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## RESEARCH ARTICLE

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# Seeing oneself as an unattractive loser: Similar interpretation and memory biases in adolescents with anorexia nervosa and adolescents with depression or anxiety

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**Abstract**

**Objective:** Anorexia nervosa (AN) is characterised by dysfunctional cognitive biases but these have rarely been investigated in adolescents with AN. The present study systematically assessed cognitive biases in adolescents with AN and addressed the questions of content-specificity (i.e., do biases occur only for eating disorder-related information?) and disorder-specificity (i.e., are biases unique to individuals with AN?).

**Methods:** Cognitive biases on three information processing levels (attention, interpretation, memory) and for two types of information content (eating disorder-related, non-eating disorder-related) were assessed within a single experimental paradigm based on the Scrambled Sentences Task. 12-18-year-old adolescents with AN ( $n = 40$ ) were compared to a healthy (HC;  $n = 40$ ) and a clinical (girls with depression and/or anxiety disorders; CC;  $n = 34$ ) control group.

**Results:** Both clinical groups (AN and CC) showed pronounced negative interpretation and memory biases compared to the HC group, for both disorder-related and non-disorder-related information. Attention biases could not be analysed.

**Conclusion:** The results support the hypothesis that adolescents with AN show negative cognitive biases but these were not limited to disorder-related information. Adolescents with depression and/or anxiety disorders showed similar biases, suggesting them to be transdiagnostic phenomena. Important implications for cognitive-behavioural theories of AN, subsequent cognitive bias modification studies in AN, as well as clinical practice are discussed.

**KEYWORDS**

adolescence, cognitive biases, eating disorders, negative biases, youth

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### Highlights

- Adolescent girls with anorexia nervosa show more pronounced negative interpretation and memory biases for eating disorder-related and more general negative information compared to adolescent girls with no mental illness.
- Adolescents with anorexia nervosa and adolescents with depression and/or anxiety disorders showed similar levels of the cognitive biases regardless the content (eating disorder-related and non-eating disorder-related).
- Transdiagnostic factors such as low self-esteem or body dissatisfaction may play an important role in explaining cognitive biases in youth with mental illness.

## 1 | BACKGROUND

Anorexia nervosa (AN) is an eating disorder (ED) that mostly affects adolescent and young adult women with a lifetime prevalence of 0.9%–2.2% (Smink et al., 2012) and an onset age peak at 15.5 years (Solmi et al., 2022). There has been a sharp rise in the incidence of AN in adolescents during the course of the COVID-19 pandemic (e.g., Gilsbach et al., 2022), further underlining the current relevance of the disorder and the need for a deeper understanding of the mechanisms involved in the development and maintenance of the disorder particularly in adolescence.

AN is characterised by significantly low body weight, persistent behaviour that interferes with gaining weight and/or intense fear of gaining weight, and body image disturbance (either disturbed perception of one's body, persistent lack of recognition of seriousness of low body weight, or self-worth overly influenced by body weight or shape; American Psychiatric Association, 2013). In addition to the core symptoms, individuals with AN often show dysfunctional cognitions regarding disorder-specific information, that is, information related to food/eating as well as body weight and shape (e.g., Vitousek & Hollon, 1990; Williamson et al., 2004). These dysfunctional cognitions manifest themselves as cognitive biases, that is, tendencies to preferentially process information that is congruent with one's maladaptive cognitive schemata, which include increased concern with body size/shape and eating (Williamson et al., 2004). Importantly, these biases are not only considered to play an important role in the development and maintenance of AN (in contrast of being mere correlates of ED psychopathology; Williamson et al., 2004), but can also be experimentally manipulated in individuals with or at risk for EDs using cognitive bias modification (CBM) trainings (see Matheson et al., 2019). They therefore represent promising targets for intervention.

Cognitive biases can be found on different levels of information processing. Attention biases refer to tendencies to focus and maintain attention on information consistent to one's maladaptive schemata (Aspen et al., 2013). Numerous studies have found individuals with AN to show attention biases for ED-related information (i.e., images or words related to food/eating or body weight and shape; see e.g., Aspen et al., 2013; Ralph-Nearman et al., 2019) and some studies have also found attention biases for non-ED-related emotional information (i.e., negative emotional faces; e.g., Cardi et al., 2013). Negative interpretation biases are tendencies to interpret ambiguous emotional information consistently with one's own maladaptive schemata, that is, to attribute negative rather than neutral or positive meanings to this information (Brockmeyer et al., 2018). Two early (Cooper, 1997; Williamson et al., 2000) and one more recent study (Brockmeyer et al., 2018) found negative body-related interpretation biases in individuals with AN or other EDs compared to individuals with no mental disorders. A few studies also found non-ED-related negative interpretation biases (for ambiguous social situations) in adolescents (Rowlands et al., 2021) as well as adults (Cardi et al., 2017) with AN. Memory biases, in turn, describe tendencies to remember schema-consistent information better than other information (Hermans et al., 1998). The few studies investigating memory biases in AN found either explicit (Hermans et al., 1998) or implicit (Johansson et al., 2008) memory biases for ED-related information and one study reported memory biases for non-ED-related emotional information (Manuel & Wade, 2013).

In summary, there is evidence for biases for ED-related and non-ED-related information on all three levels of processing. The presence of more general, non-ED-related biases (that are similar to those found in individuals with other mental disorders such as depression and anxiety; e.g., Mathews & MacLeod, 2005) challenges

the assumption that individuals with AN are characterised particularly by content-specific biases, that is, biases for information related to their ED (Williamson et al., 1999). However, only few studies so far have addressed the content-specificity hypothesis by assessing biases for both, ED-related and non-ED-related information within one study (e.g., Hermans et al., 1998; Korn et al., 2020; Radix et al., 2023). Their results indicated biases only for ED-related information, contrasting those of studies investigating biases for non-ED-related information separately. Thus, it is still unclear whether individuals with AN are characterised particularly by content-specific biases or if they also show more general negative biases. Moreover, no study has examined biases on multiple levels of information processing within the same sample and the methodological diversity of previous studies makes it difficult to compare and aggregate their results, not only across but also within information processing levels.

