

1 **Evidence for altered configural body processing in women**
2 **at risk of disorders characterised by body image**
3 **disturbance**

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1 **Abstract**

2 Two studies were conducted to assess appearance-related visual processing
3 mechanisms in populations at risk of disorders characterised by body image
4 disturbance. Using inverted stimuli, Experiment 1 assessed visual processing
5 mechanisms associated with body, face and house viewing in adolescents.
6 Experiment 2 applied the same protocol to assess appearance-related configural
7 processing in high- and low-risk adolescent women, and women recovering from
8 disorders characterised by body image disturbance. Experiment 1 found evidence for
9 typical configural face and body processing, although adolescent women reported
10 higher levels of Body Image Concern (BIC) and self-objectified to a greater extent
11 than adolescent men. In Experiment 2, typical body inversion effects were seen in
12 the low risk group, whilst there was some evidence to suggest a disruption to the
13 configural processing of body stimuli in high risk adolescents and in women
14 recovering from body image disorders. Women in recovery were also quicker to
15 respond to all stimuli, whilst high risk adolescents took longer to respond to bodies
16 than to other stimuli. Configural face processing was intact in all groups and effects
17 did not directly relate to BIC or self-objectification. These findings have implications
18 for future research looking to inform early interventions and treatment, suggesting
19 that there could be a tendency to visually process individual body parts at the
20 expense of the whole body form in women at risk of developing body image
21 disorders, as well as those in recovery.

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23 **Key words:** Eating disorders, body dysmorphia, body image, configural processing,
24 inversion effect, body representation, adolescence, adolescents

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2 Abbreviations: ED, BDD, BIC, BID, BIE, FIE

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4 **1. Introduction**

5 Body image is described as a multi-dimensional construct that reflects the malleable,
6 conscious representation a person has of their bodily self. This includes subjective
7 emotions and cognitions relating to appearance satisfaction (Cash, 2012; Cash,
8 2004). As such, body image exists on a spectrum of body image concern (BIC;
9 Callaghan, Lopez, Wong, Northcross, & Anderson, 2011), which can be understood
10 as the amount of concern an individual has about their physical appearance, ranging
11 from healthy or 'positive' to unhealthy (Mundy & Sadusky, 2014). At the extreme
12 negative end of the spectrum, these concerns manifest as body image distortions,
13 which are reported to the point of delusion in some psychiatric conditions (Phillips,
14 Kim, & Hudson, 1995). In particular, perceived flaws in appearance, that are often
15 unnoticeable or considered to be minor by others, are characteristic of mental
16 illnesses such as anorexia nervosa, bulimia nervosa and body dysmorphic disorder
17 (BDD) (American Psychiatric Association, 2013). However, there are subtle
18 symptomatic differences between the conditions, showing that those with anorexia
19 and/or bulimia tend to overemphasise the importance of body weight and shape,
20 focusing on their own 'fat' and/or 'ugly' body parts but directing attention to others'
21 'beautiful' body parts (Jansen, Nederkoorn, & Mulken, 2005). In contrast, although
22 bodily concerns may be present, those with BDD are more likely to find themselves
23 preoccupied with facial-, skin- or hair-related appearance concerns (Feusner,
24 Neziroglu, Wilhelm, Mancusi, & Bohon, 2010). As a result, the DSM-5 classifies

1 anorexia and bulimia under 'feeding and eating disorders,' whilst BDD is referred to
2 on the obsessive-compulsive spectrum. However, it has been argued that these
3 conditions might be better understood as interrelated body image disorders (Cororve
4 & Gleaves, 2001) due to their shared symptomatology such as body image
5 disturbance, severe psychological distress and reduced psychosocial functioning
6 (Harris & Barraclough, 1997; Mitchison, Crino, & Hay, 2013). Moreover, BDD is often
7 distinctly comorbid with eating disorders (EDs) (Dingemans, van Rood, de Groot, &
8 van Furth, 2012; Jolanta & Tomasz, 2000). These viewpoints were adopted during
9 our investigations, and we thus refer to disorders such as AN, BN and BDDs as
10 disorders characterised by body image disturbance throughout.

