [158,163]. Other examples of emotion-focused clinical interventions such as Cognitive Remediation and Emotion Skills Training (CREST; [164,165]) and Emotion Acceptance Behaviour Therapy (EABT; [166]) can be applied to increase emotional awareness and focus on the use of adaptive ER strategies in ED patients, and in AN patients in particular. Also targeting self-compassion by interventions such as Compassion Focused Therapy [167] can help patients to become milder to themselves, since self-compassion skills are adaptive ER strategies and negatively associated with difficulties in ER [168]. Additionally, neurostimulation to increase neural activation in the DLPFC and decrease activation in the limbic regions might enable using more adaptive ER strategies in patients with EDs [132].

All in all, future studies on treatment protocols in ED should shift attention from the commonly studies maladaptive ER strategies to more adaptive ER strategies, especially in individuals who suffer from AN. This patient group in particular shows reduced emotion processing and impairment in interoceptive awareness of emotional states [129,169,170], possible reducing the ability to apply cognitive strategies to adaptively regulate their emotional states.

Besides the strengths of this study (such as the direct comparison of a large AN and BN group of patients and the inclusion of a control group), several limitations should be considered when interpreting the results. The first limitation holds in the fact that many studies (n = 32) were excluded due to reporting only an overall score for ED and no separate score for AN and BN patients, hence effect sizes of those studies could not be calculated. Secondly because of the small numbers of studies for many of the ER strategies, low statistical power might lead to biased results. Although Hedges' g is often considered less biased compared to other measures such as Cohen's d, research has indicated that it might lead to larger bias compared to Cohen's d in meta-analysis results [171]. Furthermore, no distinction has been made between the restrictive and

binging/purging subtype of AN patients. It could be important to look at AN-R and AN-BP separately, since research has shown there is some overlap between AN-BP and BN, and the cross-over of AN-BP to BN diagnosis [172,173]. Another limitation is that the results could be biased by the use of self-report questionnaires with potentially social desirability or recall bias. Additionally, the use of different questionnaires to measure the same underlying construct can be a weakness, since they might hold different construct validity or examine a different aspect of the same construct. It would be interesting for future studies to make use of more ecologically valid measures to assess ER such as experimental paradigms (like emotion-modulated startle responses; Brockmeyer et al., 2019) or physiological data like heart rate variability, possibly accompanied by using questionnaires examining ER. ER can be seen as a dynamic, multi-stage process (identifying the need to regulate, selecting a strategy and implementing that strategy [178]), therefore using global measures like self-report questionnaires that rather assess "habitual" ER (as a trait) and fail to capture the dynamic aspect of ER [15]. Future research should therefore also include more momentary measures of ER such as daily self-reports of ER and within-person variance to see how they correspond with global self-report measures to gain more insight on differences in ER between AN and BN patients. Finally there was not sufficient data available for the current meta-analysis, but adding moderators such as comorbid diagnoses, ED symptom severity or treatment history to future analyses might also provide a more elaborate view on how and why different ER strategies are used in different ED.

### 5. Conclusion

This is the first study that makes use of the combination of a systematic review on the one hand, to provide an extensive overview of the past and recent literature on the use of ER strategies in AN and BN, and on the other hand a meta-analysis to look into differences in the use of adaptive and maladaptive ER strategies. In conclusion, we found no significant differences between AN and BN patients in the use of maladaptive ER strategies, which is in line with previous research [3,140]. In this way the distinct behavioural eating patterns of both patient groups can be understood as different ways serving the same aim: regulating undesired and/or intense mood states. On the other hand, differences in the use of adaptive ER strategies between AN and BN patients were found. This is a remarkable finding, these differences could be explained by the fact that individuals who are suffering from AN show impaired emotional awareness and recognition, and this is reflected in the usage of less adaptive ER strategies. These findings have important implications to optimize treatment outcome, and future treatment models of EDs should rather focus on shifting from maladaptive ER strategies and reinforce the use of adaptive ER strategies in ED patients, and consider looking into differentiating therapeutic interventions in AN and BN, based on their specific needs to optimize the use of adaptive ER strategies.

# Names and grant numbers of any sources of funding or support in the form of grants, equipment, drugs etc.

None.

#### **Conflict of Interest statement**

None.

#### Acknowledgments

We would like to thank Dr. Shiamalan Thanaskanda for proofreading the manuscript, and also Dr. Nele Pauwels (Knowledge Center for Health Ghent) and Dr. Ellen Deschepper (Biostatistics Unit of the Faculty of Medicine and Health Sciences of Ghent University) for sharing their knowledge on how to conduct a systematic review and meta-analysis.

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