An additional limitation of the previous literature is that most studies have been conducted in adults with AN. Studies in adolescents are scarce: Only few studies reported attention biases (e.g., Radix et al., 2023; Sfarlea et al., 2023) and only one study reported negative interpretation biases (for social information; Rowlands et al., 2021) in adolescents with AN compared to adolescents with no mental disorders, despite the facts that (i) the incidence of AN is highest in adolescence (Solmi et al., 2022) and (ii) major cognitive and affective development is ongoing during adolescence (e.g., Steinberg, 2005), making it difficult to transfer results obtained in adult samples on adolescents. As comprehensive knowledge of cognitive biases in adolescents with AN is lacking, the aim of the present study was to systematically investigate whether adolescents with AN show cognitive biases on different levels of information processing and to examine to what extent these biases are specific for ED-related information and to what extent they are general negative biases (content-specificity).

When studying cognitive biases in adolescents with AN it should be taken into account that a large proportion of the adolescent AN population (47%–60%; Bühren et al., 2014; Jaite et al., 2013) suffers from comorbid disorders, especially depression and anxiety disorders. These disorders are also associated with negative cognitive biases in adolescents (Lau & Waters, 2017; Platt et al., 2017) so it is possible that negative biases for non-ED-related information in adolescents with AN are explained by their comorbid disorders. In order to draw conclusions about the extent to which biases are specific to individuals with AN (disorder-specificity), adolescents with AN were not only compared to a group of adolescents with no mental disorders (healthy controls; HC) but

also to a clinical control (CC) group consisting of adolescents with major depression or particular anxiety disorders.

The present study assessed attention, interpretation, and memory biases within a single experimental paradigm based on the Scrambles Sentences Task (SST; Everaert et al., 2014; Wenzlaff & Bates, 1998). Two types of stimuli were included: stimuli related to one's body, weight, and shape were used to assess ED-related biases while stimuli related to non-body/appearance-related self-evaluation were used to assess non-ED-related biases (see methods for examples). According to the current literature, we expected adolescents with AN to show more pronounced cognitive biases on all three levels of information processing for both, negative ED-related information (Hypothesis 1a; e.g., Aspen et al., 2013; Brockmeyer et al., 2018; Hermans et al., 1998) as well as negative non-ED-related information (Hypothesis 2a; e.g., Cardi et al., 2013; Rowlands et al., 2021) compared to adolescents with no mental disorders (HC group). In addition, we expected adolescents with AN to show more pronounced biases for negative ED-related (Hypothesis 1b) but not for negative non-ED-related information (Hypothesis 2b) compared to adolescents with depression and/or anxiety disorders (CC group). The CC group was not expected to differ from the HC group regarding ED-related biases (Hypothesis 1c) but to show more pronounced biases for negative non-ED-related information (Hypothesis 2c; Lau & Waters, 2017). In summary, the following patterns were expected for ED-related biases (Hypothesis 1): AN > CC = HC and non-ED-related biases (Hypothesis 2): CC ≥ AN > HC. In addition, we explored to what extent ED-specific (ED symptoms, body dissatisfaction) and more general (depression symptoms, anxiety symptoms, self-esteem) participant characteristics predicted ED-related and non-ED-related biases.

## 2 | METHODS

For a detailed description of the recruitment and the experimental paradigm we refer to the study protocol of the KOALA study (KOALA stands for “Cognitive biases in adolescents with anorexia nervosa”; Sfarlea et al., 2021).

### 2.1 | Participants

The study sample included 114<sup>1</sup> adolescent females aged 12–18 years. AN ( $n = 40$ ) and CC ( $n = 34$ ) participants were recruited at the Department of Child and Adolescent Psychiatry, Psychosomatics and Psychotherapy of



the LMU University Hospital Munich. Girls in the HC group ( $n = 40$ ) were recruited via previous studies. Sample size was based on an a priori power analysis (see study protocol; Sfarlea et al., 2021). The study was approved by the ethics committee of the Medical Faculty of the LMU Munich (project-No. 20-480). Prior to participation, written informed consent was obtained from all participants (and their parents/legal custodians for participants under 18 years of age) after a comprehensive explanation of the study procedures.

A standardized, semi-structured diagnostic interview (Kinder-DIPS; Margraf et al., 2017; Schneider et al., 2017) was conducted to assess psychiatric diagnoses according to DSM-5 (American Psychiatric Association, 2013). Interrater-reliability of the interview was good in our sample (accordance rates  $\geq 93\%$  for lifetime diagnoses of AN, major depression, social phobia, and generalised anxiety disorder). Participants were included in the AN group if they currently met diagnostic criteria for AN; participants were included in the CC group if they currently met criteria for major depression, social phobia, or generalised anxiety disorder (as these are the most frequent comorbidities of AN and at the same time known to be associated with cognitive biases; Bühren et al., 2014; Lau & Waters, 2017) and did not meet criteria for a current or past ED; participants were included in the HC group if they did not meet criteria for any current or past mental disorder. Exclusion criteria for all participants were below average intelligence ( $IQ < 85$ , measured with CFT-20-R; Weiß, 2006; two participants scoring just below 85 were included nonetheless, not changing the pattern of results), insufficient German language skills, non-corrected visual impairment, pervasive developmental disorders, psychotic disorders, bipolar disorders, and substance abuse.

We assessed ED symptoms with the Eating Disorder Inventory (EDI-2; Thiel et al., 1997), depression symptoms with the Beck Depression Inventory (BDI-II; Hautzinger et al., 2009), and anxiety symptoms with the trait version of the State-Trait Anxiety Inventory (STAI-T; Laux et al., 1981). Furthermore, body dissatisfaction and self-esteem were assessed using the Body Shape Questionnaire (BSQ; Pook et al., 2002) and the Rosenberg Self-Esteem Scale (RSES; von Collani & Herzberg, 2003). Internal consistency for all questionnaires was excellent (Cronbach's  $\alpha \geq 0.95$ ).