11

12 Adolescence is a particularly vulnerable period of time for the onset of BDD
13 (Bjornsson et al., 2013) and EDs (Striegel-Moore & Bulik, 2007; Striegel-Moore et
14 al., 2003). In addition, reports show the highest mortality rate of all psychiatric
15 illnesses in anorexia (Arcelus, Mitchell, Wales, & Nielsen, 2011; Papadopoulos,
16 Ekblom, Brandt, & Ekselius, 2009; Sullivan, 1995), as well as the high levels of
17 suicide ideation and suicide attempts in BDD (Phillips et al., 2005). In sum, there is a
18 pressing need to understand the aetiology and the developmental course of such
19 disorders, so that objective symptom markers and timely interventions can be
20 identified.

21

22 Although limited, research is working towards identifying the factors that contribute to
23 the development and maintenance of the symptomatology associated with disorders
24 characterised by body image disturbance (Buchanan, Rossell, & Castle, 2011;

1 Feusner, Neziroglu, et al., 2010; Suchan, Vocks, & Waldorf, 2015). Given that body
2 image is underpinned by interrelated contributions from perception, cognition, affect
3 and behaviour (Cash, 2012; Cash, 2004) and given the elevated level of dysmorphic
4 appearance concerns seen in EDs and BDD, disturbances to visual perception have
5 been proposed as a possible factor in the maintenance and development of body
6 image disturbance. In particular, it has been suggested that preoccupations with
7 specific body areas or flaws in appearance seen in those with EDs and BDD, might
8 reflect a bias for processing local over global information (Feusner, Neziroglu, et al.,
9 2010; Lang, Lopez, Stahl, Tchanturia, & Treasure, 2014). Specifically, weak central
10 coherence, whereby detail-based, local processing is employed instead of global
11 processing, has been observed across EDs (Lang et al., 2014) as well as in
12 recovered ED participants (Lopez, Tchanturia, Stahl, & Treasure, 2009). This
13 suggests that local processing bias might be a trait characteristic of those who have
14 experienced EDs, perhaps predisposing them to, or helping them to maintain body
15 image disturbance pathologies (Lopez et al., 2009). Weak central coherence is
16 understudied in BDD, although there is evidence to suggest global processing
17 disturbances and local processing bias also exists in this population (Feusner,
18 Neziroglu, et al., 2010; Kerwin, Hovav, Helleman, & Feusner, 2014). Thus, as ED
19 and BDD symptoms are highly comorbid (Mitchison et al., 2013) it is possible that
20 such perceptual disturbances might underpin the high level of attention-to-detail
21 required for the development and maintenance of body image disturbance. Studies
22 investigating face and body processing in populations with high BIC have addressed
23 this directly and report disturbances indicative of a focus on the features of
24 appearance-related stimuli (Beilharz, Atkins, Duncum, & Mundy, 2016; Duncum,
25 Atkins, Beilharz, & Mundy, 2016; Feusner, Moller, et al., 2010; Mundy & Sadusky,

1 2014; Urgesi et al., 2014; Urgesi et al., 2012). Interestingly, evidence also suggests
2 that face processing mechanisms mature throughout adolescence (particularly early
3 adolescence) into adulthood (e.g. Blakemore, 2008; Blakemore & Mills, 2014; Cohen
4 Kadosh, Johnson, Dick, Cohen Kadosh, & Blakemore, 2013; Mondloch, Le Grand, &
5 Maurer, 2002; Steinberg, 2005; Taylor, Edmonds, McCarthy, & Allison, 2001). The
6 same may be true for body processing mechanisms, fostering the particular
7 vulnerability of some adolescents to developing EDs and BDDs.

