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Visual processing of one's own body over the course of time: Evidence for the vigilance-avoidance theory in adolescents with anorexia nervosa?

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Abstract

Objective: The vigilance-avoidance theory postulates a specific threat-related pattern of attention deployment, characterized by initial orientation towards fear-evoking stimuli and subsequent directing of attention away from them. The current eye-tracking study was the first to examine the applicability of the theory for patients with eating disorders, who perceive their own body as a highly aversive, threat-evoking stimulus.

Method: $N = 56$ female adolescents with anorexia nervosa (AN) and $n = 43$ healthy controls (HC) aged 13-18 viewed own-body pictures while their eye movements were recorded. Relative fixation times on self-defined unattractive body areas were compared between the groups by sequencing the overall presentation time of 6,000 ms into six intervals à 1,000 ms.

Results: Participants with AN showed a significantly stronger attentional bias for unattractive body areas than HC within the time intervals 1, 2, and 3. However, for intervals 4, 5, and 6, no significant group differences occurred. Within the AN group, the bias for unattractive body areas was significantly stronger in interval 1 compared to intervals 4, 5, and 6; whereas within the HC group, a stable pattern of attention deployment emerged. In AN, early attention deployment was positively correlated with the negative affect reported after photo presentation.

Discussion: The early vigilance in AN and the subsequent decrease in attention to unattractive body parts is in line with our assumptions. However, no indication of attentional avoidance was found. The current findings partially support the vigilance-avoidance theory for the exposure to one's own body in adolescents with AN.

KEYWORDS
adolescents, anorexia nervosa, avoidance, body-related attentional bias, vigilance

1 | INTRODUCTION

The vigilance-avoidance theory is a well-established cognitive model in the examination of attentional reactions to threatening stimuli (Williams, Watts, MacLeod, & Mathews, 1997). It postulates a specific pattern of attention allocation in individuals confronted with fear-relevant stimuli, characterized by a short, initial phase of attention allocation to the stimulus, and a subsequent phase of attentional avoidance (cf. Weierich, Treat, & Hollingworth, 2008). Vigilance for aversive stimuli is thought to be an automatic, pre-cognitive mechanism, aiming at an early detection of threat and hence enabling a quick reaction; attentional avoidance in the later stages of attention allocation is considered to be a rather intentional, cognitively controlled process, which reduces negative emotions (Cisler & Koster, 2010). Several eye-tracking studies provided evidence to support the vigilance-avoidance theory as a whole or the individual components of the theory for various mental

disorders, for example, in subjects with spider phobia (Pflugshaupt et al., 2005; Rinck & Becker, 2006), social anxiety (Kircanski, Joormann, & Gotlib, 2015; Vassilopoulos, 2005), generalized anxiety disorder (Mogg, Millar, & Bradley, 2000), post-traumatic stress disorder (Felmingham, Rennie, Manor, & Bryant, 2011; Kimble, Fleming, Bandy, Kim, & Zambetti, 2010), and—for the first time in children—in separation anxiety disorder (In-Albon, Kossowsky, & Schneider, 2010).

Biased attention deployment to salient cues such as body stimuli also plays an important role in the etiology and maintenance of eating disorders (Aspen, Darcy, & Lock, 2013; Rodgers & DuBois, 2016). In their well-established integrated cognitive-behavioral theory of eating disorders, Williamson, White, York-Crowe, and Stewart (2004) considered cognitive biases as a key component in the manifestation of eating pathology. According to this model, individuals with a negative body schema differentially attend to schema-consistent stimuli, for example, negative body-related information. This biased attention processing reinforces the negative self-schema as being unattractive, leads to negative emotions such as fear of fatness, and in turn activates biased attention allocation (cf. Williamson et al., 2004).

In line with these theoretical assumptions, previous research has found that females with body image disturbance or diagnosed eating disorders show an attentional bias when looking at their own body (e.g., Bauer et al., 2017; Jansen, Nederkoorn, & Mulkens, 2005; Tuschen-Caffier et al., 2015). According to a substantial number of studies, this bias seems to be characterized by stronger attention to self-defined unattractive body areas of one's own body (e.g., Bauer et al., 2017; Jansen et al., 2005; Roefs et al., 2008; Tuschen-Caffier et al., 2015). However, some studies contradict these findings. Janelle, Hausenblas, Ellis, Coombes, and Duley (2009) reported generally shorter fixation times for one's own body in women with high body dissatisfaction compared to women with low body dissatisfaction, which the authors interpreted as suggesting attentional avoidance for self-body pictures in body-dissatisfied women. Moreover, von Wietersheim et al. (2012) discussed body-related attentional avoidance in females with AN. However, their data suggest an attentional focus both towards and away from one's own body, depending on the body area.

