Sustained hypervigilance for one’s own body in women with weight and shape concerns: competition effects in early visual processing investigated by steady-state visual evoked potentials (SSVEP)

Mona M. Voges¹, Claire-Marie Giabbiconi¹, Thomas Gruber², Søren K. Andersen³, Andrea S. Hartmann¹, and Silja Vocks¹

¹ Department of Clinical Psychology and Psychotherapy, Osnabrück University, Knollstraße 15, 49069 Osnabrück, Germany
² Department of Experimental Psychology I, Osnabrück University, Seminarstraße 20, 49074 Osnabrück, Germany
³ School of Psychology, University of Aberdeen, William Guild Building, Aberdeen, AB24 3FX, United Kingdom

Corresponding author:
Mona Voges, M.Sc.
Department of Clinical Psychology and Psychotherapy
Osnabrück University
Knollstraße 15
49069 Osnabrück, Germany
+49 541/969-4771 (tel.); +49 541/969-4028 (fax)
E-mail: mona.voges@uni-osnabrueck.de

E-mail of co-authors: claire-marie.giabbiconi@uni-osnabrueck.de; thomas.gruber@uni-osnabrueck.de; skandersen@abdn.ac.uk; andrea.hartmann@uni-osnabrueck.de; silja.vocks@uni-osnabrueck.de
Abstract

This study aimed to analyze the covert attentional time course in early body processing areas in women with high body concerns. Therefore, we assessed the effect of pictures of one’s own body and other bodies as distractions from a demanding dot detection task in 24 women with low and 20 women with high body concerns. Participants were instructed to attend to flickering dots eliciting steady-state visual evoked potentials (SSVEP) measured by EEG. Both groups showed a sustained SSVEP amplitude reduction, which was more pronounced for average-weight or thin bodies than for overweight bodies. For women with high body concerns, SSVEP amplitudes decreased more in the case of pictures of their own body. The results indicate covert vigilance and maintenance patterns for body stimuli, especially for bodies representing the thin ideal. Moreover, women with high body concerns attend more to information about their own body, which might maintain body dissatisfaction.

Keywords: steady-state visual evoked potentials (SSVEP), body concerns, attentional bias, body processing
Body concerns are highly prevalent among women in Western societies (Coker & Abraham, 2014). A person’s body image is defined as a subjective multidimensional construct comprising the perception of the body, thoughts and feelings towards the body, and body-related behaviors such as body checking or body avoidance (Cash & Smolak, 2011). A disturbed body image is a main predictor for the development and maintenance of eating pathology (Stice, Marti, & Durant, 2011). According to the cognitive-behavioral theory of eating disorders, attentional biases might contribute to a disturbed body image (Williamson, White, York-Crowe, & Stewart, 2004). Attentional biases have mainly been examined in the context of anxiety disorders, and comprise the tendency to predominantly focus awareness on information in the environment that is disorder-salient (Aspen, Darcy, & Lock, 2013).

More precisely, Armstrong and Olatunji (2012) described different attentional components in which biased processing can be manifested: Vigilance is characterized by stimulus-driven, exogenous shifts of attention towards stimuli that are motivationally relevant, such as threatening stimuli in anxiety disorders, so that the stimuli can be quickly and easily detected. In contrast, maintenance refers to an impairment of endogenous shifts of attention away from threat, emphasizing a deficit in the more voluntary, goal-directed attention system in anxiety disorders. Most studies examining attentional bias have employed various reaction time tasks, i.e., the emotional Stroop task, the modified dot-probe task, and the emotional spatial cueing task, while eye-tracking studies have been used to measure eye movements as indices of overt attention (Armstrong & Olatunji, 2012). Studies employing prolonged stimulus presentations revealed another phenomenon, attentional avoidance, according to which after initial attention deployment primarily towards threatening stimuli, less attention is paid to these stimuli in later viewing stages. Whereas vigilance and maintenance biases are believed to be more automatic processes, attentional avoidance was conceptualized as a voluntary process to prevent the individual from dealing with threatening stimuli (for a review see Armstrong & Olatunji, 2012).
Following on from anxiety disorder research, multiple approaches to the assessment of attentional biases have evolved in the field of body image disturbances (Rodgers & DuBois, 2016). Some studies examined whether there are attentional biases for body stimuli in general, by using body-related words or photographs of bodies within different experimental designs such as the Stroop or dot-probe paradigm (Aspen et al., 2013; Dobson & Dozois, 2004). Women with body image disturbance were found to show attentional biases towards body stimuli, in some cases especially for negatively connoted stimuli, i.e., stimuli representing obesity (Gao et al., 2013; Shafran, Lee, Cooper, Palmer, & Fairburn, 2007). Other studies found biases towards thin bodies, leading to the assumption that women with body concerns tend to show upward comparisons with desired thin-ideal bodies (Cho & Lee, 2013; Dondzilo, Rieger, Palermo, Byrne, & Bell, 2017; Joseph et al., 2016). As most of these studies did not investigate the time course of attention allocation, Gao et al. (2014) used epoch-related analyses of gaze durations in women with body dissatisfaction. They found enhanced attention towards thin and fat body stimuli in early (400 ms) and late (3000 ms) processing stages, supporting both vigilance and maintenance biases for these stimuli in body image disturbance.

Another approach focuses on self-other differences in body processing, emphasizing a distinction between attention to other bodies and attention to one’s own body. Using the dot-probe paradigm, Blechert, Ansorge, and Tuschen-Caßfier (2010) presented participants with pictures of their own body and of another female’s body simultaneously. They found an attentional bias to one’s own body for early (150 ms) and late time intervals (1100 ms) in women with anorexia nervosa, but not in women with bulimia nervosa. Further studies examining self-other differences in attentional bias used eye-tracking to measure the eye movements of women observing pictures of their own and other bodies. Women with eating disorders showed a deficit-oriented viewing pattern when observing their own body, while they were more likely to view the positive body parts of other women (Freeman, Touyz, Sara,
& Rennie, 1991; Horndasch et al., 2012; Jansen, Nederkoorn, & Mulkens, 2005; Roefs et al., 2008). However, some studies also found that women with eating disorders looked less at their own problematic body areas (Janelle, Haubenblash, Fallon, & Gardner, 2003; von Wietersheim et al., 2012) or showed a deficit-oriented pattern when viewing other women’s bodies (Bauer, Schneider, Waldorf, Braks, et al., 2017). Furthermore, one eye-tracking study analyzing the attentional time course of looking at one’s own body found vigilance but no avoidance patterns for self-defined unattractive body areas in women with anorexia nervosa (Bauer, Schneider, Waldorf, Cordes, et al., 2017).