8

9 The present study will therefore investigate the visual processing mechanisms
10 associated with body and face stimuli in two populations: those at risk of developing
11 disorders characterised by body image disturbance, and those at risk of relapsing
12 into such disorders. We asked participants to discriminate between different bodies,
13 faces and control stimuli (houses) in a matching-to-sample task (modelled on Urgesi
14 et al., 2014; Urgesi et al., 2012). In half of the trials, the images were inverted. In line
15 with the perceptual literature, we expected to see inversion effects reflect reduced
16 performance to inverted compared to upright trials for both bodies (Body inversion
17 effect, (BIE), Minnebusch, Keune, Suchan, & Daum, 2010; Reed, Stone, Grubb, &
18 McGoldrick, 2006; Reed, Stone, Bozova, & Tanaka, 2003), and faces (face inversion
19 effect, (FIE), Yin, 1969), but not for houses. It is largely accepted that such effects
20 indicate that body, and face, stimuli are processed configurally, in a top-down global
21 manner, whilst objects are recognised in a bottom-up style according to their local
22 features (Maurer, Le Grand, & Mondloch, 2002; Minnebusch & Daum, 2009). To
23 assess the relationship between body image disturbances and global-configural vs
24 local-featural processing, two questionnaires were administered. These included the
25 self-objectification questionnaire (SOQ; Fredrickson, Roberts, Noll, Quinn, &

1 Twenge, 1998; Noll & Fredrickson, 1998) as a measure of whether the body is
2 thought of in terms of observable appearance, rather than competence (based on
3 objectification theory; Fredrickson & Roberts, 1997), and the Body Image Concern
4 Inventory (BICI; Littleton, Axsom, & Pury, 2005) as a measure of dysmorphic
5 appearance concerns.

6

7 In Experiment 1, we recruited participants within the adolescent 'at risk' age bracket
8 in order to assess general configural face and body processing mechanisms in
9 adolescence, and their relationship to BIC and SOQ. As it has been proposed that
10 the single greatest risk factor for developing EDs such as anorexia and bulimia is
11 simply being female (see Striegel-Moore & Bulik, 2007 for review), we were
12 particularly interested in assessing differences in configural processing mechanisms
13 between young men and women.

14

15 Experiment 2 was designed to test more directly whether disturbed configural
16 processing of appearance-related stimuli can precede the onset of illnesses
17 symptomatic of body image disturbance, and/or continue into recovery. To this end,
18 we compared appearance-related configural processing mechanisms between high
19 risk and low risk young women, as well as women who had partially recovered from
20 EDs and BDD. 'High risk' was determined on the basis of BIC and self-objectification
21 in those who had not been diagnosed with EDs/BDD, as self-objectification and body
22 dissatisfaction (Strelan & Hargreaves, 2005) are known traits of disorders such as
23 anorexia, bulimia (Calogero, Davis, & Thompson, 2005) and BDD (Lambrou, Veale,
24 & Wilson, 2011). Furthermore, self-objectification has been identified as a

1 contributing factor to body image disturbance (see Riva, Gaudio, & Dakanalis, 2015
2 for review).

3

4 We predicted that the adolescent women in Experiment 1 might report more BIC and
5 self-objectification than the young men, given that western societal norms encourage
6 the objectification of female bodies (Jones, 2001) and that women are more likely to
7 experience body image disturbance than men (Striegel-Moore & Bulik, 2007).

8 Furthermore, whilst we expected that adolescents would show normative configural
9 processing for faces and bodies, indexed by slower RT and reduced accuracy to
10 inverted compared to upright face and body stimuli, we thought these effects might
11 be reduced or altered in adolescent women compared to adolescent men if, indeed,
12 young women were to report greater levels of self-objectification and body concerns
13 (Duncum et al., 2016; Mundy & Sadusky, 2014).

14

15 We also expected that high risk adolescents in Experiment 2 would perform
16 comparably to the body image disturbance (BID) group, showing evidence for
17 reduced configural face and body processing. It has been hypothesised that those
18 suffering disorders characterised by high BIC might not process appearance-related
19 corporeal stimuli in the typical global-configural manner, but on the basis of their
20 local features (Beilharz et al., 2016; Duncum et al., 2016; Feusner, Moller, et al.,
21 2010; Mundy & Sadusky, 2014; Urgesi et al., 2014; Urgesi et al., 2012). In addition,
22 we expected quicker reaction times and more accurate responses to inverted body
23 and face stimuli in high risk adolescents to correlate with scores on the BICI and
24 SOQ (as in Beilharz et al., 2016)..