Also in accordance with the cognitive-behavioral model of Williamson et al. (2004), several studies showed that looking at one's own body is associated with an increase in negative affective states such as anxiety in females with eating disorders. For example, Trentowska, Bender, and Tuschen-Caffier (2013) investigated the affective states of patients with eating disorders and healthy controls during four standardized mirror exposure sessions. Across all sessions, they found significantly higher levels of distress and negative emotions such as anxiety, insecurity, or disgust, in the clinical sample. In line with these findings, Vocks, Legenbauer, Wächter, Wucherer, and Kosfelder (2007) also reported significantly more negative emotions such as fear, insecurity, and disgust during mirror exposure in females with eating disorders compared to healthy participants. In a further study by Vocks et al. (2010), females with anorexia and bulimia nervosa were presented with pictures of their own body, and reported significantly stronger negative emotions after having viewed their photographs compared to the control sample. Hints for a potential association of negative emotions with body-related avoidance behavior in females with eating pathology were provided by Tuschen-Caffier, Vögele, Bracht, and Hilbert (2003), who analyzed the emotional response to being exposed to a video recording of one's own body in females with bulimia nervosa and healthy controls. Participants with bulimia nervosa reported significantly stronger negative emotions and took significantly less time to describe their own body compared to healthy controls (Tuschen-Caffier et al., 2003). To sum up, according to current studies, in individuals with eating and body image pathology, one's own body can be considered as an unpleasant and possibly anxiety-evoking stimulus. Although most previous studies used compound scores based on different affective states, and did not analyze anxiety separately, it appears to be suitable to refer to theories from the field of anxiety disorders, such as the vigilance-avoidance theory (Williams et al., 1997), for the investigation of biased body-related attention in eating disorders.

For this purpose, detailed knowledge on attentional components over the course of time is needed. In this respect, Smeets, Roefs, van Furth, and Jansen (2008) found evidence of speeded detection of body-related words, but not of enhanced distraction due to these words, in females with eating disorders. According to the authors, this points to a vigilant-avoidant pattern of attention allocation. Gao et al. (2011) reported a similar pattern of speeded detection and subsequent avoidance of thinness-related body words in highly weight-dissatisfied women. This might reflect an attentional reaction to threat, as thinness-related cues can be interpreted as ego-threatening and thus aversive for weight-dissatisfied individuals (Gao et al., 2011). However, recent studies on the time course of attention to body pictures contradict these findings, reporting difficulties in disengagement from body stimuli (Gao et al., 2014; Moussally, Brosch, & van der Linden, 2016) or from typical "problem areas" of one's own or a model's body (Janelle et al., 2009) in body-dissatisfied females, and thus suggesting an attentional maintenance bias. These inconsistent study findings might be attributable to the paradigms used, which differ in terms of the timescale of processing and the attentional components assessed (cf. Weierich et al., 2008). Moreover, all of the aforementioned studies on attentional components (with the exception of Smeets et al., 2008) investigated females with subclinical eating disturbance, who might find body stimuli less aversive than females with diagnosed eating disorders.

In sum, current findings on the time course of body-related attention allocation are mixed, but there is evidence to support a vigilance-avoidance pattern of attention to body stimuli in females with a disturbed body image (cf. Gao et al., 2011; Smeets et al., 2008). The fear-evoking nature of one's own body reported by individuals with eating disorders (e.g., Vocks et al., 2007) further underlines these findings. However, to date, no study has investigated the vigilance-avoidance theory in individuals with diagnosed eating disorders when confronted with one's own body. Moreover, so far, no study has examined body-related attentional processing over the course of time in adolescents with or without eating pathology. As eating disorders are common in

girls and young women, and the age at onset continues to fall (Favaro, Caregaro, Tenconi, Bosello, & Santonastaso, 2009; Smink, van Hoeken, & Hoek, 2012), an investigation of the time course of body-related attention in adolescents with eating pathology would be highly relevant to gain an understanding of potentially underlying attention mechanisms contributing to the etiology and maintenance of eating disorders (cf. Faunce, 2002; Williamson et al., 2004).

The present study therefore examined the time course of attention allocation to one's own body in adolescents with eating disorders and healthy controls. The aim was to investigate threat-related patterns of attention as postulated by the vigilance-avoidance theory, and associated emotional activation. Female adolescents with anorexia nervosa (AN) and healthy controls were presented with pictures of their own body while their eye movements were recorded. Group differences in attention allocation to self-defined unattractive body areas (aversive stimuli) were investigated over a timescale of 6,000 ms, sequenced into six time intervals of 1,000 ms.