Both reaction time measures and eye-tracking are useful methods to examine attentional bias in body image disturbance. However, they also have several limitations (Armstrong & Olatunji, 2012; Thigpen, Gruss, Garcia, Herring, & Keil, 2018): Reaction time measures imply a distal relation between key press and attention, possibly leading to confounded results due to motor processes. Moreover, they do not allow a continuous measurement of the time course of attention, but rather require multiple tasks to examine different time periods. Eye-tracking enables this continuous measurement, but cannot capture very early and covert attentional processes, as it is restricted to overt observable eye movements (Armstrong & Olatunji, 2012). To overcome these limitations, studies measuring neuronal correlates of body perception might provide complementary information regarding covert attentional processes. Research using brain imaging techniques such as functional magnetic resonance tomography (fMRI) found altered activity in different brain structures, such as the extrastriate body area (EBA), the fusiform body area (FBA), and the inferior parietal lobe, when processing body stimuli in eating disorders (Esposito, Cieri, di Giannantonio, & Tartaro, 2018; Suchan, Vocks, & Waldorf, 2015). However, neuroimaging studies were unable to measure the time course of attention allocation. In contrast, electroencephalography (EEG) has a good temporal resolution. Only a small number of EEG studies have investigated attentional processing of body pictures dependent on body image
disturbance using event-related potentials (ERPs). Gao et al. (2011) found an attentional bias
toward fatness-related words during early processing stages in body-dissatisfied women. In
line with these results, Mai et al. (2015) found an attentional bias toward overweight body
pictures during early processing stages in women with bulimia nervosa. The authors noted
that these women evaluated overweight bodies as more arousing than did normal controls,
which might evoke an early attentional bias similar to the bias evoked by phobic stimuli in
anxious patients. Additionally, they found an attentional bias toward thin body pictures in late
processing stages, which was also observed in normal controls.

Steady-state visual evoked potentials (SSVEPs) constitute an alternative EEG method
to ERPs, and have already been applied in human body processing research (Giabbiconi,
Jurilj, Gruber, & Voeks, 2016). The SSVEP is a continuous oscillatory response of the visual
cortex elicited by a flickering stimulus with the same temporal frequency as the driving
stimulus (Regan, 1989). It has been described as the signature of synchronized early
perceptual neuronal networks as its signal stems from early visual processing areas (Fuchs,
Andersen, Gruber, & Müller, 2008). The amplitude of the SSVEP is enhanced by attention
(Morgan, Hansen, & Hillyard, 1996), allowing for a continuous measurement of the allocation
of attention to one or multiple stimuli (Müller, Teder-Sälejärvi, & Hillyard, 1998). In contrast
to ERP studies or neuroimaging techniques, SSVEPs allow for a ready separation of brain
responses elicited by multiple superimposed stimuli (Andersen, Hillyard, & Müller, 2008;
Müller et al., 2006). This is important, as the biased competition model of attention
(Desimone & Duncan, 1995) states that attention effects are most pronounced when
competing stimuli are presented in close spatial proximity, thus enhancing the observability of
attentional bias for motivationally relevant stimuli (Yiend, 2010). SSVEPs have been
demonstrated to be a sensitive measure for such competition effects (Fuchs et al., 2008;
Keitel, Andersen, Quigley, & Müller, 2013).
To measure such competition effects of emotionally arousing and non-arousing stimuli, Hindi Attar, Andersen, and Müller (2010) evoked SSVEP using a foreground global motion detection task while simultaneously presenting pleasant, neutral and unpleasant pictures in the background. At the beginning of each trial, a semantic non-meaningful scrambled picture was presented in the background, which changed to a pleasant, neutral, or unpleasant picture or another scrambled picture at a random time point. This design enabled the measurement of attentional resource reduction, i.e., costs, for the foreground task evoked by distraction through the different pictures. It was found that for semantic pictures, SSVEP amplitudes decreased after picture change for about 1000 ms, corresponding to worse target detection rates in this time interval. This effect was more pronounced and more sustained for emotionally arousing pleasant and unpleasant pictures. These results suggest that even neutral stimuli interfere with a demanding primary task, and that this effect is more pronounced for emotional stimuli (Hindi Attar et al., 2010). Deweese et al. (2014) used such a design in women with high or low levels of snake fear, and additionally presented snake pictures as distractors. For high-fear women, snake pictures elicited a greater and longer attenuation of task-evoked SSVEP amplitudes than other unpleasant stimuli, while this was not the case for low-fear women suggesting a sustained hypervigilance pattern for snake pictures in high-fear women. Evidence for a hypervigilance-avoidance pattern would have been an initial reduction of the SSVEP amplitude with a quick enhancement of the SSVEP amplitude, which would have suggested that women concentrated more on the dot detection task in order to avoid dealing with the snake stimuli in the background (Deweese et al., 2014). In line with these results, similar studies with high and low socially anxious subjects, using pictures of angry, neutral and happy facial expressions as distractors, revealed early and sustained prioritized sensory processing of angry faces as stimuli with high personal significance (Wieser, McTeague, & Keil, 2011, 2012).
As previous studies on attentional bias in body processing were unable to provide information about the covert attentional time course in early body processing areas, we wanted to fill this gap by using SSVEP. In particular, attention to one's own body has mostly been analyzed based on overt viewing patterns on specific body areas, while less focus has been placed on covert attentional processes. However, overt and covert attention are different processes (Petersen & Posner, 2012), and covert attention influences discriminability and information processing when people are confronted with a lot of visual information (Carrasco & McElree, 2001). Thus, an analysis of the time course of covert attention that results when people observe bodies and other stimuli simultaneously might provide information about involuntary and automatic attention allocation to bodies, which could lead to costs in everyday life. The present study was conducted to examine the covert attentional time course of body processing by administering a global motion detection task and measuring participants' distraction from this task by body stimuli. Therefore, we presented pictures of the participant's own body and pictures of another female's body in the background of a demanding dot detection task (cf. Hindi Attar et al., 2010). Both body pictures were also manipulated, i.e., we additionally presented a thinner and a more obese version of them. Our sample consisted of women with high weight and shape concerns (HWSC) and women with low shape and weight concerns (LWSC), who were instructed to focus on the dots that flickered at 7.5 Hz and elicited an SSVEP. For women with HWSC, one's own body is a negative and significant stimulus, meaning that we expected a greater attenuation of SSVEP amplitudes in the case of pictures of one's own body than in the case of the other female's body, while we did not expect this to occur in women with LWSC. We also hypothesized a greater attenuation of SSVEP amplitudes in the case of overweight bodies than in the case of average weight bodies, for both one's own and other bodies in women with HWSC (Gao et al., 2013; Mai et al., 2015; Shafran et al., 2007), accompanied by higher arousal ratings when confronted with overweight bodies. As previous studies also found biases for thin body
stimuli (Cho & Lee, 2013; Dondzilo et al., 2017; Glauert, Rhodes, Fink, & Grammer, 2010; Joseph et al., 2016; Moussally, Brosch, & Van der Linden, 2016), we further expected a greater attenuation of SSVEP amplitudes in the case of pictures of thin bodies than in the case of pictures of average-weight bodies, for both one’s own and other bodies in women with HWSC. Finally, in accordance with findings from anxiety research (Deweese et al., 2014; Wieser et al., 2011, 2012), we hypothesized a sustained hypervigilance over the whole stimulus presentation in both cases.