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2. Experiment 1: Assessing configural processing in those within the ‘at risk’ age bracket for developing EDs and BDD

Configural processing disturbances have been reported in both anorexia (Urgesi et al., 2014) and BDD (Feusner, Moller, et al., 2010), and have also been linked with BIC even in non-clinical populations (Beilharz et al., 2016; Duncum et al., 2016; Mundy & Sadusky, 2014). Experiment 1 therefore aimed to investigate configural processing mechanisms in adolescents, as this is considered a particularly vulnerable developmental stage for the onset of EDs (Striegel-Moore & Bulik, 2007; Striegel-Moore et al., 2003) and BDD (Bjornsson et al., 2013). As a result, participants were asked to discriminate between upright and inverted body, face and house stimuli in a matching-to-sample task whilst RT and accuracy was recorded. Scores on the BICI and SOQ were also assessed.

2.1 Method

2.1.1 Participants

As a result of email advertisements sent to University mailing lists and the University Outreach team, 226 participants (58 male) between the ages of 16 and 23 were recruited from local schools and colleges. Participation was on a voluntary basis and often during an optional workshop that was included as part of a University campus visit. Behavioural data failed to record for one participant and seven of those recruited reported history of an eating disorder (ED) diagnosis so their data were included in Experiment 2. As a result, data from 218 participants (58 male) were

1 analysed in Experiment 1. Age data and questionnaire scores have been
2 summarised in Table 1.

3

4 **2.1.2 Ethical declaration**

5 The study was conducted in line with the 2008 Declaration of Helsinki and approved
6 by the local Ethics Committee for the Psychology Department at the University.

7

8 **2.1.3 Apparatus and stimuli**

9 **Questionnaires**

10 The Body Image Concern Inventory (BICI; Littleton et al., 2005) is a 19-item self-
11 report measure designed to explicitly assess dysmorphic appearance concern. The
12 questionnaire assesses the level of concern and dissatisfaction with either perceived
13 or exaggerated flaws in appearance, as well as associated behaviours (e.g.
14 camouflaging and checking, reassurance seeking and appearance-related
15 comparisons, Littleton & Bretkopf, 2008; Littleton et al., 2005). Respondents are
16 required to use a 5-point Likert scale (1= 'never,' 5 = 'always') to indicate, with
17 regards to the last week, how closely they identify with statements such as, 'I
18 examine flaws in my appearance.' The measure is scored by summing all items,
19 meaning scores can range from 19 to 95 with higher scores indicative of more
20 dysmorphic concerns. High scores on the BICI may be indicative of BIC in both EDs
21 and BDD as dysmorphic appearance concern is not only the hallmark symptom of
22 BDD (American Psychiatric Association, 2013; Jorgensen, Castle, Roberts, & Groth-
23 Marnat, 2001), but is also prevalent in ED symptomatology (Cororve & Gleaves,
24 2001; Dingemans et al., 2012; Grant & Phillips, 2004; Hartmann et al., 2015;

1 Hartmann, Greenberg, & Wilhelm, 2013; Jolanta & Tomasz, 2000; Mazzeo, 1999;
2 Rosen & Ramirez, 1998; Ruffolo, Phillips, Menard, Fay, & Weisberg, 2006).

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4 The BICI has been validated multi-ethnically (Littleton & Breitkopf, 2008) and
5 deemed a recommended reliable tool for both clinical practice and research (e.g.
6 Dingemans et al., 2012; Ghadakzadeh, Ghazipour, Khajeddin, Karimian, & Borhani,
7 2011; Littleton & Breitkopf, 2008; Littleton et al., 2005).

8
9 The self-objectification questionnaire (SOQ; Fredrickson et al., 1998; Noll &
10 Fredrickson, 1998) is a 10-item self-report measure based on objectification theory
11 (Fredrickson & Roberts, 1997). The measure is designed to assess the extent to
12 which an individual thinks of their body in terms of what it looks like (observable
13 appearance) rather than in terms of its ability (non-observable competence).
14 Respondents are required to think about their physical self-concept and rank order a
15 list of 10 bodily attributes from 0 (least important) to 9 (most important). Five items
16 relate to bodily appearance. These are physical attractiveness, weight, sex appeal,
17 measurements and muscle tone. The other five items relate to bodily competence.
18 These are strength, health, energy level, physical fitness and physical coordination.
19 A trait 'self-objectification score' is obtained by subtracting the sum of the five
20 competence items from the sum of the five appearance items. The difference value
21 obtained, ranging from -25 to +25, represents the relative emphasis given to
22 appearance and competence. A positive score is therefore indicative of more focus
23 on how the body looks over what the body can do, whereas a negative score
24 indicates the reverse (Fredrickson et al., 1998).