Based on the literature outlined above, we postulated in a first hypothesis that female adolescents with eating disorders will differ from those without eating disorders in early and late stages of attention allocation: According to the vigilance-avoidance theory, participants with AN will show a stronger bias towards self-evaluated unattractive body areas (vigilance) than healthy controls in the initial phase after stimulus onset. In the later, cognitively controlled phase of stimulus presentation, they will show less attention to unattractive body areas than healthy participants (avoidance). To investigate the affective activation related to body presentation, in the second hypothesis, we postulated that adolescents with AN will report significantly more negative emotions such as anxiety or shame and significantly fewer positive emotions such as pride or excitement than the control sample. Finally, in a third hypothesis, we assumed that the initial attentive reaction within the first interval (0–1,000 ms) will be related to emotional states within both the AN group and the control group.

2 | METHOD

2.1 | Participants

Inclusion criteria for the present study were age between 13 and 18 years and (for ethical reasons) no deliberate self-harm and suicidal tendencies. A clinical subsample of $n = 61$ female adolescents diagnosed with AN was recruited at the *Klinik am Korso*, a specialist clinic for disordered eating behavior, and the Outpatient Clinic of the Ruhr-University Bochum. A nonclinical subsample of $n = 51$ female adolescents was recruited via press announcements and school presentations in North-West Germany. Due to low quality of eye-tracking data, $n = 5$ participants with AN and $n = 8$ healthy controls had to be excluded from statistical analyses; thus, a final sample of $N = 99$ remained for the analyses. To confirm the diagnoses in the clinical group and the absence of any mental disorders in the healthy control group, all participants underwent the Kinder-DIPS (Schneider, Unnewehr, & Margraf, 2009), a structured clinical interview for children and adolescents based on the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) and the International Classification of Diseases (ICD-10). A reimbursement of €15–50 was paid for participation in the study. Prior to the examination, all participants provided written informed consent. If a participant was aged between 13 and 17, informed consent was also obtained from her parents. The study protocol was approved by the ethics committee of the Ruhr-University Bochum and was in accordance with the Helsinki Declaration of 1975, as revised in 2008.

2.2 | Psychometric measures

2.2.1 | Eating Disorder Examination-Questionnaire (EDE-Q)

Eating disorder symptoms within the past 28 days were assessed with the German version of the EDE-Q (Fairburn & Beglin, 1994; German version: Hilbert & Tuschen-Caffier, 2006). The questionnaire comprises the four subscales Restraint, Eating Concern, Weight Concern, and Shape Concern, with items rated on a 7-point Likert scale ranging from *no days/not at all* (0) to *every day/markedly* (6). Internal consistencies for the current sample ranged from $\alpha = .74$ to $\alpha = .94$ in the AN group and from $\alpha = .80$ to $\alpha = .90$ in the healthy control group.

2.2.2 | Eating Disorder Inventory-2 (EDI-2)

Specific body image-related characteristics were assessed using the two subscales Drive for Thinness and Body Dissatisfaction of the EDI-2 (Garner, 1991; German version: Paul & Thiel, 2005). Items were rated on a 6-point Likert scale ranging from *never* (1) to *always* (6). For the current sample, internal consistencies were good to excellent (Drive for Thinness: $\alpha = .91$; Body Dissatisfaction: $\alpha = .89$) for the AN group and excellent (Drive for Thinness: $\alpha = .94$, Body Dissatisfaction: $\alpha = .91$) for the healthy control subgroup.

2.2.3 | Positive and Negative Affect Schedule (PANAS)

Affective reactions after stimulus presentation were assessed using the PANAS (Watson, Clark, & Tellegen, 1988; German version: Krohne, Egloff, Kohlmann, and Tausch, 1996). The PANAS consists of a 10-item Positive Affect subscale (example items: interested, excited, proud) and a 10-item Negative Affect subscale (example items: afraid, nervous, ashamed), with items rated on a 5-point Likert scale from *not at all* (1) to *extremely* (5). For the AN subgroup of the current sample, internal consistencies after presentation with own-body pictures were good to excellent (Positive Affect: $\alpha = .84$; Negative Affect: $\alpha = .92$). Likewise, Cronbach's alpha indicated a good reliability of the two subscales in the control group (Positive Affect: $\alpha = .86$; Negative Affect: $\alpha = .84$).