Mean illness duration (onset of weight loss reported in the diagnostic interview) in the AN group was 19.31 months ( $Md = 13$ ,  $SD = 2.84$ , range: 5–75). Of the adolescents in the AN group, 87.5% met criteria for at least one comorbid condition, mostly major depression ( $n = 18$ ) and anxiety disorders (social phobia:  $n = 9$ ; generalised anxiety disorder:  $n = 5$ ). Of the adolescents in the CC

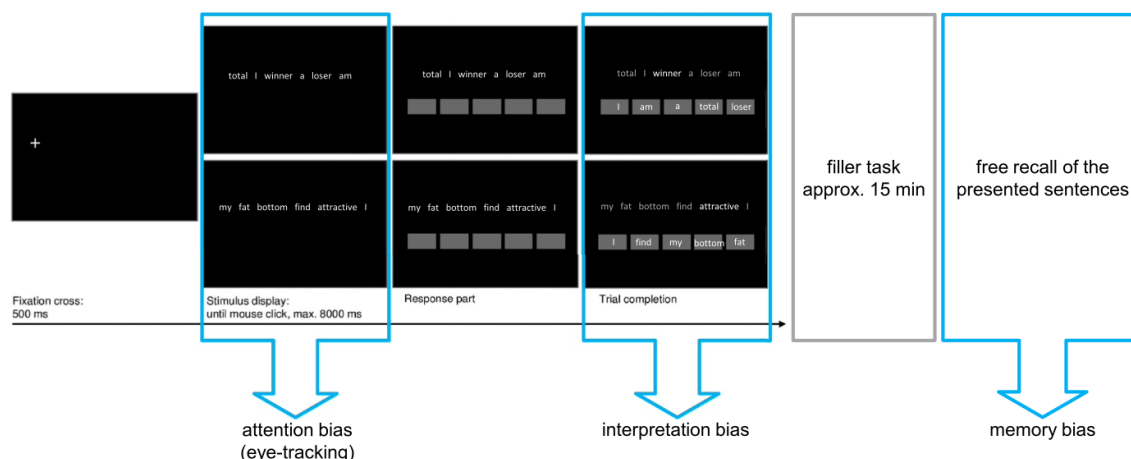
group,  $n = 26$  met criteria for major depression,  $n = 20$  for social phobia, and  $n = 9$  for generalised anxiety disorder, with 41.1% meeting criteria for more than one diagnosis. Across both clinical groups, a total of  $n = 16$  participants were receiving psychotropic medication (mostly SSRIs); excluding these participants yielded the same pattern of results.

## 2.2 | Experimental paradigm

Cognitive biases were measured with a computerised version of the SST (adapted from Everaert et al., 2014; Sfarlea et al., 2019). This task was originally designed to assess interpretation biases (Wenzlaff & Bates, 1998) but was administered during eye-tracking in the present study to enable simultaneous assessment of attention biases and was followed by an incidental free recall task to assess memory biases (cf. Everaert et al., 2014). However, as the reliability of the attention bias scores was unsatisfactory (Spearman-Brown-corrected reliability  $\leq 0.06$ ),<sup>2</sup> methods and results regarding attention biases are presented in Supplement 1 only. The SST consisted of 70 scrambled sentences pertaining to three types: (i) 28 ED-related (EDR) emotional sentences allowing the assessment of cognitive biases for ED-related information (e.g., “my fat bottom find attractive I”), (ii) 28 non-ED-related (NED) emotional sentences allowing the assessment of cognitive biases for non-ED-related information (e.g., “total I winner a loser am”), and (iii) 14 neutral sentences that were not analysed (e.g., “I exciting watching funny movies like”). Sentences were translated and adapted from the original stimulus set by Wenzlaff and Bates (1998) and the body-related stimulus set developed by Brockmeyer et al. (2018).

The trial procedure is depicted in Figure 1. Scrambled sentences consisting of six words were presented on a computer screen. Participants were asked to read the words, mentally form a grammatically correct 5-word-sentence as quickly as possible, and then click on the mouse button. In the following response part, five boxes appeared below the scrambled sentence and participants built the sentence they had mentally formed by ordering the words into the boxes. Each emotional sentence had two possible solutions, a positive one (e.g., “I find my bottom attractive”, “I am a total winner”) and a negative one (“I find my bottom fat”, “I am a total loser”). Importantly, to prevent deliberate response strategies, the task included a time limit of 8 s for the mental formation of the sentences and a cognitive load procedure (remembering a 5-digit number and recalling it at the end of each block of 10 sentences; Everaert et al., 2014). After the SST, a filler task (unrelated to the current





**FIGURE 1** Experimental paradigm including examples of non-eating disorder-related (NED) and eating disorder-related (EDR) emotional SST trials. [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1002/erv.3095)]

experiment) lasting approximately 15 min was administered (cf. Greer & Cooper, 2016), followed by the incidental (i.e., participants were not informed about the recall task beforehand) free recall task in which participants were asked to recall as many of the sentences they had previously formed as possible.

For the analysis of interpretation biases, correctly built sentences were categorised as negative or positive. Two interpretation bias scores were computed:  $IB_{EDR}$  is the ratio of negative EDR sentences relative to all correctly built EDR sentences and  $IB_{NED}$  is the ratio of negative NED sentences relative to all correctly built NED sentences (Everaert et al., 2014). Memory bias scores ( $MB_{EDR}$  and  $MB_{NED}$ ) were calculated similarly, as the proportion of negative sentences from all correctly remembered sentences.<sup>3</sup>

Interrater reliabilities (correlations of bias scores according to two independent raters) were good to excellent for all interpretation and memory bias scores ( $r_s \geq 0.87$ ). Split-half reliabilities of both interpretation bias scores were excellent (Spearman-Brown-corrected reliabilities  $\geq 0.96$ ) while split-half reliability of the  $MB_{EDR}$  score was good (Spearman-Brown-corrected reliability 0.85) and of the  $MB_{NED}$  was poor (Spearman-Brown-corrected reliability 0.52).<sup>4</sup>

## 2.3 | Data analysis

Statistical analyses were performed with SPSS. Repeated-measures ANOVAs with within-subject factor *CONTENT* (2: EDR, NED) and between-subjects factor *GROUP* (3: AN, CC, HC) were conducted separately for interpretation<sup>5</sup> and memory<sup>6</sup> bias scores. Significant main effects and interactions were followed up by post-hoc ANOVAs and

*t*-tests. We expected our hypotheses (regarding ED-related biases:  $AN > CC = HC$ ; regarding non-ED-related biases:  $CC \geq AN > HC$ ) to translate as *CONTENT* × *GROUP* interactions in the ANOVAs and corresponding results in the post-hoc tests. Exploratory regression analyses were performed to identify which participant characteristics predicted cognitive biases. Multiple linear regression analyses with ED symptoms, depressive symptoms, anxiety symptoms, body dissatisfaction, and self-esteem as predictors and MB and IB scores as dependent variables were conducted. Pearson's correlations between bias scores and questionnaire measures were calculated and are reported in Supplement 3 (Supplementary Table S1). For all analyses the significance level was set to  $p = 0.05$  (two-tailed) and adjusted according to the Bonferroni-Holm procedure (Holm, 1979) when conducting multiple post-hoc comparisons.

