Emotion Regulation in Adolescents with Anorexia and Bulimia Nervosa: Differential Use of
Adaptive and Maladaptive Strategies Compared to Healthy Adolescents

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Abstract

Objective: Adolescents with anorexia (AN) and bulimia nervosa (BN) often struggle with emotion regulation (ER). These difficulties have predominantly been assessed across emotions, without considering adaptive and maladaptive ER separately.

We compared adolescents with AN or BN to healthy adolescents (HCs) regarding the adaptive and maladaptive ER of three emotions.

Methods: A treatment-seeking sample of 197 adolescents (atypical/full-threshold AN: $N = 118$, atypical/full-threshold BN: $N = 32$; HC: $N = 47$) reported emotion-specific ER with the FEEL-KJ questionnaire. Mixed models were calculated for adaptive and maladaptive ER to assess differences between emotions (anxiety, anger, sadness) and groups (AN, BN, HC).

Results: Main effects of emotion ($p < .001$) and group ($p < .001$) were found, but no interaction effects were found ($p > .05$). Post-hoc tests showed lower maladaptive and higher adaptive ER for anxiety than anger or sadness ($p < .001$). AN and BN reported lower adaptive ($p < .001$) and higher maladaptive ER than HCs ($p < .001$). BN showed the highest levels of maladaptive ER ($p = .009$).

Discussion: The differences between AN and BN in adaptive and maladaptive ER should be considered. Furthermore, investigating differences in ER of other emotions in eating disorders might be promising.

Keywords: anorexia nervosa, bulimia nervosa, emotion regulation, eating disorders

Emotion Regulation in Adolescents with Anorexia and Bulimia Nervosa: Differential Use of Adaptive and Maladaptive Strategies Compared to Healthy Adolescents

1 Introduction

Anorexia (AN) and bulimia nervosa (BN) are serious eating disorders (EDs), associated with emotion regulation (ER) difficulties (Lavender et al., 2015). ER is the ability to regulate emotions regarding intensity, duration, and type by applying cognitive or behavioral strategies (Gross & Thompson, 2007). ER strategies can be categorized as adaptive (e.g., reappraisal) or maladaptive (e.g., rumination; Aldao et al., 2010). Maladaptive strategies are closely related to psychopathology across mental disorders (Aldao et al., 2010), including EDs (Prefit et al., 2019). Theoretical models of AN and BN conceptualize disordered eating behaviors (e.g., restriction, purging) as maladaptive behaviors to improve affect (Haynos & Fruzzetti, 2011; Stice, 2001). Cross-sectional and ecological momentary assessment studies underline these models showing that disordered eating is not only intended to regulate affect (Meule et al., 2019; Wang et al., 2020), but actually decreases negative and increases positive affect in daily life in AN (Engel et al., 2013; Kolar et al., 2020) and BN (Berg et al., 2013).

Most ER studies have assessed overall positive and negative affect, but individuals with EDs might experience distinct emotions differently. For example, fear of gaining weight is a core feature of AN and BN (Levinson et al., 2017; Murray et al., 2018), and childhood anxiety disorders predict EDs during adolescence (Schaumberg et al., 2019), indicating the centrality of anxiety for EDs. Fear of negative evaluation as a core feature of social anxiety is also associated with EDs (Levinson & Williams, 2020; Trompeter et al., 2019). Similar findings have been noted for depression, as studies acknowledge the impact of depressive symptoms on ED symptom trajectories (Allen et al., 2013; Herpertz-Dahlmann et al., 2015). Adolescent patients with comorbid depression show more ED symptoms compared to patients with comorbid anxiety disorders (Hughes et al., 2013). In summary, ED patients may struggle

1 particularly with specific emotions associated with comorbid anxiety or depressive disorders.
2 Sadness might be suppressed by restriction and purging (Espeset et al., 2012) and patients
3 with AN restricted their eating further after sadness was induced (Naumann et al., 2014).
4 Other maladaptive ER strategies such as anger suppression also seem to be relevant in EDs
5 (Fox & Power, 2009; Waller et al., 2003). However, there is a lack of studies examining
6 whether adolescents with EDs apply adaptive and maladaptive ER differentially in response
7 to specific emotions.

8 Adolescence is a phase of simultaneous emotional disturbance and adaptive ER
9 development (Gullone et al., 2010). Moreover, many mental disorders emerge during
10 adolescence (Kessler & Wang, 2008), including AN and BN (Smink et al., 2012).
11 Consequently, higher difficulties in ER were found in adolescents with EDs compared to
12 healthy adolescents (Segal & Golan, 2016), and greater dysfunctional ER for binge–purge
13 compared to restrictive EDs in adolescents (Weinbach et al, 2018). To date, only one study
14 has investigated age-specific differences of ER in EDs, finding no difference between
15 adolescents and adults (Anderson et al., 2018). However, ER difficulties typically decrease
16 when transitioning from adolescence into adulthood (Zimmermann & Iwanski, 2014),
17 indicating that healthy adolescents continue developing adaptive ER, whereas this process is
18 interrupted by EDs. Thus, investigating whether adolescents with EDs differ from healthy
19 adolescents in adaptive and maladaptive ER might further increase insight into the
20 relationship between ER and EDs.

21 Therefore, we hypothesize that adolescents with AN or BN differ from healthy
22 adolescents (HCs) in using adaptive and maladaptive ER. Specifically, we assume that
23 adolescents with EDs use less adaptive and more maladaptive ER strategies, with higher
24 maladaptive ER levels reported among adolescents with BN. In addition, we hypothesize that
25 strategies are differentially applied in response to anxiety, anger, and sadness in individuals
26 with and without EDs.