2.3 | Procedure

The examination took place in the eye-tracking laboratories of Osnabrück University, Ruhr-University Bochum and the facilities of the *Klinik am Korso*, Bad Oeynhausen, Germany. It began with a photo shoot to create the individual body stimuli. A female research assistant took four whole-body pictures of each participant from four perspectives. The pictures were taken from the neck down to the feet using a digital camera (LUMIX DMC-TZ8, Panasonic) under standardized light conditions. Participants stood in front of a standardized white screen

and wore identical grey underwear (bra and pants) in their size. Afterwards, participants were seated in front of a PC monitor (approx. 60–80 cm distance) with an integrated eye-tracking system (RED 500, SensoMotoric Instruments, Teltow, Germany), were calibrated ($M = 0.47°$, $SD = 0.21$), indicating sufficient data accuracy according to Holmqvist et al. (2011), and then presented with the pictures of their own body while their eye movements were recorded. For stimulus presentation, the software program Experiment Center (SensoMotoric Instruments; Teltow, Germany) was used; eye movements were recorded with iViewX (SensoMotoric Instruments; Teltow, Germany). To avoid deliberate changes in gaze behavior, participants were told that the main purpose of the study was to examine pupil diameter. Presentation time was 6,000 ms per stimulus. Before presentation of each picture, a fixation cross was shown for 2,000 ms. Participants were asked to look at the body pictures, but did not receive any further instructions in order to minimize the influence on their natural gaze behavior and thus enhance ecological validity. As this study was part of a larger project on various aspects related to body-related attention (see Bauer et al., 2017), participants were also presented with an additional photo set of an unknown female's body. This additional photo set—consisting of four body pictures which were taken under the same conditions as the participants' individual photos—was shown either before or after the set of own-body pictures. The presentation order was randomized by throwing a die, resulting in a balanced distribution within both groups. As visual attention processes to other persons' bodies are irrelevant for the current research question, attention deployment to the additional body was not analyzed in the present study. After the recording of eye movements, participants were shown their body pictures again for 6,000 ms per slide, without eye-tracking. This time, they were instructed to look precisely at the stimuli, as they would be asked to give attractiveness evaluations afterwards. After this second photo presentation, participants created a hierarchy of attractiveness for 12 previously defined body areas (breasts, décolleté, stomach, bottom, thighs, lower legs, upper arms, forearms, upper back, lower back, hands, feet) and completed the PANAS (Krohne et al., 1996). The Kinder-DIPS (Schneider et al., 2009) was then administered by a clinical psychologist. Finally, the participants were paid for their participation and debriefed.

2.4 | Statistical analyses

For the analysis of the time course, the total presentation time of 6,000 ms per stimulus was divided into six 1,000-ms intervals. Minimum fixation duration was set at 100 ms (e.g., von Wietersheim et al., 2012). Fixation times on the three body areas individually defined as most unattractive—based on the attractiveness ratings taken from each participant—were summed up for each interval and divided by the overall fixation time (fixations on body areas individually defined as unattractive, attractive, and neutral) within the respective interval (in line with the procedure of In-Albon et al., 2010). The resulting six quotients, henceforth referred to as *bias scores*, represent the extent of participants' attention allocation to unattractive body areas in relation to the overall fixation time on the stimulus, separately for six time intervals; thus, the higher the bias score, the longer the fixation time on unattractive areas of one's own body relative to the overall fixation time on the stimulus. As the vigilance-avoidance theory (Williams et al., 1997) refers to attentional processing of aversive stimuli only and does not allow for specific assumptions about attentional processing of positive or neutral stimuli, fixations on body areas defined as positive or neutral were not differentiated from each other.

From the described calculation of bias scores as ratios (In-Albon et al., 2010), missing values within single time intervals emerged in five cases, as a denominator of zero (resulting from null fixations within a single time interval of 1,000 ms) is not defined as a natural number in mathematics. To retain the respective cases in the analyses, the missing values were substituted by the last measured value prior to the missing value according to the last-observation-carried-forward method, which is an established approach to handle missing data in the analysis of time series (cf. Moritz, Sardá, Bartz-Beielstein, Zaefferer, & Stork, 2015). The preparation of the eye-tracking data for statistical analyses was carried out using the analysis software BeGaze (SensoMotoric Instruments; Teltow, Germany). In the present study, only front-perspective pictures were analyzed, as they best reflect the everyday perception of oneself (e.g., by looking in the mirror).

To examine the first hypothesis on the time course of body-related attention, a 2×6 mixed model analysis of variance (ANOVA) was conducted with the between factor Group (AN vs. healthy controls), the within factor Time (time interval, ending at 1,000, 2,000, 3,000, 4,000, 5,000, and 6,000 ms) and the bias score as dependent variable. In the case of significant interactions or main effects, *post hoc* Bonferroni tests were performed. The requirements to perform an ANOVA were met (Levene's Test of Equality of Error Variances: all $ps > .05$; Box's Test of Equality of Covariance Matrices: $p = .323$; Mauchly's test of sphericity for the factor Time: $p = .081$). To examine the second hypothesis on affective reactions after presentation of the pictures of one's own body, independent *t*-tests were conducted to compare the PANAS subscales Positive Affect and Negative Affect and their single items for participants with and without AN. For the single-item analyses of the PANAS subscales, alpha levels were family-wise corrected by applying the Bonferroni–Holm procedure (Aickin & Gensler, 1996). To examine the third hypothesis on the association of affective state and initial attention allocation, product–moment correlation coefficients between the PANAS subscales and the bias score within the first time interval (ending at 1,000 ms) were calculated separately for the AN group and the healthy controls.