**Method**

**Participants**

The study protocol was approved by the ethics committee of Osnabrück University and conformed to the Declaration of Helsinki. Written consent was obtained from all participants. Inclusion criteria were female sex, age between 18 and 30 years, BMI of 19 to 23 kg/m² as well as high or low weight and shape concerns. Exclusion criteria were a mental disorder, a neurological disorder, an uncorrectable eye disease, current pregnancy or pregnancy less than six months ago, and extensive tattoos or other salient body features. To screen for weight and shape concerns, women answered the Eating Disorder Examination Questionnaire (EDE-Q; Fairburn & Cooper, 1993; Hilbert, Tuschen-Caffier, Karwautz, Niederhofer, & Munsch, 2007), and the combined score on the two scales weight and shape concerns was calculated. Based on Hilbert et al. (2007), we added one standard deviation to the mean of the combined score in healthy women to obtain the cut-off for HWSC and subtracted one standard deviation to obtain the cut-off for LWSC. Thus, only women with a score higher than 3.36 or lower than 0.38 were included in the present study. Subjects were recruited via e-mail distribution lists of undergraduates, via press releases and announcements at the University, as well as via facebook advertisements. They received a link to an online survey in Unipark (Questback GmbH; Cologne, Germany) to screen for inclusion criteria, after which they were contacted by email if they fulfilled the criteria. Women who replied to
this email stating their interest in participating were then given information about the study in
a telephone call and an appointment at the lab was arranged. 1264 women completed the
online survey, 115 women received an email informing them that they fulfilled the
participation criteria, 67 women received a telephone call, and 52 women attended the lab
appointment. One participant was excluded due to too poor task performance during training;
thus, 51 women participated in the study. Four women were excluded due to insufficient
behavioral data performance or excessive EEG artifacts. Therefore, data from 20 women with
HWSC and 24 women with LWSC were analyzed. All women were Caucasian and women
with HWSC ($M = 22.45, SD = 3.33$) and women with LWSC ($M = 22.00, SD = 2.84$) did not
differ regarding age, $t(42) = 0.48, p = .631, d = 0.15$, body mass index (HWSC: $M = 20.84,\nSD = 1.17$; LWSC: $M = 20.32, SD = 0.93$), $t(42) = 1.65, p = .107, d = 0.50$, or the highest
level of educational attainment (intermediate school-leaving certificate: $1_{\text{HWSC}}, 1_{\text{LWSC}}$;
advanced technical college entrance qualification: $1_{\text{HWSC}}, 1_{\text{LWSC}}$; higher education entrance
qualification: $13_{\text{HWSC}}, 15_{\text{LWSC}}$; technical college degree: $0_{\text{HWSC}}, 1_{\text{LWSC}}$; university degree:
5_{\text{HWSC}}, 6_{\text{LWSC}}$), $\chi^2(4) = 0.877, p = .928$. The combined score of weight and shape concerns from
the EDE-Q was higher for women with HWSC ($M = 4.12, SD = 0.65$) than for women with
LWSC ($M = 0.20, SD = 0.13$), $t(20.34) = 26.33, p < .001, d = 8.76$. Furthermore, in the EDE-
Q, women with HWSC reported higher levels of eating concerns ($M = 1.63, SD = 1.25$) than
women with LWSC ($M = 0.09, SD = 0.12$), $t(19.28) = 5.49, p < .001, d = 1.82$, and higher
levels of restraint eating ($M = 2.04, SD = 1.35$) than women with LWSC ($M = 0.15, SD =
0.21$), $t(19.80) = 6.18, p < .001, d = 2.05$. Participants were reimbursed with student
participant credit or monetary compensation (15-30 Euros). The type of reimbursement was
not associated with the highest level of educational attainment, group allocation, age or BMI,
all $p > .165$.

Stimuli and procedure
The experimental procedure took place in the EEG Laboratory at the Unit for Clinical Psychology and Psychotherapy at Osnabrück University. First, we took a photograph of the participant’s whole body in a standardized posture and with a neutral facial expression in front of a white background. Participants were dressed in standard grey underwear. Based on this original picture, further processing was conducted. We created a thinner and a more overweight version of the body picture of each participant by creating a very thin and an obese body, dressed in grey underwear and posing in the same way as the subject, using the software DAZ studio 4.6 (DAZ Productions, Inc.; Salt Lake City, Utah, USA). We then morphed the subject’s original photo with the two computer-generated DAZ bodies using the software FantaMorph 5 Deluxe (Abrossoft; www.fantamorph.com). In each case, we took the morph with 50% original photo and 50% DAZ body for the thinner version and the more obese version of the original body. Then, we cut the head of the subject from the original photo, placed it onto the two morph bodies, greyscaled, and retouched everything to achieve coherent body pictures. Furthermore, we flipped each picture horizontally to create a view on the bodies like that seen in a mirror reflection. The picture of the other female’s body was that of a 26-year-old Caucasian female undergraduate who was 165 cm tall and weighed 56.3 kg (BMI = 20.68). The female undergraduate received 50 Euros as reimbursement and agreed to her picture being shown in the context of a study. We conducted the same manipulation steps with her photo as with the subjects’ photos. The final stimulus set thus consisted of pictures of the subject’s original body, a thinner version of the subject’s body, a more obese version of the subject’s body, as well as of corresponding pictures of the other female’s body (see Figure 1). Additionally, we generated three further computerized body pictures with DAZ studio 4.6, which were used in catch trials and in training (see below).
Figure 1. Pictures of the other female’s body in a thinner (a), originally average-weight (b) and more overweight version (c). The woman’s face is masked to prevent identification. In the study, the pictures were shown with the faces.

Figure 2. Illustration of the task procedure. The body picture presents a body from the catch trials.
The stimulation was run using MATLABR version 2007b (The MathWorks., Inc.;
Natick, Massachusetts, USA) and the Cogent Graphics toolbox (developed by John Romaya,
Wellcome Department of Imaging Neuroscience, London, UK). The task design was adapted
from the study by Hindi Attar et al. (2010). Stimuli were presented centrally on a 24-inch Dell
UltraSharp Monitor (U2412M), set at a resolution of 1920 × 1200 with a refresh rate of 60
frames per second and viewed at a distance of 70 cm. Task stimuli consisted of an array of
100 randomly distributed moving magenta dots (each 0.6° × 0.6° of visual angle) overlaid on
one of the body pictures (each 11° × 9° of visual angle). Each trial started with a centrally
located yellow fixation cross and the presentation of a scrambled picture with the magenta
dots on it. Scrambling of the body pictures was performed by a Fourier transform, leading to
the same global low-level properties as the original body picture, i.e., luminance and spectral
energy, but without any semantic information. Therefore, the original phase spectrum of a
body picture was replaced with random values. By using an inverse Fourier transform, the
new scrambled picture was then rebuilt. To prevent anticipation effects, the scrambled picture
changed at different time points into one of the body pictures. In 8.3% of the trials, the picture
change occurred in the time interval 133-1067 ms after stimulus onset (early change); in 75%
of the trials, it occurred in the time interval 1200-2267 ms after stimulus onset (middle
change); and in 16.7% of the trials, it occurred in the time interval 2400-4400 ms after
stimulus onset (late change). Trials with early and late picture changes were catch trials to
make picture onset unpredictable. These trials were excluded from the data analysis. In
middle change trials, one of the six body pictures was presented. The interval from stimulus
onset to stimulus offset including picture change always lasted for 4533 ms. Then, an
interstimulus interval of 900-1400 ms followed, in which only a black screen was presented
(see Figure 2). Every subject ran through nine blocks of 72 trials, resulting in 648 trials. As
only 75% of these trials contained the body pictures of interest, 486 trials were analyzed. The
body pictures were presented in a randomized order, with each of the six pictures appearing 81 times.