2 Methods

The sample comprised 197 female adolescents aged 12-20 years, of those 118 with a clinical diagnosis of AN (atypical: $N = 35$), 32 with BN (atypical: $N = 12$), and 47 HCs. Diagnoses were classified as atypical when at least one DSM-5 symptom was not met, but a clinical impression of AN/BN was apparent (e. g. AN: higher body weight, atypically low fear of weight gain; BN: lower frequency of bingeing/purging). Patients were diagnosed by an experienced clinician after diagnostic assessment. Data were pooled from four sources (cf. supplement file 1). This study received institutional review board approval from the medical faculty of the Ruhr-University Bochum (nos. 4359-12; 17-6140) and the State Medical Association at Mainz (no. 2020-15090).

2.1 Measures

Weight and height were objectively measured for patients with AN and BN to calculate BMI (kg/m^2) and age- and gender-adjusted BMI standard deviation scores (BMI-SDS; Kromeyer-Hauschild et al., 2001).

Eating Disorder Examination Interview and Questionnaire

Eating Disorder Examination Interviews (EDE; child version: ChEDE) and Questionnaire (EDE-Q) were used to compare symptom severity between patient groups and sample sites (Fairburn & Beglin, 1994). A thorough description of the EDE assessment in this study can be found in supplement file 2.

Questionnaire to assess children's and adolescents' emotion regulation strategies (FEEL-KJ)

The FEEL-KJ (Grob & Smolenski, 2005) is a 90-item questionnaire assessing ER of children and adolescents in response to anxiety, anger, and sadness. For each emotion, mean scores of two second-order factor scales (adaptive and maladaptive ER strategies) were computed. Problem solving, forgetting, acceptance, distraction, humor, cognitive problem

solving, and reappraisal were adaptive, and giving up, withdrawal, ruminating, self-evaluation, and aggressive behavior were maladaptive strategies. Participants indicated how much they apply each of the strategies (e.g., ‘I keep my feelings to myself’) repeatedly for each emotion. The FEEL-KJ was administered prior to or during early treatment phases. The FEEL-KJ is a reliable and valid measure for ER (Grob & Smolenski, 2005) and has been used in studies with ED patients (e.g., Czaja et al., 2009). In our sample, the emotion-specific adaptive and maladaptive scales showed good internal consistency ($.77 \leq \alpha \leq .88$).

2.2 Analysis

Baseline differences were analyzed using ANOVAs and t-tests. Two linear mixed models with random intercepts were calculated for adaptive and maladaptive ER, accounting for repeated assessments (i.e., answering the same items for three distinct emotions) within participants. They are comparable to repeated-measures ANOVAs, with the advantage of allowing partially-missing data. Emotion (anger, sadness, and anxiety; within-factor), group (AN, BN, and HC; between-factor), and Emotion $\times$ Group interaction fixed effects were calculated. Two-tailed Alpha was set at $\alpha = .05$. Post-hoc t-tests were Tukey-adjusted. Data analysis was conducted with R 3.5.0 (R Core Team, 2020) using the nlme package (Pinheiro et al., 2020). An a priori power analysis indicated 80% power to detect a small interaction effect with this sample size. The analysis plan and power analysis were preregistered (<https://osf.io/s2w76>).

3 Results

3.1 Sample characteristics

Supplement file 3 provides sample characteristics. AN, BN and HC participants differed in age, $F(2, 194) = 3.12, p = .046, \eta^2 = 0.03$, indicating that patients with BN were older than patients with AN ($t(194) = 2.39, p = .047, d = 0.46$). Patients with atypical AN showed higher BMI (BMI-SDS) scores compared to patients with full-threshold AN, but no differences in questionnaire scores were observed. No differences between patients

with atypical and full-threshold BN emerged, except for EDE eating concern (cf. supplement 4). Thus, combining participants with full-threshold and atypical AN or BN seemed reasonable. Regarding site differences, patients with AN recruited at Mainz had a higher BMI, as only inpatients were recruited in Hamm. This difference disappeared using BMI-SDS. The HC groups differed in maladaptive ER for sadness between study sites (cf. supplement file 5).

3.2 Emotion-specific adaptive and maladaptive emotion regulation

Table 1 provides linear mixed model and post-hoc comparison test statistics. For both adaptive and maladaptive ER, significant main effects of emotion and group were found, in line with our hypotheses. Significant post-hoc comparisons revealed higher adaptive (figure 1A) and lower maladaptive ER (figure 1C) of anxiety compared to anger, but no difference between anger and sadness. Compared to HC, patients with AN and BN reported less adaptive (figure 1B) and higher maladaptive ER (figure 1D). Maladaptive (but not adaptive) ER in patients with BN was also higher than in patients with AN.

Contrary to our hypotheses, interaction effects of Emotion $\times$ Group were not found for either adaptive or maladaptive ER (table 1). Thus, patients with AN or BN utilized ER strategies for all emotions similarly, compared to HC. Additional exploratory analyses, including age or BMI-SDS as predictors were conducted. Results were mostly identical, however, post-hoc differences in maladaptive strategies between AN and BN disappeared after controlling for BMI-SDS (cf. supplement file 6). Finally, exploratory analyses on differences between AN subtypes based on reported binge/purge frequencies in the last month revealed that the AN binge/purge subtype falls in between AN restrictive subtype and BN for adaptive and maladaptive strategies. However, it was not statistically significantly different from AN restrictive subtype or BN (see supplement file 7).

4 Discussion

We investigated adaptive and maladaptive ER in adolescents with AN and BN, compared to HCs. In line with our hypotheses, adolescents with AN and BN used more maladaptive and less adaptive strategies than HC, and adolescents with BN more maladaptive strategies than adolescents with AN. As expected, differences between emotions were observed: participants reported more adaptive and less maladaptive ER to regulate anxiety compared to anger and sadness. This indicates that even adolescents with AN or BN struggle less when regulating anxiety, compared to anger or sadness. AN binge/purge subtype reported less adaptive and more maladaptive strategies compared to AN restrictive subtype, and more adaptive and less maladaptive strategies compared to BN. Supporting Weinbach et al. (2018), ER difficulties seem to increase continuously from restrictive to binge/purge EDs). Altogether, both EDs and emotions explain a substantial part of the variance in using adaptive and maladaptive ER strategies.