Statistical significance was set at $p < .05$. As indices of effect size, partial eta squared (ηp^2; .01, .06, and .15 for small, medium and large effects) and, due to unequal sample sizes, Hedges' g (0.2, 0.5, and 0.8 for small, medium and large effects; Cohen, 1988) were reported. Statistical analyses were performed using the Statistical Package for the Social Sciences SPSS 24 (IBM; Armonk, USA).

3 | RESULTS

Table 1 presents sample characteristics. No group differences were found in terms of age. As expected, participants with AN showed a

TABLE 1 Descriptive data and group comparisons regarding sample characteristics

	Anorexia nervosa (n = 56)		Healthy controls (n = 43)		Group comparison		
	Mean	*SD*	Mean	*SD*	*T*	*df*	*p*
Age (years)	16.09	1.03	15.85	1.77	−.851	97	.397
BMI (kg/m^2)	16.54	1.36	19.97	2.44	8.86	97	<.001
Eating Disorder Examination-Questionnaire (EDE-Q)							
Restraint	3.11	1.66	0.85	1.26	−7.67	97	<.001
Eating Concern	3.08	1.37	0.66	0.96	−10.30	96.14	<.001
Weight Concern	3.65	1.65	1.32	1.27	−7.93	97	<.001
Shape Concern	4.40	1.59	1.61	1.37	−9.21	97	<.001
Eating Disorder Inventory-2 (EDI-2)							
Drive for Thinness	4.49	1.59	2.33	1.23	−8.89	97	<.001
Body Dissatisfaction	4.59	1.01	3.08	1.13	−7.03	97	<.001

Note. BMI = Body mass index; SD = Standard deviation.

significantly lower BMI than the healthy controls. The two subgroups differed in terms of eating pathology and body image-related cognitions and behaviors, assessed with the EDE-Q and the EDI-2 subscales: As expected due to the diagnosis under investigation, the AN group showed significantly higher scores on all scales. The clinical group consisted of $n = 30$ female adolescents diagnosed with AN, restrictive subtype, and $n = 26$ female adolescents diagnosed with AN, binge eating/purging subtype, according to the classification of the DSM-IV-TR and DSM-5. Within this group, $n = 15$ participants were diagnosed with a comorbid depression, $n = 5$ participants with a comorbid anxiety disorder and $n = 1$ participant with a comorbid post-traumatic stress disorder, which were all secondary to the eating disorder. The healthy controls did not fulfill the criteria for any mental disorder at the time of study participation.

3.1 | Time course of body-related attention allocation

The 2 × 6 mixed model ANOVA with the between factor Group and the within factor Time revealed a significant interaction, $F(5, 485) = 2.28$, $p = .046$, $\eta p^2 = .02$, indicating that the time course of attention allocation to unattractive body areas differed significantly between the two groups. *Post hoc* comparisons revealed that the bias score was significantly higher in the AN group than in the control group in interval 1 ($p = .001$, $g = 0.69$), interval 2 ($p = .028$, $g = 0.46$) and interval 3 ($p = .039$, $g = 0.43$), whereas no group differences were found in interval 4 ($p = .753$, $g = 0.05$), interval 5 ($p = .965$, $g = 0.00$) and interval 6 ($p = .642$, $g = 0.10$). Further *post hoc* analyses within the AN group showed that the bias scores in interval 1 were significantly higher than in interval 4 ($p = .019$, $g = 0.57$), interval 5 ($p < .001$; $g = 0.72$) and interval 6 ($p = .002$, $g = 0.64$), indicating a decrease in attention over time to body parts subjectively perceived as unattractive. No further differences in the bias scores were found between the time intervals within the AN subgroup. Within the control group, relative fixation times on unattractive body areas did not differ at all between the six time intervals (all $ps = 1.000$). Means and standard deviations can be found in Table 2.

Furthermore, a significant main effect of the factor Group was found, $F(1, 97) = 4.81$, $p = .031$, $\eta p^2 = .05$, indicating generally higher bias scores in AN ($M = 0.59$, $SD = 0.25$) compared to healthy controls ($M = 0.48$, $SD = 0.24$, $g = 0.44$). The significant main effect of Time, $F(5, 485) = 2.75$, $p = 0.18$, $\eta p^2 = .03$, indicated generally higher bias scores in interval 1 ($M = 0.63$, $SD = 0.38$) compared to interval 5 ($M = 0.48$, $SD = 0.39$, $g = .39$) (see Figure 1).