## 3 | RESULTS

### 3.1 | Sample characteristics

Participant characteristics are presented in Table 1. As expected, groups differed significantly in BMI(-percentile/-SDS), with lower values in adolescents with AN. Furthermore, both clinical groups (AN and CC) reported more ED, depression, and anxiety symptoms compared to the HC group, but differed from each other only in certain subscales of the EDI (see Supplement 4, Supplementary Table S2). Both clinical groups also reported lower self-esteem and higher body dissatisfaction than the HC group, with the AN group also showing higher body dissatisfaction compared to the CC group. Of note,

TABLE 1 Demographic and clinical characteristics.

	AN <i>n</i> = 40 <i>M</i> ( <i>SD</i> )	CC <i>n</i> = 34 <i>M</i> ( <i>SD</i> )	HC <i>n</i> = 40 <i>M</i> ( <i>SD</i> )	ANOVA		Post-hoc tests
				<i>F</i>	<i>p</i>	
Age	15.50 (1.55)	16.48 (1.58)	15.74 (1.80)	3.44	0.035	CC > AN
IQ	102.83 (14.73)	107.65 (11.19)	110.13 (14.09)	3.00	0.054	
BMI	16.14 (1.37)	21.63 (3.85)	21.03 (2.95)	43.12	<0.001	AN < CC = HC
BMI-percentile	5.08 (8.52)	53.32 (29.37)	54.00 (24.09)	63.15	<0.001	AN < CC = HC
BMI-SDS	-2.02 (0.02)	0.04 (0.91)	0.17 (0.81)	84.50	<0.001	AN < CC = HC
ED symptoms (EDI) <sup>a</sup>	303.43 (73.00)	308.73 (51.06)	179.68 (40.15)	60.41	<0.001	CC = AN > HC
Depression symptoms (BDI) <sup>b</sup>	24.44 (14.74)	27.90 (11.86)	2.88 (5.18)	54.54	<0.001	CC = AN > HC
Anxiety symptoms (STAI) <sup>c</sup>	55.15 (12.84)	59.74 (9.48)	32.33 (9.41)	68.05	<0.001	CC = AN > HC
Body dissatisfaction (BSQ) <sup>d</sup>	133.72 (41.44)	92.59 (37.50)	57.13 (27.73)	45.11	<0.001	AN > CC > HC
Self-esteem (RSES) <sup>e</sup>	12.67 (7.37)	10.44 (6.20)	25.32 (5.49)	58.07	<0.001	CC = AN < HC

Note: Post-hoc *t*-tests were significant after correction for multiple testing.

Abbreviations: AN, anorexia nervosa; BDI, Beck Depression Inventory-II; BMI, body mass index; BMI-SDS, body mass index standard deviation score; BSQ, Body Shape Questionnaire; CC, clinical control; ED, eating disorder; EDI, Eating Disorder Inventory-2; HC, healthy control; IQ, Intelligence quotient; RSES, Rosenberg Self-Esteem Scale; STAI, trait version of the State-Trait Anxiety Inventory.

<sup>a</sup>Available from *n* = 103 participants.

<sup>b</sup>Available from *n* = 110 participants.

<sup>c</sup>Available from *n* = 109 participants.

<sup>d</sup>Available from *n* = 111 participants.

<sup>e</sup>Available from *n* = 111 participants.

groups differed also in age with the CC group being slightly older than the AN group, but age was not related to any of the outcome measures ( $r_s \leq 0.11$ ;  $p_s \geq 0.24$ ).