Our results indicate that using adaptive strategies to regulate anger and sadness might be especially difficult for adolescents; therefore, more maladaptive strategies are used. Alternatively, adaptive ER for anxiety may be developed earlier during adolescence, compared to anger and sadness. However, because anxiety has been implicated as crucial during onset and maintenance of EDs (Levinson et al., 2017; Murray et al., 2018; Schaumberg et al., 2019), it is surprising that adolescents with EDs also reported fewer problems with ER of anxiety. An explanation might be that compared to ED-specific fears, dealing with anxiety, in general, may seem easier. A different explanation could be that fear of weight gain is more closely linked to sadness or depression, as a recent study has suggested (Levinson et al., 2020).

Our results underline that ER difficulties constitute a transdiagnostic factor across EDs and support targeting ER in interventions for adolescents with EDs. Hence, future studies should investigate whether adolescents with EDs benefit from ER interventions, such as

1 dialectical behavior therapy skills training (Reilly et al., 2020). Given that adolescents with
2 BN exhibit higher levels of maladaptive ER than AN, they might specifically benefit from
3 interventions aimed at increasing negative affect tolerance to decrease impulsive engagement
4 in maladaptive ER.

5 Our data were pooled from four sources using different instruments. Therefore,
6 diagnostic categories were partially based on clinical assessments instead of structured
7 interviews, limiting their reliability. Our findings were based on self-reports, which may be
8 biased as previous studies have found that adolescents with AN have difficulties identifying
9 and describing emotions (Kolar et al., 2017). Sample sizes in the BN and HC groups were
10 relatively small. Finally, we focused on anger, sadness, and anxiety, although emotions such
11 as disgust, shame, and guilt have also been linked to EDs (Fox & Power, 2009). Thus, future
12 studies might investigate whether adolescents with EDs apply ER differentially for these
13 emotions, given their importance in EDs (Berg et al., 2013; Haynos et al., 2017).

14 In conclusion, our study indicates that deficits in adaptive and excesses in maladaptive
15 ER appear transdiagnostic and “trans-emotional,” at least for anxiety, anger, and sadness in
16 adolescents with AN and BN. Higher levels of maladaptive ER have been reported in
17 adolescents with BN, warranting special attention. Future studies should corroborate our
18 findings with measures other than self-reports and might investigate emotion-specific
19 differences in the regulation of other emotions such as guilt or shame.

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6 Tables

Table 1. Model parameters of the linear mixed models and post-hoc comparisons for adaptive and maladaptive emotion regulation strategies as assessed with the FEEL-KJ.

A:	Adaptive emotion regulation strategies						Maladaptive emotion regulation strategies					
Fixed effects	<i>F</i>	<i>df</i>	<i>p</i>				<i>F</i>	<i>df</i>	<i>p</i>			
Intercept	5058.36	1; 385	<.001				4963.46	1; 386	<.001			
Emotion	25.53	2; 385	<.001				61.84	2; 386	<.001			
Group	20.92	2; 193	<.001				27.68	2; 193	<.001			
Emotion × Group	1.98	4; 385	.098				0.95	4; 386	.437			
Random effects	<i>Variance</i>						<i>Variance</i>					
Intercept	0.290						0.300					
Residual	0.134						0.124					
Model fit indices												
AIC	924						899					
BIC	972						947					
<i>R</i> ² marginal	.17						.23					
<i>R</i> ² conditional	.74						.77					
B:	Adaptive emotion regulation strategies						Maladaptive emotion regulation strategies					
Post-hoc comparisons	<i>M</i> ₁	<i>M</i> ₂	<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>	<i>M</i> ₁	<i>M</i> ₂	<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
Anger v. Anxiety	2.82	3.12	-7.01	385	<.001	0.46	3.02	2.70	7.95	386	<.001	0.50
Anger v. Sadness	2.82	2.92	-2.26	385	.063	0.14	3.02	3.10	-1.82	386	.165	0.11
Anxiety v. Sadness	3.12	2.92	4.74	385	<.001	0.31	2.70	3.10	-9.78	386	<.001	0.61
HC v. AN	3.40	2.86	5.39	193	<.001	0.83	2.43	3.02	-5.87	193	<.001	0.92
HC v. BN	3.40	2.61	5.93	193	<.001	1.21	2.43	3.37	-7.02	193	<.001	1.45
AN v. BN	2.86	2.61	2.15	193	.083	0.38	3.02	3.37	-2.99	193	.009	0.53

Note. *N* = 196 participants, 587 observations (Maladaptive: 588 observations). AIC: Akaike Information Criterion. BIC: Bayesian information criterion. *R*² indices are calculated with the formula proposed by Nakagawa, et al. (2017). FEEL-KJ: Questionnaire for the assessment of children's and adolescents' emotion regulation strategies. HC: Healthy control participants; AN: participants with anorexia nervosa; BN: participants with bulimia nervosa. Means are estimated marginal means. *P*-Values of post-hoc comparisons are Tukey-corrected for multiple comparisons.

Figure 1. Estimated marginal means of adaptive and maladaptive emotion regulation scores by emotion and group.

Note: Estimated marginal means (EMM) of the linear mixed models for adaptive and maladaptive emotion regulation. A: EMM of adaptive emotion regulation by emotion. B: EMM of adaptive emotion regulation by group. C: EMM of maladaptive emotion regulation by emotion. D: EMM of maladaptive emotion regulation by group. Error bars represent standard errors. Significance levels of main effects: * $p < .05$; ** $p < .01$; *** $p < .001$. AN: Anorexia nervosa. BN: Bulimia nervosa. HC: Healthy controls.