TABLE 2 Descriptive data and group comparisons regarding bias scores for the six intervals and PANAS subscales

	Anorexia nervosa (n = 56)		Healthy controls (n = 43)		Group comparison		
	Mean	*SD*	Mean	*SD*	*T*	*df*	*p*
Bias score (relative fixation times on unattractive body areas)							
Interval 1 (0–1,000 ms)	0.74	0.34	0.49	0.38	−3.50	97	.001
Interval 2 (1,001–2,000 ms)	0.66	0.36	0.49	0.38	−2.23	97	.028
Interval 3 (2,001–3,000 ms)	0.59	0.39	0.42	0.39	−2.09	97	.039
Interval 4 (3,001–4,000 ms)	0.54	0.39	0.52	0.40	−0.32	97	.753
Interval 5 (4,001–5,000 ms)	0.48	0.40	0.48	0.38	−0.44	97	.965
Interval 6 (5,001–6,000 ms)	0.50	0.43	0.46	0.39	−0.47	97	.642
Positive and Negative Affect Schedule (PANAS)							
Positive Affect	1.90	0.66	2.20	0.61	2.36	97	.020
Negative Affect	2.65	1.08	1.49	0.59	−6.39	88.76	<.001

Note. SD = Standard deviation.

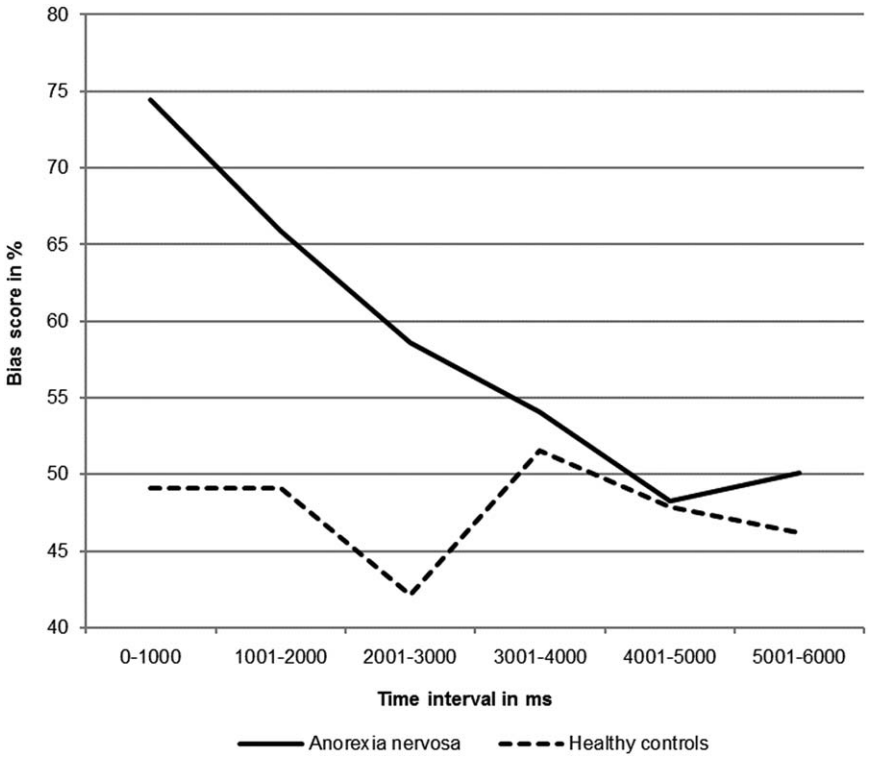

FIGURE 1 Bias scores indicating the relative fixation time on unattractive areas of one's own body over the course of time

3.2 | Affective reactions to looking at one's own body

Independent sample *t*-tests conducted to compare the PANAS scores between adolescents with AN and healthy controls revealed significant group differences for the two subscales positive affect and negative affect (see Table 2). Participants with AN reported significantly less positive affect after own-body presentation than healthy controls, $t(97) = 2.36$, $p = .020$, $g = 0.47$. Negative affective reactions after own-body presentation were significantly stronger in AN than in healthy controls, $t(88.76) = -6.39$, $p < .001$, $g = 1.28$. The analysis of single affective reactions showed that each of the ten items of the PANAS subscale Negative Affect ('distressed', 'upset', 'guilty', 'scared', 'hostile', 'irritable', 'ashamed', 'nervous', 'jittery', 'afraid') was rated significantly higher in AN compared to healthy controls. Regarding the PANAS subscale Positive Affect, participants with AN reported significantly less positive affect than healthy controls for the items 'excited', 'strong', 'proud', 'enthusiastic', and 'determined' (see Table 3).