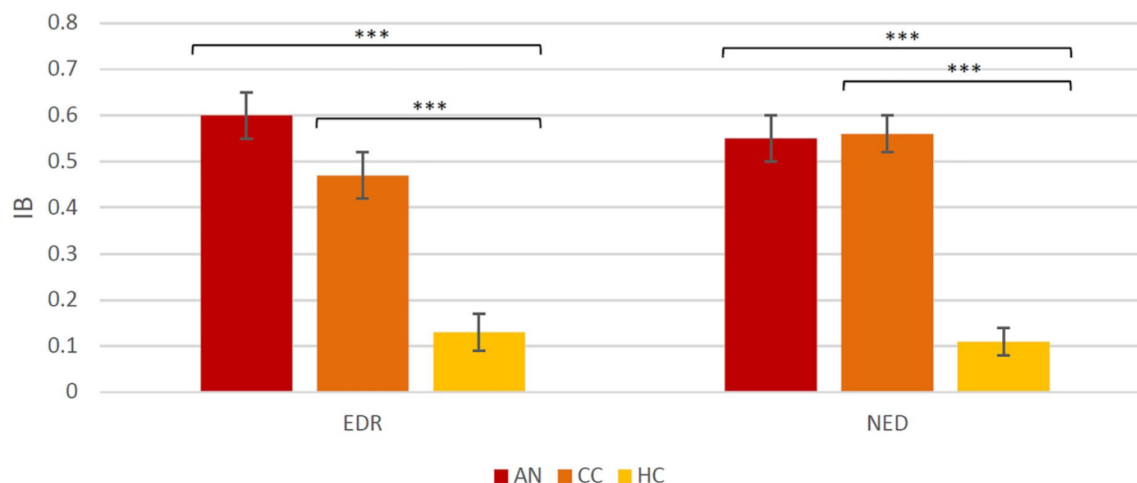
### 3.2 | Interpretation bias

The repeated-measures ANOVA on interpretation bias scores showed a significant main effect of GROUP ( $F_{2,110} = 37.90$ ,  $p < 0.001$ ,  $\eta_p^2 = 0.408$ ,  $\eta_G^2 = 0.370$ ) while the main effect of CONTENT was not significant ( $F < 1$ ). Furthermore, a significant GROUP  $\times$  CONTENT interaction emerged ( $F_{2,110} = 4.08$ ,  $p = 0.020$ ,  $\eta_p^2 = 0.069$ ,  $\eta_G^2 = 0.010$ ), followed up by one-way ANOVAs with the factor GROUP separately for IB<sub>EDR</sub> and IB<sub>NED</sub> scores and subsequent *t*-tests. For IB<sub>EDR</sub>, a significant effect of GROUP emerged ( $F_{2,58} = 2.32$ ,  $p < 0.001$ ,  $\eta_p^2 = 0.326$ ): The AN group had significantly higher IB<sub>EDR</sub> scores (i.e., more pronounced negative interpretation biases,  $M = 0.60$ ,  $SD = 0.33$ ) compared to the HC group ( $M = 0.13$ ,  $SD = 0.24$ ;  $t_{77} = 7.24$ ,  $p < 0.001$ ,  $d_s = 1.63$ ). The CC group also had significantly higher IB<sub>EDR</sub> scores ( $M = 0.47$ ,  $SD = 0.31$ ) than the HC group ( $t_{61.12} = 5.30$ ,  $p < 0.001$ ,  $d_s = 1.23$ ). The AN and the CC group did not differ

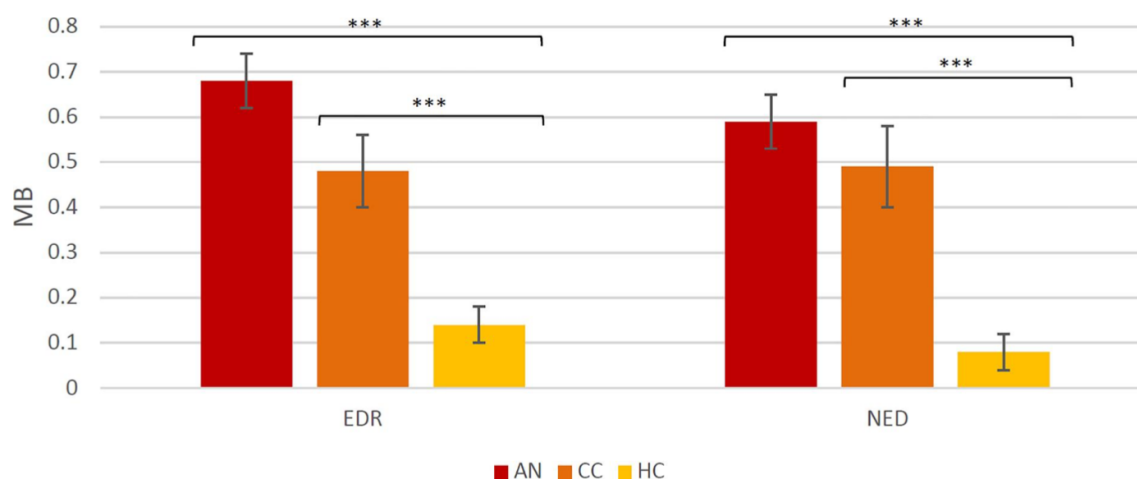
significantly in IB<sub>EDR</sub> scores ( $t_{72} = 1.65$ ,  $p = 0.104$ ). The results of the follow-up one-way ANOVA for IB<sub>NED</sub> also showed a significant effect of GROUP ( $F_{42,06} = 2.58$ ,  $p < 0.001$ ,  $\eta_p^2 = 0.433$ ): Both the AN ( $M = 0.55$ ,  $SD = 0.28$ ;  $t_{69.41} = 8.11$ ,  $p < 0.001$ ,  $d_s = 1.80$ ) and the CC group ( $M = 0.56$ ,  $SD = 0.25$ ;  $t_{61.88} = 8.46$ ,  $p < 0.001$ ,  $d_s = 2.00$ ) had significantly higher IB<sub>NED</sub> scores than the HC group ( $M = 0.11$ ,  $SD = 0.20$ ) while not differing from each other ( $t_{72} < 1$ ). Results are presented in Figure 2.

### 3.3 | Memory bias

The repeated-measures ANOVA on memory bias scores showed no main effect for CONTENT ( $F_{1,83} = 1.30$ ,  $p = 0.258$ ) or GROUP  $\times$  CONTENT interaction ( $F < 1$ ), while it yielded as a significant main effect of GROUP ( $F_{2,83} = 33.26$ ,  $p < 0.001$ ,  $\eta_p^2 = 0.445$ ,  $\eta_G^2 = 0.343$ ): Adolescents with AN ( $M = 0.63$ ,  $SD = 0.31$ ;  $t_{51.02} = 8.97$ ,  $p < 0.001$ ,  $d_s = 2.17$ ) as well as adolescents in the CC group ( $M = 0.48$ ,  $SD = 0.34$ ;  $t_{26.42} = 5.01$ ,  $p < 0.001$ ,  $d_s = 1.60$ ) showed more negative memory biases compared to the HC group ( $M = 0.09$ ,  $SD = 0.16$ ), regardless of content, while AN and CC groups not differ



**FIGURE 2** Interpretation bias (IB) scores (proportion of negative sentences from all correctly built sentences of the respective category) for eating disorder-related (EDR) and non-eating disorder-related (NED) information for the three groups. Error bars represent standard errors. Significant group differences are indicated with \*\*\* ( $p < 0.001$ ). [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1002/erv.3095)]



**FIGURE 3** Memory bias (MB) scores (proportion of negative sentences from all correctly remembered sentences of the respective category) for eating disorder-related (EDR) and non-eating disorder-related (NED) information for the three groups. Error bars represent standard errors. Significant group differences are indicated with \*\*\* ( $p < 0.001$ ). [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1002/erv.3095)]

significantly in their memory bias scores ( $t_{53} = 1.65$ ,  $p = 0.105$ ). Results are presented in Figure 3.