To evoke a task-related SSVEP, the magenta dots flickered at 7.5 Hz, thus containing 34 cycles each with four frames on and four frames off. In every frame of screen refresh (16.67 ms), the dots moved randomly in one of four directions, i.e., up, down, left, right. Targets were defined as short intervals (two cycles or ~ 267 ms) in which the dots moved with 35% coherence in one direction. They could appear in every cycle (every ~ 133 ms) equally and were randomly distributed over the whole experiment. Zero to four of these targets could occur during each trial, and this could not be predicted by the subject. Subsequent targets were separated by at least 667 ms in order to allow for an unambiguous assignment of detection responses to targets. Subjects were instructed to focus on the brief coherent dot motions and to press the response button as quickly as possible. The body pictures were task-irrelevant. Up to three training blocks preceded the nine experimental blocks. Feedback about the subject’s performance was provided after each block (detection rate, false alarm rate and reaction time).

Behavioral data

Button presses between 250 and 900 ms after target onset were classified as correct responses. Due to the high target presentation rate, we chose this time window in order to rule out misattributed button presses, in line with previous studies with similar SSVEP designs (Andersen & Müller, 2010; Hindi Attar et al., 2010; Müller et al., 2006). We measured the target detection rates in percent and the number of false alarms of each participant and calculated d-prime as a perceptual sensitivity measure for paradigms with fast or continuous stimulus presentation according to Bendixen and Andersen (2013). This reflects the participant’s performance in distinguishing targets from background noise considering false alarms and hits. Subjects who reached a d-prime lower than 1 or produced overall mean detection rates lower than 30% were excluded as they were possibly not sufficiently focused
on the task. Furthermore, we calculated t-tests to test whether groups differed in overall task
performance.

**Rating of body pictures**

Following the experiment, each of the six body pictures was presented again three
times for three seconds in a randomized order. After each picture presentation, subjects rated
their emotional state according to valence (very negative - very positive) and arousal (very
calm - very excited), and the body attractiveness (very unattractive - very attractive) and body
fat (very little body fat - very much body fat) on Likert scales from 1 to 9. The ratings were
calculated over the three picture repetitions. To analyze how women rated and felt about the
bodies, we ran a $2 \times 2 \times 3$ MANOVA with the between-subjects factor Group (HWSC,
LWSC) and the factors Identity (Self, Other) and Build (Thin, Average weight, Overweight).
The dependent variables were ratings of valence, arousal, body attractiveness and body fat.

**EEG recording and analysis**

The EEG was recorded from 64 electrodes at a sampling rate of 500 Hz and with a
high impedance amplifier (BrainAmp Amplifier/actiCAP, Brain Products GmbH, Gilching,
Germany). Electrodes were placed on the basis of the extended International 10-20 System of
electrode positions (Jasper, 1958; Klem, Lüders, Jasper, & Elger, 1999). During recordings,
electrode FCZ served as reference and electrode AFZ as ground. Eye movements and blinks
were controlled by a vertical and horizontal electrooculogram (EOG). The EEG data were
segmented into epochs from -1000 to 2500 ms relative to picture change with the baseline
from -900 to -700 ms relative to picture change. Artifact correction was performed offline by
the fully automated statistical thresholding for EEG artifact rejection (FASTER; Nolan,
Whelan, & Reilly, 2010). FASTER is an automated, unsupervised method for EEG artifact
detection and rejection based on independent component analyses (ICA). The sensitivity and
specificity of this method rely on combining the application of the statistical thresholding
method to ICA data with the subtraction of the EOG contribution to the EED data. Within
FASTER, a high pass filter of 1 Hz was used. Thereafter, the data were manually corrected by visual inspection to eliminate artifacts not detected by FASTER. For this purpose and further analysis steps, we used the toolbox EEGLAB (Delorme & Makeig, 2004). The data were referenced to the average of all electrodes. In order to analyze the temporally changing magnitude of the SSVEP at 7.5 Hz, the averaged EEG signal (i.e., the event-related potential to stimulus onset) was spectrally decomposed by means of Morlet wavelet analysis for a group of wavelets ranging from ~1 to 42 Hz, with approximately 8 cycles per wavelet (Bertrand & Pantev, 1994). For the 7.5-Hz wavelet, this procedure resulted in a wavelet duration of approximately 170 ms and a spectral bandwidth of approximately 1.9 Hz. For more details, see Giabbiconi et al. (2016). Then, we conducted a time by frequency plot averaged across all electrodes to determine whether SSVEPs were successfully elicited. To select appropriate electrodes for further analyses, we plotted a topography of the 7.5 Hz SSVEP signal for the time window of 800-2200 ms after picture change based on the time by frequency plot. The mean SSVEP amplitudes of the selected electrodes PO3, POz, PO4, O1, Oz and O2 were then used to examine whether identity or the build of the body pictures influenced SSVEP amplitudes. Therefore, we conducted a $2 \times 2 \times 3$ ANOVA with the between-subjects factor Group (HWSC, LWSC) and the factors Identity (Self, Other) and Build (Thin, Average weight, Overweight) as repeated measures. The dependent variable was the mean SSVEP amplitude for the time interval at the electrodes that were chosen based on previously created plots. All statistical analyses were run with SPSS Statistics (IBM; Armonk, New York, USA). For significant ANOVA effects, post-hoc $t$-tests with Bonferroni correction were conducted, which were implemented in the SPSS ANOVA procedure. We always report the Bonferroni-adjusted $p$-values for these $t$-tests.

**Results**

**Rating of body pictures**
The MANOVA yielded a main effect of the factor Group, Pillai’s trace $= 0.43$, $F(4, 39) = 7.35, p < .001$, $\eta^2_p = .430$, a main effect of the factor Identity, Pillai’s trace $= 0.68$, $F(4, 39) = 20.34, p < .001$, $\eta^2_p = .676$, a main effect of the factor Build, Pillai’s trace $= 1.01$, $F(8, 164) = 21.04, p < .001$, $\eta^2_p = .507$, an interaction of the factors Group and Identity, Pillai’s trace $= 0.32$, $F(4, 39) = 4.49, p = .004$, $\eta^2_p = .315$, an interaction of the factors Group and Build, Pillai’s trace $= 0.42$, $F(8, 164) = 5.40, p < .001$, $\eta^2_p = .209$, and an interaction of the factors Identity and Build, Pillai’s trace $= 0.41$, $F(8, 164) = 5.35, p < .001$, $\eta^2_p = .206$. The three-way interaction of Group, Identity and Build was not significant, Pillai’s trace $= 0.16$, $F(8, 164) = 1.72, p = .098$, $\eta^2_p = .077$.