Emotion Regulation in Adolescents with Anorexia and Bulimia
Nervosa: Differential Use of Adaptive and Maladaptive Strategies
Compared to Healthy Adolescents

Supplementary Files

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Supplementary file 1. Data description and inclusion/exclusion criteria.

The data for this publication were comprised of four individual datasets as detailed below:

Patient data from the Joint Inpatient and Outpatient Specialized Eating Disorders Treatment Center, Department of Child and Adolescent Psychiatry, University Medicine Mainz in cooperation with Rheinhessen-Fachklinik Mainz, Mainz, Germany

Of $N = 97$ patients that were diagnosed with either (atypical) anorexia or (atypical) bulimia nervosa, $N = 93$ patients responded to the FEEL-KJ questionnaire (response rate: 95.9%). $N = 92$ female adolescents aged 12 to 19 years with a diagnosis of either (atypical) anorexia nervosa ($N = 75$) or (atypical) bulimia nervosa ($N = 17$) were included, one male adolescent was excluded. All adolescents were assessed at the beginning of inpatient or outpatient treatment at this facility between January 2013 and December 2019. Age and gender were the only exclusion criteria for this data analysis.

Patient data from the Eating Disorders Inpatient Center of the Child and Adolescent Psychiatry, LWL University Hospital Hamm of the Ruhr-University Bochum, Germany

$N = 58$ female adolescents aged 13 to 17 years with a diagnosis of either (atypical) anorexia nervosa ($N = 43$) or (atypical) bulimia nervosa ($N = 15$) were included, one participant without a diagnosis was excluded (response rate: 98.3 %). All adolescents were assessed at the beginning of inpatient treatment at this facility between January 2013 and December 2019. Of note, these are 27 adolescents more than pre-registered. This difference is due to a mistake in the preregistration.

Control data from the Department of Child and Adolescent Psychiatry, University Medicine Mainz

Data of $N = 20$ female healthy control participants aged 12 to 19 years were included as control participants. Exclusion criteria were any current or past diagnosis of a mental disorder in the past 5 years, as well as a current high symptom burden based on the global severity index of the Symptom Checklist 90. The data were originally recruited as a control group for an ecological momentary assessment study on aversive tension in adolescents with and without anorexia nervosa (cf. for more details: D.R. Kolar, Bürger, Hammerle, & Jenetzky, 2014; D. R. Kolar, Hammerle, Jenetzky, Huss, & Burger, 2016; D. R. Kolar et al., 2017).

Control data from the Eating Disorders Inpatient Center of the Child and Adolescent Psychiatry, LWL University Hospital Hamm of the Ruhr-University Bochum, Germany

$N = 27$ female adolescents aged 13 to 18 years were included as control participants. Inclusion criteria were a) age between 13 and 18 years, b) IQ score of at least 70 and c) had no current clinical symptoms as well as were not diagnosed with a mental disorder or received psychotherapy in the past. The control participants were part of an experimental study on adolescent depression that is currently in preparation for publication.

Supplementary file 2. Eating Disorder Examination Interview and Questionnaire.

The Eating Disorder Examination Interview (EDE; child version: ChEDE) and Questionnaire (EDE-Q) assess disordered eating within the last four weeks (Fairburn & Beglin, 1994). The EDE is an interview, whereas the EDE-Q is a self-report measure. Both instruments provide global scales and four subscales that are comparable between measures: restraint scale, eating, weight, and shape concern. Both instruments have been validated in German clinical samples (Hilbert et al., 2007; Hilbert et al., 2004). In this study, patients younger than 14 years were assessed using the ChEDE, older patients were assessed using the EDE in Mainz by supervised and trained raters (B.Sc. level or higher). The EDE-Q was used in Hamm. A mean global score and mean subscale scores were computed to ensure the comparability of the samples regarding symptom severity. Internal consistencies for the ChEDE, EDE and EDE-Q in this sample were good for global ($.85 \leq \alpha \leq .94$ across instruments) and subscale scores ($.71 \leq \alpha \leq .91$ across subscales and instruments).

1 **Supplementary file 3. Baseline characteristics for participants with anorexia nervosa, bulimia nervosa and healthy control participants.**

	Anorexia nervosa					Bulimia nervosa					Healthy control				
	<i>N</i>	%				<i>N</i>	%				<i>N</i>	%			
Total sample	118	100				32	100				47	100			
Full-threshold	83	70.3				20	62.5								
Atypical	35	29.7				12	37.5								
	<i>N</i>	<i>Min</i>	<i>Max</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>Min</i>	<i>Max</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>Min</i>	<i>Max</i>	<i>M</i>	<i>SD</i>
Age	118	12.92	19.17	15.47	1.53	32	13.00	17.42	16.20	1.09	47	12.00	19.00	15.81	1.76
BMI [†]	114	11.85	23.99	16.75	1.96	31	15.27	31.65	21.30	3.44	26	16.00	31.22	20.94	3.38
BMI-SDS [†]	114	-4.61	1.18	-1.73	1.00	31	-2.98	2.56	0.03	1.14	26	-2.10	2.49	0.00	1.00
<i>Eating Disorder Examination[‡]</i>															
Restraint	102	0.00	6.00	2.85	1.81	22	0.00	5.80	3.50	1.45					
Eating Concern	100	0.00	5.40	2.59	1.53	21	1.00	6.00	3.64	1.57					
Shape Concern	95	0.13	6.00	3.71	1.72	19	2.75	6.00	4.97	0.93					
Weight Concern	99	0.20	6.00	3.44	1.69	21	1.80	6.00	4.71	1.13					
Global Score	92	0.36	5.60	3.20	1.46	18	1.59	5.50	4.22	1.11					
<i>FEEL-KJ</i>															
Global Adaptive Scale	110	1.31	4.40	2.88	0.58	32	1.62	4.07	2.61	0.60	47	1.88	4.81	3.40	0.55
Global Maladaptive Scale	111	1.53	4.60	3.02	0.63	32	2.33	4.40	3.37	0.49	46	1.23	3.60	2.43	0.53
Anger Adaptive Scale	116	1.14	4.21	2.78	0.63	32	1.36	4.00	2.49	0.61	47	1.43	4.64	3.20	0.69
Anger Maladaptive Scale	118	1.50	4.50	3.10	0.66	32	2.50	4.50	3.45	0.53	46	1.50	3.90	2.52	0.63
Anxiety Adaptive Scale	114	1.21	4.71	2.98	0.65	32	1.57	4.07	2.83	0.68	47	2.14	5.00	3.57	0.63
Anxiety Maladaptive Scale	113	1.30	4.50	2.80	0.69	32	1.90	4.10	3.07	0.66	47	1.10	4.00	2.20	0.58
Sadness Adaptive Scale	114	1.00	4.57	2.84	0.66	32	1.29	4.21	2.51	0.69	47	1.36	4.79	3.43	0.63
Sadness Maladaptive Scale	115	1.60	4.80	3.16	0.70	32	2.30	4.70	3.59	0.50	47	1.00	3.80	2.54	0.66