### 3.4 | Exploratory analyses

The exploratory regression analyses aiming to identify which participant characteristics predicted cognitive biases were all significant and explained a considerable amount of variance in interpretation ( $IB_{EDR}$ :  $F_{5,92} = 49.05$ ,  $p < 0.001$ ,  $R^2 = 0.73$ ;  $IB_{NED}$ :  $F_{5,92} = 39.11$ ,  $p < 0.001$ ,  $R^2 = 0.68$ ) and memory bias scores ( $MB_{EDR}$ :  $F_{5,81} = 19.51$ ,  $p < 0.001$ ,  $R^2 = 0.55$ ;  $MB_{NED}$ :  $F_{5,76} = 12.08$ ,  $p < 0.001$ ,  $R^2 = 0.44$ ). For  $IB_{EDR}$ , body dissatisfaction and self-esteem

were significant predictors, while for  $IB_{NED}$ , self-esteem and depression symptoms were significant predictors. For  $MB_{EDR}$ , body dissatisfaction was a significant predictor, while for  $MB_{NED}$ , self-esteem was a significant predictor, see Table 2 for detailed results.

## 4 | DISCUSSION

The aim of the present study was to systematically investigate cognitive biases in adolescents with AN. Biases on different levels of information processing (attention, interpretation, memory) and with regard to two types of information (ED-related, non-ED-related) were assessed



TABLE 2 Results of the regression analyses.

	<i>B</i>	<i>SE for B</i>	<i>95% CI for B</i>	$\beta$	<i>t</i>	<i>p</i>
<b>IB<sub>EDR</sub><sup>a</sup></b>						
ED symptoms (EDI)	0.000	0.001	[-0.002, 0.002]	-0.033	-0.175	0.861
Depression symptoms (BDI)	0.001	0.003	[-0.005, 0.008]	0.025	0.378	0.707
Anxiety symptoms (STAI)	0.001	0.004	[-0.007, 0.009]	0.031	0.173	0.863
<b>Body dissatisfaction (BSQ)</b>	0.003	0.001	[0.002, 0.005]	0.425	4.081	<b>&lt;0.001</b>
<b>Self-esteem (RSES)</b>	-0.017	0.006	[-0.028, -0.006]	-0.431	-3.060	<b>0.003</b>
<b>IB<sub>NED</sub><sup>b</sup></b>						
ED symptoms (EDI)	0.000	0.001	[-0.001, 0.002]	0.046	0.263	0.793
<b>Depression symptoms (BDI)</b>	0.010	0.003	[0.004, 0.015]	0.465	3.685	<b>&lt;0.001</b>
Anxiety symptoms (STAI)	0.000	0.003	[-0.007, 0.006]	-0.023	0.142	0.887
Body dissatisfaction (BSQ)	0.000	0.001	[-0.002, 0.001]	-0.037	0.383	0.703
<b>Self-esteem (RSES)</b>	-0.015	0.005	[-0.024, -0.006]	-0.433	3.327	<b>0.001</b>
<b>MB<sub>EDR</sub><sup>c</sup></b>						
ED symptoms (EDI)	0.002	0.001	[-0.001, 0.005]	0.338	1.335	0.186
Depression symptoms (BDI)	-0.005	0.005	[-0.014, 0.004]	-0.179	-1.062	0.291
Anxiety symptoms (STAI)	0.004	0.006	[-0.008, 0.016]	0.143	0.649	0.518
<b>Body dissatisfaction (BSQ)</b>	0.003	0.001	[0.000, 0.005]	0.300	2.202	<b>0.031</b>
Self-esteem (RSES)	-0.008	0.008	[-0.024, 0.008]	-0.178	-1.043	0.300
<b>MB<sub>NED</sub><sup>d</sup></b>						
ED symptoms (EDI)	0.000	0.001	[-0.003, 0.002]	-0.094	-0.341	0.734
Depression symptoms (BDI)	0.003	0.006	[-0.010, 0.015]	0.094	0.422	0.675
Anxiety symptoms (STAI)	0.003	0.007	[-0.010, 0.016]	0.130	0.511	0.611
Body dissatisfaction (BSQ)	-0.001	0.001	[-0.004, 0.001]	-0.140	-0.906	0.368
<b>Self-esteem (RSES)</b>	-0.029	0.009	[-0.047, -0.011]	-0.641	-3.161	<b>0.002</b>

Note: Significant predictors are highlighted in bold.

Abbreviations: BDI, Beck Depression Inventory-II; BSQ, Body Shape Questionnaire; EDI, Eating Disorder Inventory-2; IB<sub>EDR</sub>, interpretation bias for eating disorder-related information; IB<sub>NED</sub>, interpretation bias for non-eating disorder-related information; MB<sub>EDR</sub>, memory bias for eating disorder-related information; MB<sub>NED</sub>, memory bias for non-eating disorder-related information; RSES, Rosenberg Self-Esteem Scale; STAI, trait version of the State-Trait Anxiety Inventory.

<sup>a</sup>Analysis was performed on  $n = 98$  participants.

<sup>b</sup>Analysis was performed on  $n = 98$  participants.

<sup>c</sup>Analysis was performed on  $n = 97$  participants.

<sup>d</sup>Analysis was performed on  $n = 82$  participants.

within one experimental paradigm. Adolescents with AN were compared to adolescents with depression and/or anxiety disorders (CC group) and adolescents with no mental disorders (HC group). We found more pronounced negative interpretation and memory biases for ED-related as well as non-ED-related information in both, AN and CC groups compared to the HC group, while the two clinical groups did not differ significantly from each other.

Adolescents in the AN and the CC groups built more negative sentences in the SST, that is, showed more

negative interpretation biases, than adolescents with no mental disorders. These negative interpretation biases were evident for both ED-related information (e.g., "I find my bottom fat") and non-ED-related emotional information (e.g., "I am a total loser"). The results of adolescents with AN showing negative interpretation biases are in line with previous studies reporting negative interpretation biases for body-related information (e.g., Brockmeyer et al., 2018; Cooper, 1997) as well as non-ED-related emotional information (Cardi et al., 2017;

Rowlands et al., 2021) in individuals with AN compared to individuals with no mental disorders. They are also in line with studies reporting a negatively biased self-concept in adults and adolescents with AN compared to individuals with no mental disorders (e.g., McAdams & Krawczyk, 2014; Mendoza et al., 2022). Results of adolescents in the CC group showing negative interpretation biases for non-ED-related information are in line with previous studies reporting negative interpretation biases in adolescents with depression and/or anxiety disorders (Lau & Waters, 2017). Cognitive biases for information related to body weight and shape have not been investigated in adolescents with depression and/or anxiety before, but a study including adults with anxiety disorders reported them to show interpretation biases not only for anxiety-related but also for appearance-related information (Dietel et al., 2021), in line with our results.