3.3 | Correlations of initial attention allocation with positive and negative affect

In the AN group, the bias score reflecting the initial body-related attention allocation pattern within the first 1,000 ms after stimulus onset was significantly correlated with the PANAS scale Negative Affect, $r = .37$, $p = .005$, but not with the PANAS scale Positive Affect, $r = -.04$, $p = .771$. In the healthy control sample, no significant correlations were found between the PANAS subscales and the bias score for the first time interval, PANAS Negative Affect: $r = .27$, $p = .077$; PANAS Positive Affect: $r = -.13$, $p = .404$.

4 | DISCUSSION

The current study investigated the time course of attention allocation to pictures of one's own body in adolescents with AN and healthy controls as well as the evoked emotional reactions, with the aim of testing the applicability of the vigilance-avoidance theory (Williams et al., 1997) for the field of eating disorders. The results partially support the postulated theory in female adolescents with AN.

In line with our first hypothesis, participants with AN showed a significantly stronger bias towards unattractive body areas in early phases of attention allocation compared to healthy controls: In the first 1,000 ms, they directed about 74% of their fixations to self-defined unattractive body areas, compared to about 49% for healthy adolescents. The significant group differences found in the early stages of visual processing (intervals 1, 2, and 3) provide evidence in support of an initial vigilance to disliked body areas of one's own body in female adolescents with AN. This finding extends previous research, which reported vigilance to body- or shape-related words in body-dissatisfied females (Gao et al., 2011) or females with eating disorders (Smeets et al., 2008), and points to an automatic, pre-intentional threat-related reaction in AN, comparable to the attentional processing of fearful objects reported in anxiety disorders (e.g., In-Albon et al., 2010; Rinck & Becker, 2006).

Over the time course of stimulus presentation, a significant decrease in attention to disliked body areas from interval 1 to 4, 5, and

TABLE 3 Descriptive data and group comparisons regarding specific affective reactions assessed with the PANAS

	Anorexia nervosa ($n = 56$)		Healthy controls ($n = 43$)		Group comparison		
	Mean	*SD*	Mean	*SD*	*T*	*df*	*p*
PANAS Positive Affect							
Active	1.88	1.10	1.95	0.90	0.38	97	.704
Interested	2.57	1.14	2.83	1.03	1.17	96	.245
Excited	1.27	0.70	1.79	0.86	3.24	79.81	.002
Strong	1.41	0.89	1.86	0.97	2.40	97	.018
Inspired	1.32	0.66	1.60	0.90	1.73	74.27	.088
Proud	1.41	0.83	1.86	1.08	2.27	76.35	.026
Enthusiastic	1.21	0.56	1.63	0.76	3.00	74.95	.004
Alert	2.77	1.27	2.65	1.19	−0.47	97	.642
Determined	1.91	1.01	2.44	1.14	2.45	97	.016
Attentive	3.25	1.03	3.40	1.12	0.67	97	.504
PANAS Negative Affect							
Distressed	2.57	1.44	1.72	0.85	−3.66	91.79	<.001
Upset	2.64	1.46	1.56	0.85	−4.63	91.26	<.001
Guilty	2.52	1.45	1.28	0.70	−5.59	83.40	<.001
Scared	3.09	1.41	1.88	1.14	−4.72	96.69	<.001
Hostile	2.25	1.49	1.00	0.00	−6.27	55.00	<.001
Irritable	2.07	1.35	1.19	0.59	−4.40	79.29	<.001
Ashamed	3.29	1.37	1.67	0.94	−6.91	95.97	<.001
Nervous	2.89	1.34	1.72	0.91	−5.17	95.60	<.001
Jittery	2.84	1.36	1.56	0.76	−5.94	89.77	<.001
Afraid	2.34	1.31	1.21	0.51	−5.89	75.30	<.001

Note. PANAS = Positive and Negative Affect Schedule; *SD* = Standard deviation.

6 was found in AN. The control group, however, showed a stable pattern of attention deployment over time, without any significant differences between intervals. This decrease in biased attention to unattractive body areas in AN is consistent with previous findings showing a decline in attention to threatening information in later phases of visual processing (e.g., In-Albon et al., 2010; Rinck & Becker, 2006). However, this gaze pattern does not indicate an avoidance reaction, as the bias score never fell below the level of healthy participants' attention allocation. Instead, our findings point to a general attentional focus on unattractive body areas of one's own body in AN (in line with Jansen et al., 2005; Tuschen-Caffier et al., 2015), which is especially pronounced in the first time intervals after stimulus onset.