2 Note: [†]Weight and height were only assessed in 26 control participants. [‡]EDE (Eating Disorder Examination) scores are based on EDE (adults) and ChEDE (Children version of the EDE) interviews in patients of the Mainz center, whereas
3 EDE-Q (EDE questionnaire) was used in the Hamm center. EDE scores were not assessed in control participants. BMI: Body Mass Index (kg/m²). BMI-SDS: age- and gender-adjusted BMI standard scores. FEEL-KJ: Questionnaire to assess
4 children's and adolescents' emotion regulation strategies

1 **Supplementary file 4. Comparisons of patients with full-threshold and atypical anorexia or bulimia nervosa.**

ED type	Variable	<i>M</i>	<i>M</i>	<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
		full-threshold ED	atypical ED				
AN	BMI	16.02	18.52	-6.66	47.49	< .001	1.34
AN	BMI-SDS	-2.09	-0.85	-7.16	58.78	< .001	1.44
AN	EDE – Global score	3.15	3.33	-0.50	43.99	.620	0.11
AN	EDE – Restraint	2.95	2.63	0.78	52.17	.439	0.18
AN	EDE – Eating concern	2.60	2.56	0.10	53.81	.921	0.02
AN	EDE – Shape concern	3.59	4.00	-1.04	50.38	.305	0.24
AN	EDE – Weight concern	3.38	3.56	-0.46	54.64	.644	0.10
AN	FEEL-KJ – Adaptive gobal	2.93	2.77	1.42	63.13	.160	0.30
AN	FEEL-KJ – Maladaptive global	3.01	3.04	-0.21	49.32	.835	0.04
AN	FEEL-KJ – Anger Adaptive	2.84	2.61	1.91	66.42	.060	0.40
AN	FEEL-KJ – Anger Maladaptive	3.10	3.11	-0.04	56.72	.968	0.01
AN	FEEL-KJ – Anxiety Adaptive	2.97	2.98	-0.07	54.97	.943	0.02
AN	FEEL-KJ – Anxiety Maladaptive	2.83	2.75	0.50	49.48	.617	0.11
AN	FEEL-KJ – Sadness Adaptive	2.90	2.72	1.31	58.95	.196	0.27
AN	FEEL-KJ – Sadness Maladaptive	3.12	3.24	-0.73	52.14	.470	0.15
ED type	Variable	<i>M</i>	<i>M</i>	<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
		full-threshold ED	atypical ED				
BN	BMI	21.70	20.67	0.80	22.35	.434	0.29
BN	BMI-SDS	0.16	-0.17	0.74	17.98	.469	0.27
BN	EDE – Global score	4.62	3.41	1.98	6.14	.093	0.97
BN	EDE – Restraint	3.87	2.69	1.76	10.04	.108	0.86
BN	EDE – Eating concern	4.24	2.43	2.53	8.65	.033	1.24
BN	EDE – Shape concern	5.31	4.23	1.98	5.54	.099	0.97
BN	EDE – Weight concern	4.98	4.03	1.33	5.80	.232	0.65
BN	FEEL-KJ – Adaptive gobal	2.61	2.61	0.03	18.89	.978	0.01
BN	FEEL-KJ – Maladaptive global	3.45	3.23	1.24	22.82	.229	0.45
BN	FEEL-KJ – Anger Adaptive	2.50	2.48	0.06	18.45	.954	0.02
BN	FEEL-KJ – Anger Maladaptive	3.53	3.32	1.06	21.69	.303	0.39
BN	FEEL-KJ – Anxiety Adaptive	2.77	2.93	-0.61	18.96	.552	0.22
BN	FEEL-KJ – Anxiety Maladaptive	3.19	2.88	1.30	22.58	.208	0.48
BN	FEEL-KJ – Sadness Adaptive	2.57	2.40	0.61	18.28	.552	0.22
BN	FEEL-KJ – Sadness Maladaptive	3.65	3.50	0.80	21.91	.432	0.29

2 Note. Uncorrected t-tests comparing BMI and questionnaire scores between participants with full-threshold or atypical anorexia or bulimia
3 nervosa. A diagnosis was classified as atypical when at least one DSM-5 symptoms was not met, but a clinical impression of AN or BN was
4 apparent (e. g. higher body weight, or atypically low fear of weight gain for AN; lower frequency of bingeing/purging in BN). AN: Anorexia
5 nervosa. BN: Bulimia nervosa. BMI: Body Mass Index (kg/m²). BMI-SDS: age-adjusted standardized BMI. ED: Eating disorder. EDE: Eating
6 Disorder Examination (data either from self-report or interview). FEEL-KJ: Questionnaire to assess children's and adolescents' emotion
7 regulation strategies.