Similar results were found regarding memory biases: Adolescents in the AN and CC groups remembered more negative sentences, that is, showed more pronounced negative memory biases compared to the HC group, for both ED-related and non-ED-related information. The result of negative memory biases for ED-related information and non-ED-related information in adolescents with AN is in line with previous studies in adults with AN (Hermans et al., 1998; Johansson et al., 2008; Manuel & Wade, 2013). The results are also in line with studies reporting negative memory biases in adolescents with depression and/or anxiety disorders (Lau & Waters, 2017).

Importantly, there were no statistically significant differences between the two clinical groups: The expected difference (adolescents with AN showing more pronounced negative biases for ED-related information than adolescents with depression and/or anxiety disorders) was only found descriptively. Thus, the pattern AN = CC > HC emerged for biases regarding both ED-related as well as non-ED-related information, confirming Hypothesis 2 fully but Hypothesis 1 only in part. Of note, it is possible that there *are* differences between adolescents with AN and adolescents with depression and/or anxiety disorders regarding ED-related information but that these differences were too small to be detected in the present sample. Still, the results suggest that not only cognitive biases for non-ED-related information but also for ED-related information are not specific for adolescents with AN but represent transdiagnostic characteristics that are also shown (at least to some extent) by adolescents with different mental disorders.

Our study was among the first studies to address the content-specificity hypothesis regarding cognitive biases in AN (Williamson et al., 1999) by investigating biases for different contents. While our results support the assumption that adolescents with AN show biased processing of ED-related information, they challenge the assumption

that these biases are specific for this type of information. Instead, they suggest that the biased processing is not limited to information related to one's body, weight, and shape, but generalises to non-body/appearance-related self-referent information. This might indicate an overarching negative self-schema in adolescents with AN, in which both body- and appearance-related as well as more general information about the self (e.g., about one's abilities and worth) are integrated. This assumption is in line with results in a sample of adult women with high ED symptoms that showed interpretation biases not only for ED-related information but also for anxiety-related information (Korn et al., 2020).

One possible explanation for the lack of disorder- and content-specificity is that our stimuli might not have been appropriate to measure different biases: The similarity/overlap between the stimuli intended to measure ED-related and non-ED-related biases might have been too large (also indicated by strong relationships between EDR and NED bias scores; see Supplement 3), so that they might have measured basically the same thing. Our explorative analyses can help to shed light on this: To disentangle which participant characteristics were best reflected by the bias scores we performed regression analyses with ED-specific (eating disorder symptoms, body dissatisfaction) and more general (depression symptoms, anxiety symptoms, self-esteem) participant characteristics as predictors and bias scores as outcomes.<sup>7</sup> The regression analyses revealed that body dissatisfaction was a significant predictor for ED-related biases, suggesting that cognitive biases for ED-related information are not necessarily linked to having an ED but rather to high values in certain aspects of ED symptomatology (in line with studies reporting relationships between appearance-related cognitive biases and body dissatisfaction; see Rodgers & DuBois, 2016). More general characteristics, that is, low self-esteem and high depression symptoms, were predictors for non-ED-related biases. Of note, low self-esteem was a significant predictor of both, ED- and non-ED-related biases, suggesting that it may play a central role in explaining negative interpretation and memory biases for self-referent information, in line with Rimes et al.'s (2023) model that suggests people with low self-esteem to be particularly characterised by cognitive biases. So the regression analyses revealed some specificity by showing that EDR and NED bias scores were explained by the conceptually matching participant characteristics, suggesting them to represent different biases associated to different facets of psychopathology.

Thus, the lack of specificity might be better explained by similarities between the two clinical groups. As expected, a high proportion of adolescents with AN met criteria for comorbid depression (45%) and anxiety disorders (35%), that is, the disorders included in the CC



group. At the same time, adolescents in the CC group reported high ED symptoms in the questionnaire assessment, even though none of them met criteria for an ED in the diagnostic interview. In fact, the clinical groups did not differ in any of the symptom questionnaires. While the similar scores for depression and anxiety symptoms were expected, the similar scores for ED symptoms were surprising but can be explained by the EDI questionnaire capturing a rather broad concept of ED psychopathology.<sup>8</sup> The clinical groups also reported similar self-esteem, a transdiagnostic characteristic that, according to the regression analyses, might play a particularly important role for explaining negative biases in the processing of self-referent information.

Our findings have important implications for cognitive behavioural theories of AN, for future research, as well as for clinical practice. Cognitive behavioural theories suggest that individuals with AN (and other EDs) are characterised by cognitive biases for disorder-related information (e.g., Williamson et al., 2004). Our results empirically confirm that this applies to adolescents with AN, while also suggesting that negative interpretation- and memory biases in this population are not limited to ED-related information but can also be found for more general self-referent information. Cognitive biases are assumed to play an important role in the development and maintenance of AN (e.g., Williamson et al., 2004). However, finding particular cognitive biases to characterise individuals with AN and to be associated to their psychopathology is necessary but not sufficient for establishing these biases as etiological or maintaining factors; studies experimentally manipulating biases and longitudinal studies are necessary next steps.

Our study provides a foundation for such subsequent studies aiming to experimentally modify cognitive biases in adolescents with AN using CBM trainings. Systematic knowledge on cognitive biases in a particular population is necessary for the development of such trainings as it enables to choose the most promising biases as modification targets. Our results suggest that interpretation biases<sup>9</sup> are a particularly suitable target for CBM in adolescents with AN as they meet the necessary requirements of (i) characterising the target population, (ii) being related to their psychopathology, and (iii) being reliably measured (Sfärlea et al., 2021). Some studies have already investigated the effects of CBM trainings for interpretation biases (CBM-I) in adults at risk for (Dietel et al., 2020; Yiend et al., 2014) or with EDs (Turton et al., 2018; Williamson et al., 2000) and reported promising results, while only one preliminary study to date has investigated the effects of a CBM-I training in adolescents with AN (Cardi et al., 2019).