The analysis of the emotional reactions assessed after body presentation with the PANAS (hypotheses 2 and 3) revealed significantly stronger negative emotions and significantly weaker positive emotions in adolescents with AN compared to healthy controls, which further underlines the potentially aversive nature of one's own body in eating pathology (cf. Tuschen-Caffier et al., 2003; Vocks et al., 2007, 2010). Furthermore, the significant correlation of the initial attentional pattern within the first time interval and the PANAS subscale Negative Affect in AN indicates that a higher extent of biased attention to unattractive body areas is associated with stronger negative emotions reported after body presentation. In healthy participants, however, the initial gaze pattern was not related to positive or negative affective states. These findings suggest that one's own body seems to be a less salient stimulus in healthy adolescents, as its visual processing was not associated with the extent of various affective states reported after body presentation. In contrast, own-body pictures are highly salient stimuli in females with eating disorders and are therefore believed to initiate the reciprocal loop of biased information processing and negative emotions postulated by Williamson et al. (2004), which is underlined by our findings. However, it remains unclear whether the negative affect reported in the clinical group was actually induced by the presentation of one's own body, as we did not assess baseline data on affective states before photo presentation.

Some limitations of the current study need to be mentioned. First, the between-subject—but not between-groups—variation of the stimulus presentation order might be criticized: About half of the participants were presented with a control body before being presented with their own body pictures, whereas the other half of looked at the control body after having seen their own body (see procedure section). However, additional analyses revealed that presentation order did not affect group differences in the time course of attention allocation and did not lead to group-specific differences in participants' reported affective reactions.

A second limitation, which concerns data analysis and interpretation, is the potential adjustment of fixation parameters for the size of the body areas (cf. Holmqvist et al., 2011), an issue with which previous body-related eye-tracking research has dealt in various ways (e.g., Horndasch et al., 2012; Jansen et al., 2005; Nikkelen, Anschutz, Ha, & Engels, 2012; Roefs et al., 2008). The potential impact of size differences in specific body areas on the participants' gaze behavior could have been accounted for by means of an area size-related correction of the outcome parameters. However, such an adjustment of outcome parameters would have led to substantial violations of ecological validity, as human body areas are naturally different in size. Furthermore, according to theoretical considerations on the concept of attentional biases (cf. Aspen et al., 2013; Williamson et al., 2004), it is primarily the subjective emotional valence of a stimulus which leads to biased

attentional processing, and not only its inherent features or its size. Based on these considerations, data analysis without prior correction for the size of specific body parts appeared to be the most appropriate approach for examining the current research question. Additionally, statistical analyses showed that the size of self-defined unattractive body areas did not differ between the two groups under investigation.

Eye-tracking research allows for conclusions about overt attention allocation processes and is an excellent method for investigating visual processing over the course of time (Armstrong & Olatunji, 2012). However, it is limited to the detection of observable eye events such as fixations and saccades, and does not record covert, peripheral visual processing beyond the foveal focus (cf. Giel et al., 2011; In-Albon et al., 2010). An interplay of overt (vigilance, avoidance) and covert (maintenance) attentional components in the time course of threat processing has already been taken into consideration in the field of anxiety disorders (Weierich et al., 2008), and might also be a useful approach to integrate the mixed findings in the field of body image disturbance (e.g., Gao et al., 2014; Smeets et al., 2008). As specific methodological approaches are recommended for the investigation of overt and covert attention (cf. Cisler & Koster, 2010; Weierich et al., 2008), future studies aiming to shed further light on the interplay of attentional components in threat-related visual information processing in eating disorders should combine different paradigms and methods (e.g., Gao et al., 2011).

Another implication for future research to take into consideration is the definition of cutoff scores based on larger samples, which would allow for the evaluation of individual gaze patterns. To our knowledge, no study so far has provided such specific cutoff scores in the area of attentional bias research. The specification of empirically based reference scores might be a promising supplement for transferring research findings on body-related attentional bias to clinical practice.

This is the first study to investigate the time course of attention allocation to photographs of one's own body in patients with AN. It enables a differentiation between early, pre-intentional and later, cognitively controlled attentional components in body processing. Thus, it provides specific clinical implications for the treatment of body image disturbance. Our finding of an early, implicit vigilance reaction suggests a therapeutic approach targeting automatic, potentially unconscious attentional processes, such as attentional bias modification (ABM) training (Bar-Haim, 2010). Despite the disputed evidence in support of ABM (Clarke, Notebaert, & MacLeod, 2014; Emmelkamp, 2012), it might nevertheless provide a useful supplement to conventional treatments of body image disturbance in eating pathology (cf. Renwick, Campbell, & Schmidt, 2013). Regarding the intentional, cognitively controlled component of attention allocation, our findings suggest that body exposure could be used to foster a stronger focus on neglected, positively evaluated attributes of one's own body (Jansen et al., 2016; Vocks et al., 2011).

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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