1 **Supplementary file 5. Site comparisons between Mainz and Hamm.**

2 **Table 5a. Eating Disorder Examination comparisons between sites.**

ED type	Variable	Mainz <i>M</i>	Hamm <i>M</i>	<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
AN	EDE – Global score	3.32	2.88	1.18	36.18	.248	0.27
AN	EDE – Restraint	2.84	2.87	-0.05	39.13	.958	0.01
AN	EDE – Eating concern	2.62	2.50	0.32	41.26	.750	0.07
AN	EDE – Shape concern	3.90	3.25	1.57	43.35	.123	0.35
AN	EDE – Weight concern	3.59	2.99	1.53	42.07	.133	0.35
BN	EDE – Global score	4.32	3.87	0.48	3.47	.657	0.27
BN	EDE – Restraint	3.71	2.76	0.93	4.66	.399	0.53
BN	EDE – Eating concern	3.84	3.00	1.09	7.23	.311	0.62
BN	EDE – Shape concern	4.99	4.88	0.15	3.52	.886	0.09
BN	EDE – Weight concern	4.81	4.30	0.53	3.37	.631	0.30

3 *Note.* AN: Anorexia nervosa. BN: Bulimia nervosa. ED: Eating disorder. EDE: Eating Disorder Examination. EDE was assessed as interview in
4 Mainz and self-report in Hamm. Welch *t*-tests were conducted.

6 **Table 5b. FEEL-KJ comparisons between sites.**

FEEL-KJ Adaptive scales								FEEL-KJ Maladaptive scales						
Scale	ED-type	Mainz	Hamm	<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>	ED-type	Mainz	Hamm	<i>t</i>	<i>df</i>	<i>p</i>	<i>d</i>
		<i>M</i>	<i>M</i>						<i>M</i>	<i>M</i>				
Global	AN	2.92	2.83	-0.82	183	.958	0.03	AN	2.99	3.07	0.73	183	.979	0.03
	BN	2.83	2.36	-2.76	183	.198	0.17	BN	3.28	3.47	0.95	183	.937	0.07
	HC	3.36	3.44	0.47	183	.998	0.02	HC	2.69	2.23	-2.71	183	.085	0.14
Anger	AN	2.81	2.72	-0.75	189	.976	0.03	AN	3.07	3.15	0.67	190	.984	0.03
	BN	2.71	2.24	-2.47	189	.315	0.17	BN	3.36	3.55	0.86	190	.958	0.07
	HC	3.18	3.21	0.16	189	.999	< 0.01	HC	2.79	2.32	-2.47	190	.120	0.14
Anxiety	AN	2.99	2.95	-0.31	187	.999	0.01	AN	2.79	2.83	0.31	186	.999	0.01
	BN	3.04	2.58	-2.30	187	.355	0.16	BN	3.05	3.08	0.13	186	.999	0.01
	HC	3.59	3.55	-0.21	187	.999	0.01	HC	2.38	2.05	-1.65	186	.541	0.10
Sadness	AN	2.86	2.80	-0.46	187	.997	0.02	AN	3.12	3.23	0.92	188	.947	0.04
	BN	2.73	2.26	-2.35	187	.316	0.17	BN	3.43	3.78	1.52	188	.641	0.12
	HC	3.29	3.53	1.26	187	.817	0.07	HC	2.90	2.28	-3.26	188	.017	0.18

7 *Note.* Tukey-adjusted post-hoc comparisons of four ANOVAs with site and diagnostic group as factors. Only meaningful comparisons within
8 diagnostic groups were presented. AN: Anorexia nervosa. BN: Bulimia nervosa. ED: Eating disorder. HC: Healthy Control. FEEL-KJ:
9 Questionnaire for the assessment of children's and adolescents' emotion regulation strategies.

1 **Supplementary file 6. Exploratory analyses with the inclusion of age or BMI-SDS as covariates.**

2 **Table 6a. Model parameters after including age as a covariate.**

	Adaptive emotion regulation strategies			Maladaptive emotion regulation strategies		
Fixed effects	<i>F</i>	<i>df</i>	<i>p</i>	<i>F</i>	<i>df</i>	<i>p</i>
Intercept	5048.57	1; 384	<.001	4949.98	1; 385	<.001
Age	0.43	1; 384	.514	0.27	1; 385	.606
Emotion	25.51	2; 384	<.001	61.82	2; 385	<.001
Group	20.90	2; 193	<.001	27.55	2; 193	<.001
Emotion × Group	1.97	4; 384	.098	0.94	4; 385	.438
Random effects	<i>Variance</i>			<i>Variance</i>		
Intercept	0.291			0.300		
Residual	0.134			0.124		
Model fit indices						
AIC	931			906		
BIC	983			959		
<i>R</i> ² marginal	.17			.23		
<i>R</i> ² conditional	.74			.77		

3 *Note.* *N* = 196 participants, 587 observations (Maladaptive: 588 observations). AIC: Akaike Information Criterion. BIC: Bayesian information
4 criterion. *R*² indices are calculated with the formula proposed by Nakagawa, et al. (2017).