25

1 The SOQ has been validated against measures of body shame, body dissatisfaction,
2 appearance anxiety, negative affect and neuroticism (Miner-Rubino, Twenge, &
3 Fredrickson, 2002; Noll & Fredrickson, 1998) as well across cultures, life styles, ages
4 and psychiatric illnesses (Calogero, 2012). It is therefore an appropriate research
5 tool.

6

7 **Body, face and house stimuli**

8 The stimulus set was comprised of 10 digital photographs of houses (width 300 x
9 height 340 pixels, width 3.5 cm x height 4.3 cm) downloaded from the World Wide
10 Web, 10 front-facing digital photographs of bodies (five men) (200 x 350 pixels, 2.5
11 cm x 4.5 cm) taken from a stimulus set created for use in our lab, and 10 digital
12 photographs of emotionally neutral faces (five men) (210 x 330 pixels, 2.5 cm x 4.8
13 cm) downloaded from the MacBrain NimStim face stimulus set (Tottenham et al.,
14 2009) (available to the scientific community at
15 <http://www.macbrain.org/resources.htm>; see Figure 1 for examples). Body stimuli
16 depicted the upper thighs and torso, did not include the head and were clothed in a
17 neutral white vest and briefs so as to minimize cues from clothing that might alter
18 inversion effects (Robbins & Coltheart, 2012). Faces were resized and cropped so
19 that facial features fit into a standard oval. Luminosity was adjusted to control for
20 brightness across all images, and stimuli were presented greyscale on a black
21 background (384 x 512 pixels, 2.5 cm x 4.0 cm).

22

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FIGURE 1 HERE

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1 **2.1.4 Procedure**

2 A standardised summary of procedures was explained to participants prior to task
3 completion. Written consent was obtained once the experimenters were sure
4 procedures had been understood, and questionnaires were then administered.
5 Following this, participants were instructed to complete a delayed matching-to-
6 sample task as in Urgesi et al. (2014). Stimuli were displayed on a black background
7 with screen resolution of 1920 x 1200 pixels (screen size 47.3 cm x 26.8 cm) at
8 approximately 70 cm viewing distance. This means that the stimuli subtended a
9 visual angle of approximately 2.0°-3.0° x 3.4°-4.1°. Each trial started with a central
10 fixation cross presented for 500 ms, followed by a sample stimulus presented
11 centrally for 250 ms (consistent with Minnebusch, Suchan, & Daum, 2009; Reed et
12 al., 2006; Urgesi et al., 2014; Yovel, Pelc, & Lubetzky, 2010). Image retention was
13 reduced by subsequently presenting a mask for 500 ms, which was obtained by
14 shifting each horizontal row of pixels of the sample stimulus by a random amount
15 (see Figure 2). Directly after the mask, the two probe stimuli appeared, one left of
16 centre and one right of centre, until a response was given (see Figure 2).
17 Participants were asked to respond as quickly and accurately as possible using their
18 dominant hand, by pressing the left or right mouse button in order to indicate which
19 probe matched the sample stimulus.

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FIGURE 2 HERE

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23 Body, face and house stimuli were presented four times each (twice upright, twice
24 inverted, with the 'different' probe altered each time) in three discrete, randomised,
25 40-trial blocks. In each stimulus block, the matching probe appeared on the left for

1 20 trials (10 upright and 10 inverted) and on the right for 20 trials (10 upright and 10
2 inverted). Genders were consistent between sample and probe stimuli for both body
3 and face trials, and body, face and house blocks were separated by self-paced
4 breaks. During the break, participants were given a summary of their performance,
5 including the amount of correct trials and an average RT in order to maintain
6 motivation and engagement with the task. A summary of performance was also
7 provided at the end of the task.