The post-hoc ANOVA results for valence, arousal, attractiveness and body fat are depicted in Table 1.
Table 1

*Post-hoc ANOVA results for valence, arousal, attractiveness and body fat.*

<table>
<thead>
<tr>
<th></th>
<th>Valence</th>
<th>Arousal</th>
<th>Attractiveness</th>
<th>Body fat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$F$</td>
<td>$df_1$</td>
<td>$df_2$</td>
<td>$p$</td>
</tr>
<tr>
<td>Group</td>
<td>21.02</td>
<td>1</td>
<td>42</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Build</td>
<td>67.11</td>
<td>1.48</td>
<td>62.01</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Identity</td>
<td>48.42</td>
<td>1</td>
<td>42</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>G × B</td>
<td>6.08</td>
<td>1.48</td>
<td>62.01</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>G × I</td>
<td>14.49</td>
<td>1</td>
<td>42</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>B × I</td>
<td>6.45</td>
<td>1.95</td>
<td>81.76</td>
<td>.003</td>
</tr>
</tbody>
</table>

*Note.* G = Group, B = Build, I = Identity, $\eta^2_p = $ Partial eta-squared.

Greenhouse-Geisser correction was used by default.
Figure 3. Means and standard deviations of the body ratings dependent on group, identity and
build. HWSC = women with high weight and shape concerns, LWSC = women with low
weight and shape concerns.

The means and standard deviations of body ratings are listed in Figure 3. Across both
groups, women reported significantly different emotional states both in the self- and in the
other-condition depending on the bodies, with the most positive emotional states when the
thin bodies were presented, followed by the average-weight bodies, and finally the overweight
bodies (all \( p \leq .001 \)). Only in the self-condition was arousal higher in the case of the
overweight bodies than in the case of the thin bodies, \( p = .027 \); other arousal differences
dependent on identity and build were not observable (all \( p > .174 \)). Across both groups, and in
both the self- and the other-condition, women rated the overweight bodies as less attractive
and as having more body fat than the average-weight bodies, and the average-weight bodies
as less attractive and as having more body fat than the thin bodies (all \( p < .001 \)). Women in
both groups perceived their feelings for each of the three body build types (overweight,
average weight and thin) as less positive (all \( p < .040 \)) and with more arousal (all \( p < .009 \)) in
the self-than in the other-condition, and rated the bodies as less attractive (all \( p < .001 \)) and as
having more body fat (all \( p < .047 \)) in the self-than in the other-condition.

Post-hoc \( t \)-tests revealed that women with HWSC reported a less positive feeling (\( p < .001 \)) and more arousal (\( p < .001 \)) in the case of bodies in the self-condition than in the case of bodies in the other-condition, and rated bodies in the self-condition as less attractive (\( p < .001 \)) and as having more body fat (\( p < .001 \)) than bodies in the other-condition. Women with LWSC also reported a less positive feeling (\( p = .024 \)) and more arousal (\( p = .017 \)) in the case of bodies in the self-condition than in the case of bodies in the other-condition, and rated bodies in the self-condition as less attractive (\( p = .001 \)), but not as having more body fat (\( p = .061 \)) than bodies in the other-condition. Within the self-condition, women with HWSC perceived a less positive feeling (\( p < .001 \)) and more arousal (\( p = .004 \)) than women with LWSC and rated the bodies in the self-condition as less attractive (\( p < .001 \)) and as having more body fat (\( p < .001 \)) than did women with LWSC. Within the other-condition, women with HWSC also reported a less positive feeling (\( p = .039 \)), but not more arousal (\( p = .166 \)), than women with LWSC, and rated the bodies in the self-condition as less attractive (\( p = .018 \)) and with more body fat (\( p = .001 \)) than did women with LWSC.

Furthermore, women with HWSC differed significantly in valence and arousal depending on the bodies, with the most positive feeling in the case of the thin bodies, followed by the average-weight bodies, and finally the overweight bodies (all \( p < .001 \)). Arousal was higher in the case of the overweight bodies than in the case of the thin (\( p = .050 \)) and average-weight bodies (\( p = .005 \)), with the latter two not differing in arousal (\( p = .919 \)). Women with HWSC rated the overweight bodies as less attractive (\( p < .001 \)) and as having more body fat (\( p < .001 \)) than the average-weight bodies, and the average-weight bodies as less attractive (\( p < .001 \)) and as having more body fat (\( p < .001 \)) than the thin bodies. Women with LWSC also differed significantly in valence depending on the bodies, with the most negative feeling in the case of the overweight bodies, followed by the average-weight bodies
(p < .001) and the thin bodies (p < .001), while the latter two did not differ in valence (p = .630). In women with LWSC, the arousal ratings did not differ depending on the bodies (all p > .208). Women with LWSC rated the overweight bodies as less attractive (p < .001) and as having more body fat (p < .001) than the average-weight bodies, and the average-weight bodies as having more body fat (p < .001) than the thin bodies, but with no differences in attractiveness (p = .100).

Women with HWSC reported a less positive feeling (p = .001) and more arousal (p = .010) in the case of the overweight bodies than did women with LWSC, but did not rate the overweight bodies differently from women with LWSC in terms of attractiveness and body fat (both p > .068). In the case of the average-weight bodies, women with HWSC reported a less positive feeling (p < .001) and more arousal (p = .008) than did women with LWSC, and rated them as less attractive (p < .001) and as having more body fat (p < .001) than did women with LWSC. Women with HWSC rated the thin bodies as having more body fat (p < .001) than did women with LWSC, but their ratings did not differ from the women with LWSC with respect to attractiveness or emotional states (all p > .323).

**Behavioral data analysis**

Women with HWSC and women with LWSC did not differ in d-prime ($M_{LWSC} = 2.04$, $SD_{LWSC} = 0.51$; $M_{HWSC} = 2.08$, $SD_{HWSC} = 0.62$), in the percentage of the detection rate ($M_{LWSC} = 62.54$, $SD_{LWSC} = 11.34$; $M_{HWSC} = 59.06$, $SD_{HWSC} = 13.57$), or in the amount of false alarms ($M_{LWSC} = 22.12$, $SD_{LWSC} = 22.50$; $M_{HWSC} = 18.70$, $SD_{HWSC} = 20.90$) over all conditions and the whole task presentation, all p > .36. Detection rates of about 60% confirmed that participants were engaged in the dot detection task and that it was a task with high difficulty.