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1 **Table 6b. Post-hoc comparisons for emotion and group after controlling for age.**

A: Adaptive emotion regulation strategies								
Group comparison	M_1	M_2	Mean difference	SE	t	df	p	d
Anger v. Anxiety	2.82	3.12	-0.30	0.04	-7.00	384	< .001	0.46
Anger v. Sadness	2.82	2.92	-0.10	0.04	-2.26	384	.063	0.15
Anxiety v. Sadness	3.12	2.92	0.20	0.04	4.74	384	<.001	0.31
HC v. AN	3.40	2.86	0.54	0.10	5.30	193	<.001	0.82
HC v. BN	3.40	2.60	0.80	0.13	5.96	193	<.001	1.22
AN v. BN	2.86	2.60	0.26	0.12	2.23	193	.069	0.40
B: Maladaptive emotion regulation strategies								
Group comparison	M_1	M_2	Mean difference	SE	t	df	p	d
Anger v. Anxiety	3.03	2.70	0.33	0.04	7.95	385	<.001	0.50
Anger v. Sadness	3.03	3.10	-0.07	0.04	-1.82	385	.165	0.11
Anxiety v. Sadness	2.70	3.10	-0.40	0.04	-9.78	385	<.001	0.61
HC v. AN	2.42	3.02	-0.60	0.10	-5.88	193	<.001	0.92
HC v. BN	2.42	3.36	-0.94	0.13	-6.97	193	<.001	1.44
AN v. BN	3.02	3.36	-0.34	0.12	-2.88	193	.012	0.18

2 *Note:* HC: Healthy control participants; AN: participants with anorexia nervosa; BN: participants with bulimia nervosa. M_1 corresponds to the
3 first group, M_2 to the second. P -Values are Tukey-corrected for multiple comparisons.

1 **Table 6c. Model parameters after including BMI-SDS as a covariate.**

	Adaptive emotion regulation strategies			Maladaptive emotion regulation strategies		
Fixed effects	<i>F</i>	<i>df</i>	<i>p</i>	<i>F</i>	<i>df</i>	<i>p</i>
Intercept	4105.37	1; 332	<.001	4389.41	1; 333	<.001
BMI-SDS	0.15	1; 332	.699	0.37	1; 333	.541
Emotion	19.17	2; 332	<.001	52.04	2; 333	<.001
Group	15.08	2; 167	<.001	28.23	2; 167	<.001
Emotion × Group	2.80	4; 332	.026	2.13	4; 333	.077
Random effects	<i>Variance</i>			<i>Variance</i>		
Intercept	0.308			0.302		
Residual	0.122			0.118		
Model fit indices						
AIC	786			772		
BIC	836			823		
<i>R</i> ² marginal	.15			.26		
<i>R</i> ² conditional	.76			.79		

2 *Note.* *N* = 170 participants, 509 observations (Maladaptive: 510 observations), as several control participants did not provide BMI-SDS. AIC: Akaike Information Criterion. BIC: Bayesian information criterion. *R*² indices are calculated with the formula proposed by Nakagawa, et al. (2017). BMI: Body Mass Index (kg/m²). BMI-SDS: age- and gender-adjusted BMI standard scores.

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1 **Table 6d. Post-hoc comparisons of adaptive emotion regulation for emotion and group after controlling for**
2 **BMI-SDS.**

Emotion	Group comparison	M_1	M_2	Mean difference	SE	t	df	p	d
Anger	HC v. AN	3.30	2.77	0.53	0.16	3.24	167	.004	0.79
Anger	HC v. BN	3.30	2.55	0.75	0.18	4.30	167	<.001	1.13
Anger	AN v. BN	2.77	2.55	0.22	0.15	1.47	167	.310	0.34
Anxiety	HC v. AN	3.60	2.95	0.65	0.16	4.00	167	<.001	1.17
Anxiety	HC v. BN	3.60	2.89	0.71	0.18	4.07	167	<.001	1.57
Anxiety	AN v. BN	2.95	2.89	0.06	0.15	0.40	167	.914	0.39
Sadness	HC v. AN	3.59	2.81	0.78	0.16	4.79	167	<.001	0.98
Sadness	HC v. BN	3.59	2.55	1.04	0.18	5.94	167	<.001	1.07
Sadness	AN v. BN	2.81	2.55	0.26	0.15	1.70	167	.209	0.09
Group	Emotion comparison	M_1	M_2	Mean difference	SE	t	df	p	d
HC	Anger v. Anxiety	3.30	3.60	-0.30	0.09	-3.25	332	.004	0.46
HC	Anger v. Sadness	3.30	3.59	-0.29	0.09	-3.11	332	.006	0.44
HC	Anxiety v. Sadness	3.60	3.59	0.01	0.09	0.14	332	.990	0.02
AN	Anger v. Anxiety	2.77	2.95	-0.18	0.05	-3.83	332	<.001	0.27
AN	Anger v. Sadness	2.77	2.81	-0.04	0.05	-0.80	332	.703	0.06
AN	Anxiety v. Sadness	2.95	2.81	0.14	0.05	2.99	332	.008	0.21
BN	Anger v. Anxiety	2.55	2.89	-0.34	0.09	-3.87	332	<.001	0.52
BN	Anger v. Sadness	2.55	2.55	0.00	0.09	-0.03	332	.999	0.00
BN	Anxiety v. Sadness	2.89	2.55	0.34	0.09	3.84	332	<.001	0.51

3 *Note:* HC: Healthy control participants; AN: participants with anorexia nervosa; BN: participants with bulimia nervosa. M_1 corresponds to the
4 first group, M_2 to the second. P -Values are Tukey-corrected for multiple comparisons. $N = 170$ participants, as several control participants did
5 not provide BMI-SDS. BMI: Body Mass Index (kg/m^2). BMI-SDS: age- and gender-adjusted BMI standard scores.