Once CBM-I trainings that successfully change ED psychopathology through the modification of cognitive

biases have been developed, such trainings could complement existing evidence-based treatments for adolescents with AN, such as cognitive-behaviour therapy (CBT; e.g., Le Grange et al., 2022), as they attempt to modify cognitive biases on an automatic level while CBT addresses cognitive processes on a more conscious, reflected level. Beyond attempts to modify cognitive biases, mere knowledge about biases might be a useful tool in therapy, helping adolescents with AN to identify and understand automatic processes that maintain their ED.

Some limitations need to be mentioned. Unfortunately, we cannot draw conclusions about attention biases, as the low reliability of the attention bias scores prevents us from interpreting their results. Accordingly, the lack of group differences in attention biases scores does *not* mean that adolescents in the clinical groups do not show attention biases. Results regarding memory biases should also be interpreted with some caution, since reliability of the MB<sub>NED</sub> score was also relatively low and the memory bias analysis had to be performed on a smaller sample, as some participants did not remember any EDR or NED sentences correctly. However, groups did not differ in their overall memory performance, ruling out that memory difficulties in the clinical groups influenced the results. Furthermore, our study is a cross-sectional study investigating the presence of cognitive biases in adolescents with AN compared to a healthy and a clinical control group. As such, it only allows conclusions about particular populations being characterised by cognitive biases while the investigation of the causal role of cognitive biases in the development and maintenance of AN remains subject to future experimental studies. It also has to be noted that participants were recruited at a child and adolescent psychiatry and most were undergoing treatment which may have addressed cognitive processes and affected our results. The bias scores in our clinical samples may therefore be underestimates of cognitive biases in treatment-naïve adolescents with AN or depression/anxiety disorders.

## 5 | CONCLUSION

To the best of our knowledge, this is the first study to comprehensively assess cognitive biases in adolescents with AN: We assessed cognitive biases on multiple levels of information processing, investigated content-specificity by assessing biases for ED- and non-ED-related information, and investigated disorder-specificity by comparing adolescents with AN not only to a HC but also to a CC group. As expected, adolescents with AN showed pronounced negative interpretation and memory biases compared to adolescents with no mental disorders, but these biases were not specific for



information related to their ED. Furthermore, adolescents with depression and/or anxiety disorders showed similar cognitive biases, suggesting these biases to be transdiagnostic phenomena which are less related to symptoms of a particular disorder than to transdiagnostic characteristics such as body dissatisfaction and low self-esteem.

### AUTHOR CONTRIBUTIONS

Anca Sfärlea designed the study and was awarded the grant from the Friedrich-Baur-Stiftung to perform the study. Linda Lukas and Belinda Platt contributed to the study design and development of measures. Linda Lukas and Laura Nuding collected the data. Analyses were performed by Linda Lukas, Laura Nuding, and Anca Sfärlea. Linda Lukas and Anca Sfärlea wrote the manuscript. Belinda Platt and Gerd Schulte-Körne supervised the study and contributed to writing the manuscript. All authors read and approved the final manuscript.

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### CONFLICT OF INTEREST STATEMENT

The authors declare that they have no competing interests.

### DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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### ENDNOTES

<sup>1</sup> 115 participants were tested but one was excluded from all analyses due to technical difficulties. One additional participant qualified as accuracy outlier as defined in the study protocol (Sfärlea et al., 2021: correct sentence rate <3SD from mean) but was retained in the

sample as the correct sentence rate was still 80%. Excluding this participant did not change the pattern of results.

- <sup>2</sup> This low reliability is in line with other studies reporting psychometric properties of attention bias assessment via the SST (Platt et al., 2022).
- <sup>3</sup> We defined a sentence to be remembered “correctly” if it was presented in the SST, not only if that sentence was built. This seemed a more adequate measure of biased memory independent of interpretation. Furthermore, excluding all sentences that were not built would have led to a very high proportion of sentences and thus participants being excluded from the memory bias analysis. As this definition deviates from our initial analysis plan (see study protocol; Sfärlea et al., 2021) the planned analysis is reported in Supplement 2.
- <sup>4</sup> Assessment of split-half reliabilities of the memory bias scores was difficult as participants differed widely in the number of remembered sentences and some did not remember any EDR or NED sentences correctly. The low split-half reliability of the MB<sub>NED</sub> score might be explained by the overall lower number of remembered NED sentences compared to EDR sentences.
- <sup>5</sup> One additional participant was excluded from the interpretation bias analysis due to technical difficulties.
- <sup>6</sup> As some participants did not remember any EDR or NED sentences correctly, only 34 AN, 21 CC, and 31 HC participants could be included in the memory bias analysis. Separate one-way ANOVAs for MB<sub>EDR</sub> and MB<sub>NED</sub> scores that allowed inclusion of more participants revealed the same pattern of results. Of note, groups did *not* differ in the sum of correctly remembered sentences ( $F = 2.34$ ;  $p = 0.101$ ), that is, in overall memory performance.
- <sup>7</sup> Importantly, since this is a cross-sectional study the regression analyses do *not* imply any causality or temporal relationships.
- <sup>8</sup> When examining the EDI subscales separately, we found the AN group to show higher values than the CC group on the subscales “Drive for Thinness” and “Body Dissatisfaction”, while the CC group showed higher values on other subscales (see Supplement 4). This explains the missing group difference on the total score and suggests that drive for thinness and body dissatisfaction (also measured via the BSQ) are the most ED-specific characteristics, that is, the characteristics that distinguish best between individuals with and without AN.
- <sup>9</sup> We also found memory biases to characterise adolescents with AN and to be related to their psychopathology. However, to date only few studies have attempted to modify (depression-related) memory biases using CBM trainings (e.g., Vrijzen et al., 2019). Together with the lower reliability of the memory bias assessment, CBM trainings specifically addressing memory biases in adolescents with AN seem less promising at this stage. Interestingly, some studies indicated that modifying negative interpretation biases also leads to corresponding changes in memory biases (e.g., Joermann et al., 2015).

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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