**Steady-state visual evoked potentials analyses**

As shown in the time by frequency plot over all scalp electrodes in Figure 4, SSVEP was successfully elicited at 7.5 Hz. Based on this plot, we selected the time window 800-2200 ms after picture change, which allowed us to eliminate an overlap of SSVEPs and early ERP
components (Müller, Malinowski, Gruber, & Hillyard, 2003). As the topography for this time
window showed a posterior maximum, we used the averaged amplitudes of this occipito-
parietal cluster of electrodes including PO3, POz, PO4, O1, Oz and O2 for further analyses
(see Figure 4). These amplitudes were then baseline-corrected by subtracting the amplitudes
in a latency range from -900 to -700 ms before the change from a scrambled picture to the
body picture. As illustrated in the time by frequency plot in Figure 4, all body pictures led to a
drop in SSVEP amplitudes, which was stable for the time window of about 800-2200 ms
relative to picture change in both groups. As no recovery of the SSVEP amplitudes was
observed, we decided to analyze the mean SSVEP amplitudes of this one time window to
examine whether identity or the build of the body pictures influenced SSVEP decrease. Thus,
for the ANOVA, the dependent variable was the SSVEP amplitudes in the time interval 800-
2200 ms relative to picture change. The ANOVA revealed a significant main effect of Build,
\[ F(1.82, 76.55) = 8.92, p < .001, \eta^2_p = .175, \] as well as a significant interaction of Group ×
Identity, \[ F(1, 42) = 4.15, p = .048, \eta^2_p = .090. \] Further effects were not significant, all \( p > .309. \) Post-hoc \( t \)-tests indicated that the SSVEP amplitudes in the case of the overweight
bodies (\( M = -1.14, SD = 1.08 \)) were higher than those in the case of the average-weight bodies
(\( M = -1.32, SD = 1.18 \)), \( p = .003, d = 0.54 \), and the thin bodies (\( M = -1.27, SD = 1.20 \)), \( p =
.012, d = 0.47 \). SSVEP amplitudes in the case of the thin and the average-weight bodies did
not differ significantly, \( p = .644, d = 0.19 \). Furthermore, post-hoc \( t \)-tests revealed that for
women with HWSC, the SSVEP amplitudes in the self-condition (\( M = -1.20, SD = 1.07 \)) were
lower than those in the other-condition (\( M = -1.08, SD = 1.04 \)), \( p = .044, d = 0.58 \). For women
with LWSC, no significant differences were observable between the self- (\( M = -1.31, SD =
1.18 \)) and the other-condition (\( M = -1.35, SD = 1.29 \)), \( p = .460, d = 0.13 \).
Figure 4. Baseline-corrected grand mean time by frequency plot averaged across all electrodes illustrating stable SSVEP of 7.5 Hz (a) and the spherical spline interpolated topography based on the selected time window 800–2200 ms after picture change for 7.5 Hz (b). The dashed box indicates the selected time window and black disks indicate selected electrodes for further analyses.
Figure 5. Post-hoc effects of the interaction of Identity × Group (a, c) and the main effect of Build (b, d) for the SSVEP amplitudes (a, b) and the detection rates (c, d). HWSC = women with high weight and shape concerns, LWSC = women with low weight and shape concerns. * \( p < .05 \) (after Bonferroni correction) 

To examine whether target detection rates correspond with SSVEP results, we ran a 2 × 2 × 3 ANOVA with the between-subjects factor Group (HWSC, LWSC) and the factors Identity (Self, Other) and Build (Thin, Average weight, Overweight) as repeated measures. The dependent variable was the mean target detection rate for the time interval 800-2200 ms relative to picture change. Resembling the SSVEP amplitudes results, the main effect of Build was significant, \( F(1.96, 82.18) = 6.41, p = .003, \eta^2_p = .132 \), and the interaction of Group × Identity was marginally significant, \( F(1, 42) = 3.64, p = .063, \eta^2_p = .080 \). Further effects were not significant, all \( p > .297 \). Post-hoc \( t \)-tests revealed that the detection rate in the case of the overweight bodies (\( M = 72.43, SD = 10.44 \)) was significantly higher than that in the case of the average-weight bodies (\( M = 69.14, SD = 10.95 \)), \( p = .005, d = 0.51 \). Detection rates did not differ in the case of the overweight and thin bodies (\( M = 70.66, SD = 10.50 \)), \( p = .140, d = 0.31 \), or in the case of the thin and the average-weight bodies, \( p = .307, d = 0.26 \). Furthermore, post-hoc \( t \)-tests revealed that for women with HWSC, the detection rate in the self-condition (\( M = 68.15, SD = 10.28 \)) was marginally significantly lower than that in the other-condition (\( M = 70.32, SD = 11.17 \)), \( p = .051, d = 0.44 \). For women with LWSC, no significant difference was observable between the self- (\( M = 72.31, SD = 9.97 \)) and the other-condition (\( M = 71.69, SD = 10.10 \)), \( p = .531, d = 0.13 \). Post-hoc test results for the SSVEP amplitudes and the detection rates are depicted in Figure 5. To gain a more accurate picture of the associations, we also analyzed whether the self-other differences in the SSVEP amplitudes correlated with the self-other differences in the detection rate and the self-other-differences in
the four body ratings. Furthermore, we analyzed whether the differences in the SSVEP amplitude between thin and average weight bodies and between overweight and average weight bodies correlated with the corresponding differences in detection rate and body ratings. We found a significant Spearman’s rho correlation between the self-other difference in body attractiveness and the self-other difference in the SSVEP amplitude ($r_s = .435, p = .003$). Other correlations were not significant, all $p > .145$. This suggests that with a greater tendency to evaluate one’s own body as less attractive than the other woman’s body, women showed a stronger SSVEP amplitude attenuation, i.e., a stronger distraction, for one’s own body than for the other woman’s body.

**Discussion**

This study was conducted to examine the attentional time course of covert body processing in women with high and low body concerns in early visual cortex. To this aim, participants were presented with task-related dots that flickered and elicited an SSVEP, as well as pictures of bodies. As the dots and body stimuli competed for attentional resources, the distraction from the dot detection task by body stimuli was measured by the extent of the SSVEP amplitude reduction. In line with expectation, body pictures distracted both women with HWSC and women with LWSC, as SSVEP amplitudes decreased with body stimuli presentation, and this decrease was maintained for the whole stimulus presentation. However, for women with HWSC, pictures of their own body led to a greater distraction, resulting in a greater attenuation of the SSVEP amplitudes as compared to pictures of another woman’s body. This was not found for women with LWSC. Furthermore, average-weight and thin bodies led to a greater attenuation of the SSVEP amplitudes than overweight bodies.