7 **Table 6e. Post-hoc comparisons of maladaptive emotion regulation for emotion and group after controlling for**
8 **BMI-SDS.**

Group comparison	M_1	M_2	Mean difference	SE	t	df	p	d
Anger v. Anxiety	2.93	2.63	0.30	0.05	6.74	333	<.001	0.47
Anger v. Sadness	2.94	2.99	-0.05	0.05	-1.16	333	.478	0.08
Anxiety v. Sadness	2.63	2.99	-0.36	0.05	-7.94	333	<.001	0.55
HC v. AN	2.19	3.04	-0.85	0.15	-5.72	167	<.001	1.31
HC v. BN	2.19	3.33	-1.14	0.16	-7.29	167	<.001	1.75
AN v. BN	3.04	3.33	-0.29	0.14	-2.05	167	.104	0.44

9 *Note:* HC: Healthy control participants; AN: participants with anorexia nervosa; BN: participants with bulimia nervosa. M_1 corresponds to the
10 first group, M_2 to the second. P -Values are Tukey-corrected for multiple comparisons. $N = 170$ participants, as several control participants did
11 not provide BMI-SDS. BMI: Body Mass Index (kg/m^2). BMI-SDS: age- and gender-adjusted BMI standard scores.

1 **Supplementary file 7. Exploratory re-analyses of the main models with separate groups for restrictive and**
2 **binge/purge Anorexia nervosa subtypes.**
3 Subtypes were determined based on the Eating Disorder Examination interview, child version of the Eating Disorder
4 Examination interview or the Eating Disorder Examination Questionnaire scores of the Anorexia nervosa participants
5 for items 10, 16, and 17 (binge episodes, vomiting episodes and laxative abuse episodes in the last 28 days or last
6 month, respectively).

7 **Table 7a. Model parameters with Anorexia nervosa patients split into restrictive and binge/purge subtype.**

	Adaptive emotion regulation strategies			Maladaptive emotion regulation strategies		
Fixed effects	<i>F</i>	<i>df</i>	<i>p</i>	<i>F</i>	<i>df</i>	<i>p</i>
Intercept	4648.48	1; 347	<.001	4483.48	1; 348	<.001
Emotion	26.30	2; 347	<.001	55.33	2; 348	<.001
Group	14.64	3; 174	<.001	19.46	3; 174	<.001
Emotion × Group	1.54	6; 347	.164	1.20	6; 348	.307
Random effects	<i>Variance</i>			<i>Variance</i>		
Intercept	0.289			0.299		
Residual	0.139			0.139		
Model fit indices						
AIC	864			835		
BIC	924			894		
<i>R</i> ² marginal	.19			.25		
<i>R</i> ² conditional	.74			.78		

8 *Note.* *N* = 178 participants, 533 observations (Maladaptive: 534 observations), as several participants with Anorexia nervosa did not answer all
9 EDE items. Binge/purge subtype was defined when at least one episode of binge-eating, vomiting or laxative abuse was reported within the last
10 month during EDE, ChEDE or EDE-Q. AIC: Akaike Information Criterion. BIC: Bayesian information criterion. *R*² indices are calculated with
11 the formula proposed by Nakagawa, et al. (2017). (Ch)EDE: (Child) Eating Disorder Examination, interview version. EDE-Q: Eating Disorder
12 Examination questionnaire.

1 **Table 7b. Post-hoc comparisons for emotion and group with Anorexia nervosa patients split into restrictive and**
2 **binge/purge subtype.**

A: Adaptive emotion regulation strategies								
Group comparison	M_1	M_2	Mean difference	SE	t	df	p	d
Anger v. Anxiety	2.86	3.16	-0.30	0.04	-7.15	347	<.001	0.44
Anger v. Sadness	2.86	2.95	-0.09	0.04	-1.76	347	.186	0.11
Anxiety v. Sadness	3.16	2.95	0.21	0.04	5.37	347	<.001	0.34
AN-R v. AN-BP	2.96	2.74	0.22	0.12	1.87	174	.244	0.34
AN-R v. BN	2.96	2.61	0.35	0.13	2.79	174	.030	0.54
AN-R v. HC	2.96	3.40	-0.44	0.11	-3.88	174	.001	0.67
AN-BP v. BN	2.74	2.61	0.13	0.14	0.92	174	.794	0.20
AN-BP v. HC	2.74	3.40	-0.66	0.13	-5.21	174	<.001	1.01
BN v. HC	2.61	3.40	-0.79	0.13	-5.93	174	<.001	1.21
B: Maladaptive emotion regulation strategies								
Group comparison	M_1	M_2	Mean difference	SE	t	df	p	d
Anger v. Anxiety	2.98	2.67	0.31	0.04	8.06	348	<.001	0.48
Anger v. Sadness	2.98	3.04	-0.06	0.04	-1.86	348	.153	0.11
Anxiety v. Sadness	2.67	3.04	-0.37	0.04	-9.90	348	<.001	0.59
AN-R v. AN-BP	2.94	3.16	-0.22	0.12	-1.86	174	.251	0.34
AN-R v. BN	2.94	3.37	-0.43	0.13	-3.40	174	.005	0.66
AN-R v. HC	2.94	2.43	0.51	0.11	4.49	174	<.001	0.78
AN-BP v. BN	3.16	3.37	-0.21	0.14	-1.49	174	.444	0.32
AN-BP v. HC	3.16	2.43	0.73	0.13	5.74	174	<.001	1.13
BN v. HC	3.37	2.43	0.94	0.13	7.03	174	<.001	1.45

3 *Note:* $N = 178$ participants, 533 observations (Maladaptive: 534 observations), as several participants with Anorexia nervosa did not answer all
4 EDE items. HC: Healthy control participants; AN-R: participants with anorexia nervosa – restrictive subtype; AN-BP: participants with anorexia
5 nervosa – binge/purge subtype; BN: participants with bulimia nervosa. AN-BP was defined when at least one episode of binge-eating, vomiting
6 or laxative abuse was reported within the last month during EDE, ChEDE or EDE-Q. (Ch)EDE: (Child) Eating Disorder Examination, interview
7 version. EDE-Q: Eating Disorder Examination questionnaire. M_1 corresponds to the first group, M_2 to the second. P -Values are Tukey-corrected
8 for multiple comparisons.

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