First of all, we can state that female bodies capture women’s attention in general. In both groups, the attenuation of the SSVEP amplitudes was stable over the course of the whole body presentation, and did not recover until after 1000 ms, as was previously found during the presentation of neutral, positive or negative pictures in healthy men and women (Hindi Attar
et al., 2010). For women, female bodies seem to be motivational relevant stimuli that capture attention, automatically supporting vigilance for body stimuli. It is then difficult to turn the attention away from the bodies, even when participants are instructed to pay attention to a demanding task which supports the maintenance component of attention. We found no evidence for avoidance patterns in covert body processing in early visual cortex. If SSVEP amplitudes had been quickly and abruptly enhanced after an initial reduction, suggesting that women concentrated more on the dot detection task in order to avoid dealing with the body stimuli in the background, this would have hinted at avoidance. As this was not the case, the present study supports previous findings that avoidance is not present in covert processing in early visual cortex, but seems to be a more voluntary and late attentional process which can rather be measured by eye-tracking (Armstrong & Olatunji, 2012; Deweese et al., 2014). In line with studies on phobic stimuli (Deweese et al., 2014; Wieser et al., 2011, 2012), we found vigilance and maintenance patterns for body stimuli in women with high and low body concerns.

When considering differences in the presented body builds, we found a greater distraction by thin and average-weight bodies than by overweight bodies, as the attenuation of the SSVEP amplitudes was greater for these stimuli. This was the case for both groups, i.e., women with HWSC and women with LWSC. As the SSVEP amplitudes also decreased constantly in the case of the overweight body, the finding is not due to avoidance, in which case SSVEP amplitudes should have risen again as outlined above. Regarding the body ratings, we found that both groups rated the overweight bodies as the most unattractive and with the most negative feeling. In contrast, thin and average-weight bodies were rated as more positive and attractive. However, the groups differed in the ratings of thin and average-weight bodies: Women with LWSC rated the average-weight and thin bodies as equally positive and attractive, while women with HWSC rated the thin bodies as more attractive and positive than the average-weight bodies. However, no differences between the bodies were found in terms
of arousal ratings. In line with the thesis that emotional responses to stimuli are influenced
more by subjectively rated relevance than by intrinsic valence and arousal (Brosch, Sander,
Pourtois, & Scherer, 2008; Sander, Grandjean, & Scherer, 2005), our results underline the
greater motivational relevance of thin or average-weight bodies compared to overweight
bodies in young, average-weight women. As the ratings indicate, women with LWSC find
average-weight and thin bodies attractive, while women with HWSC seem to have a thin body
ideal. Thus, women were more distracted by their ideal body pictures than by the negative
overweight body pictures. This is in accordance with previous studies that found stronger
biases towards thin than towards overweight bodies in women with body dissatisfaction (Cho
& Lee, 2013; Dondzilo et al., 2017; Glauert et al., 2010; Joseph et al., 2016; Moussally et al.,
2016). In contrast to most of these studies, which reported attentional biases only for women
with body dissatisfaction, we found a bias toward thin and average-weight bodies both in
women with HWSC and in women with LWSC. In terms of differences in the samples, we
screened for shape and weight concerns and BMI, meaning that only average-weight women
with extremely high or extremely low body concerns took part. Previous studies included
women with more diverse BMI and body concerns. For average-weight women with LWSC
and less thinness idealization, attention to thin and average-weight bodies might affirm self-
worth because they can conclude that they look as good as the other women (Posavac,
Posavac, & Posavac, 1998). However, contradicting this interpretation in our study, these
women evaluated their own body as less attractive than the other woman’s body. As an
explanation, it cannot be ruled out that women with LWSC wanted to appear modest by
evaluating their own body as less attractive than the other woman’s body. Alternatively, it
may be that women with LWSC do not necessarily need to find themselves very attractive but
might have fewer concerns than other women due to other reasons (e.g. they might find body
attractiveness to be less important for their own self-worth or be better able to accept their
own body deficits (Tylka & Wood-Barcalow, 2015)). In this case, an attentional bias for
average-weight and thin bodies would at least not be harmful. In contrast, average-weight
women with HWSC and a high degree of internalization of the thin ideal might fall into
harmful upward comparisons, which might maintain the negative body image (Cho & Lee,
2013; Myers & Crowther, 2009).

Other studies found a more pronounced attentional bias for overweight bodies than for
thin bodies in body image disturbance (Aspen et al., 2013; Mai et al., 2015; Shafran et al.,
2007). Besides methodological differences as an explanation for this differing finding, a
strong bias for obesity might become more relevant if an eating disorder exists. For women
with a high risk of developing an eating disorder, as was the case for some of our sample, the
idealization of a thin body might be more in the foreground than the fear of fatness, with the
latter possibly becoming more relevant in progressed eating disorders (Rieger, Dolan,
Thomas, & Bell, 2017). To confirm this, it would be interesting to repeat our study with
women with an eating disorder diagnosis.

Looking at self-other differences in the present study, we found a more pronounced
vigilance maintenance pattern for one’s own body only in women with HWSC. Comparable
to women with eating disorders (Blechert et al., 2010), one’s own body is an emotionally and
motivationally relevant stimulus for women with high body concerns, which is preferably
processed in a similar manner to a phobic stimulus (Deweese et al., 2014). This motivational
relevance is underlined by the body ratings, as the women with HWSC rated their own body
pictures as more negative, more unattractive and more arousing than pictures of the other
body and as compared to women with L.WSC. In line with this, we found that with a greater
tendency to evaluate one’s own body as less attractive than the other woman’s body, women
showed a stronger SSVEP amplitude attenuation, i.e., a stronger distraction, for one’s own
body than for the other woman’s body. In previous studies examining self-other differences
in body perception, women were instructed to look at body pictures and their viewing patterns
were measured (Bauer, Schneider, Waldorf, Braks, et al., 2017; Freeman et al., 1991;
Horndasch et al., 2012; Jansen et al., 2005; Roefs et al., 2008). Besides such overt attentional processes, our study shows that women with HWSC attend covertly and automatically to information about their own body even when they are engaged in another task. Thus, in everyday life, women with HWSC might be more distractible by information about their own body than other women. Consequently, their thoughts revolve more often around their own bodies and they focus less on other things. Dysfunctional beliefs, concerns, and emotions like fear, sadness, disgust or insecurity regarding one’s own body (Vocks, Iegenbauer, Wächter, Wucherer, & Kosfelder, 2007) as well as body checking and body avoidance behaviors might be easily activated and maintain the negative body image (Williamson, White, York-Crowe, & Stewart, 2004).

Detection rates were descriptively consistent with the SSVEP results, and were also significantly higher when viewing overweight bodies than when viewing average-weight bodies for both groups. For women with HWSC, there was a trend towards lower detection rates when viewing one’s own body than when viewing the other woman’s body. However, correlation analyses showed no significant associations between SSVEP amplitudes and detection rates. The detection rate as a behavioral measure provides an endpoint assessment of many different processes occurring after stimulus onset until a motor response occurs. Thus, detection rates represent a combined effect of processes, rather than just selective attention (Kappenman, MacNamara, & Proudfit, 2013). In contrast, SSVEP amplitudes can better illustrate attentional processes by representing the engagement of neural masses in early visual cortex in response to a continuously presented stimulus (Mcteague, Shumen, Wieser, Lang, & Keil, 2012). As the two measures characterize different processes, they might not correlate and this might also explain the less significant effects of group allocation, body builds and identity on detection rate than on the SSVEP amplitudes. On the other hand, the SSVEP amplitude is only one specific brain signal, and does not represent all brain processes that contribute to ratings of valence and arousal and estimations of attractiveness and body fat.
As such, significant correlations between the SSVEP and self-ratings were not necessarily expected. It is therefore all the more remarkable that the belief of having a substantially less attractive body than another woman is associated with a stronger attentional bias for one’s own body than for the other body in early visual areas. This underpins the idea that women who evaluate their own body as unattractive are also more distractible by information about their own body which might maintain negative body image.

These findings lead to several practical and research implications. Women with body dissatisfaction should be educated about the possibility that they might automatically attend to information about their own bodies, consequently maintaining body dissatisfaction. Furthermore, specific intervention methods could be applied, such as attention bias modification training (ABMT), which reinforces automatic attention allocation away from body stimuli (Renwick, Campbell, & Schmidt, 2013). Positive results of this training have been found for anxiety disorders (Hakamata et al., 2010), but critical objections to this method have also been raised (Emmelkamp, 2012; Mogoase, David, & Koster, 2014). Thus, this method could be used in the long term, once it has received greater validation. For the time being, other, more conscious, cognitive techniques such as body exposure (Vocks et al., 2007) or mindful acceptance of emotions or thoughts about bodies (Baer, Fischer, & Huss, 2005) could be considered. As mentioned above, one research implication would be to repeat the study with women with eating disorders in order to allow conclusions about clinical populations. A potential improvement of the current design would be to use different tag frequencies for the foreground task and the distracting body pictures in order to reveal the time course of enhancement and suppression resulting from biased competition (Desimone & Duncan, 1995) between these superimposed stimuli (Andersen & Müller, 2010).

Some limitations of the present study should be mentioned. One limitation might lie in the ecological validity of the stimulus material, as the bodies were presented in grey and in underwear in a standardized posture. In everyday life, presentation of bodies is much more
diverse. As more natural pictures might hamper internal validity due to less standardization, we decided to use standardized pictures. The inclusion of a control condition with non-body stimuli would have allowed us to compare attentional processes between bodies and non-bodies in our sample. Another aspect to consider is the fact that all subjects were photographed in underwear before the EEG measurement. This might have activated self-referential body schemata, leading to mood alteration. However, as every subject underwent this process in the same manner, different effects of this influence in the two groups were not to be expected. Furthermore, as EEG application took about 30 minutes, there was some time for the participants to take their mind off the photo shoot before measurement.

This is the first study to use an SSVEP design to examine covert attentional bias in early visual body processing in women with high body concerns. Altogether, our study shows that women are easily and automatically distracted by body stimuli, even when they are instructed to concentrate on another task. In doing so, women with high and low body concerns focus more on thin-ideal and average-weight body stimuli than on negatively valued overweight bodies, suggesting that the pursuit of thinness might possibly be more important than the fear of fatness. Furthermore, for women with high body concerns, one’s own body attracts more attention than other bodies. In everyday life, this automatic and involuntary attentional bias could reinforce the prominent role of one’s own body and might maintain negative body image.
Compliance with Ethical Standards

Conflict of Interest: On behalf of all authors, the corresponding author states that there is no conflict of interest.

Statement of human rights: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data Availability

The local ethics committee of Osnabrück University stipulated that data must not be passed on to third parties. Therefore, data sharing is not applicable to this article.
References


5 auditory evoked response (40 Hz) studied by electric and magnetic recordings in human.
6 In C. Pantev, T. Elbert, & B. Lütkenhöner (Eds.), *Oscillatory event-related brain
7 dynamics* (pp. 231–242). New York: Plenum.
9 reveals distinct attentional patterns for bulimia nervosa and anorexia nervosa. *Journal of
12 orienting toward positive emotional stimuli: Research article. *Psychological Science,
14 Carrasco, M., & McElree, B. (2001). Covert attention accelerates the rate of visual
16 5367. https://doi.org/10.1073/pnas.081074098
20 biases toward idealized bodies. *Body Image, 10*(1), 95–102.
21 https://doi.org/10.1016/j.bodyim.2012.09.005
24 https://doi.org/10.1016/j.eatbeh.2014.06.014
26 trial EEG dynamics including independent component analysis. *Journal of Neuroscience

https://doi.org/10.1146/annurev.ne.18.030195.001205

https://doi.org/10.1016/j.psychres.2014.05.042

https://doi.org/10.1016/j.cpr.2003.09.004

https://doi.org/10.1371/journal.pone.0177870


Neuroscience, 10(4), 577–583. https://doi.org/10.1093/scan/nsu098


https://doi.org/10.1016/j.bodyim.2017.06.002


https://doi.org/10.1016/j.cpr.2016.04.006


https://doi.org/10.1016/j.appet.2008.04.008


https://doi.org/10.1016/j.neunet.2005.03.001


https://doi.org/10.1002/eat.20375


*Psychophysiology.* https://doi.org/10.1111/psyp.13058


https://doi.org/10.1016/j.bodyim.2015.04.001
2 in the course of body exposure?. Emotional, cognitive, and physiological reactions to
3 mirror confrontation in eating disorders. *Journal of Psychosomatic Research, 62*(2),
4 231–239. https://doi.org/10.1016/j.jpsychores.2006.08.007
6 Selective attention of patients with anorexia nervosa while looking at pictures of their
7 own body and the bodies of others: an exploratory study. *Psychosomatic Medicine,*
8 74*(1), 107–113. https://doi.org/10.1097/PSY.0b013e31823ba787
10 social threat cues: bias without competition? *Journal of Cognitive Neuroscience,* 23*(8),
16 https://doi.org/10.1177/014544503259853
17 Yiend, J. (2010). The effects of emotion on attention: A review of attentional processing of
19 https://doi.org/10.1080/02699930903205698
20
Table 1

Post-hoc ANOVA results for valence, arousal, attractiveness and body fat.

<table>
<thead>
<tr>
<th></th>
<th>Valence</th>
<th>Arousal</th>
<th>Attractiveness</th>
<th>Body fat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$F$</td>
<td>$df_1$</td>
<td>$df_2$</td>
<td>$p$</td>
</tr>
<tr>
<td>Group</td>
<td>21.02</td>
<td>1</td>
<td>42</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Build</td>
<td>67.11</td>
<td>1.48</td>
<td>62.01</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Identity</td>
<td>48.42</td>
<td>1</td>
<td>42</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>G × B</td>
<td>6.08</td>
<td>1.48</td>
<td>62.01</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>G × I</td>
<td>14.49</td>
<td>1</td>
<td>42</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>B × I</td>
<td>6.45</td>
<td>1.95</td>
<td>81.76</td>
<td>.003</td>
</tr>
</tbody>
</table>

Note. G = Group, B = Build, I = Identity, $\eta^2_p$ = Partial eta-squared.

Greenhouse-Geisser correction was used by default.