8

9 Medical history was sought upon task completion and a full debrief was given.

10

11 **2.2 Results**

12 **2.2.1 Assessing the differences between young men and women**

13 Three separate independent sample t-tests were conducted to assess whether
14 adolescent men and women differed with regards to self-objectification, BIC and age.
15 T-tests are reported unsigned.

16

17 Independent sample t-tests revealed that as a group, adolescent women gave a
18 relative emphasis to appearance over competence, whilst adolescent men gave a
19 relative emphasis to competence over appearance ($t(203) = 4.664, p < .001$).

20 Additionally, young women reported a higher level of BIC than young men ($t(216) =$
21 $7.828, p < .001$, see Table 1). The age of young men and women in the sample did
22 not differ ($t(216) = .329, p = .742$).

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TABLE 1 HERE

Inversion task performance

The proportion of correct responses (accuracy) and mean RTs to correct responses were calculated for each stimulus and orientation in each participant (as in Feusner, Moller, et al., 2010; Mundy & Sadusky, 2014; Urgesi et al., 2014). Trials with an RT higher than 5000 ms were identified and discarded (as in Urgesi et al., 2014). Both RTs and accuracy were then averaged across participants and subjected to separate 2 x 3 x 2 between-subjects analysis of variance (ANOVA), with Orientation (upright vs. inverted) and Stimulus (bodies vs. faces vs. houses) as within-subjects factors and Gender (young men vs. young women) as a between-subjects factor. Follow-up comparisons of the estimated marginal means were Bonferroni-corrected. Greenhouse-Geisser adjustments to degrees of freedom were applied where necessary. Where applicable, t-tests are reported unsigned.

RTs

The ANOVA on RTs revealed a main effect of Orientation ($F(1, 216) = 142.53, p < .001, \eta_p^2 = .40$) and a main effect of Stimulus ($F(2, 432) = 306.09, p < .001, \eta_p^2 = .59$), which was qualified by a significant two-way interaction between them ($F(2, 432) = 31.55, p < .001, \eta_p^2 = .13$). Comparisons of the estimated marginal means revealed that participants were slower to respond to inverted compared to upright faces ($t(217) = 11.87, p < .001$), bodies ($t(217) = 5.23, p < .001$) and houses ($t(217) = 3.95, p < .001$), although such inversion effects were most prominent for faces

1 (mean difference = 174 ms), followed by bodies (mean difference = 75 ms) and least
 2 prominent for houses (mean difference = 37 ms, see Figure 3, top panel). The
 3 between-subjects effect of Gender was not significant ($F(1, 216) = .12, p = .732, \eta_p^2$
 4 $< .01$), it did not interact with either of the within-subjects factors ($F(2, 432) \leq 1.10, p$
 5 $\geq .331, \eta_p^2 \leq .01$) and there was no three-way interaction either ($F(2, 432) = .702, p$
 6 $= .486, \eta_p^2 < .01$) However, we investigated this interaction further because separate
 7 follow-up comparisons were planned a priori and as argued by Howell (2010),
 8 significant interactions in the omnibus ANOVA are unnecessary when specific simple
 9 effects are predicted by the study's hypothesis (p.372-373). Thus, Bonferroni-
 10 corrected follow-up comparisons revealed that inversion effects were present for
 11 faces ($t(217) \geq 6.44, p \leq .001$) and bodies ($t(217) \geq 4.50, p \leq .001$) in both genders.
 12 Similarly, inversion effects were present for houses in the female adolescents ($t(217)$
 13 $= 4.39, p < .001$) whilst being marginally evident in adolescent men ($t(217) = 1.96, p$
 14 $= .051$). This therefore demonstrates no evidence for a difference in face or body
 15 inversion effects between adolescent men and women.

16

17 **Accuracy**

18 ANOVA on accuracy data (see Figure 3, bottom panel) revealed a main effect of
 19 Orientation ($F(1, 216) = 109.43, p < .001, \eta_p^2 = .34$) and of Stimulus ($F(2, 432) =$
 20 $102.10, p < .001, \eta_p^2 = .32$), which was qualified by a significant two-way interaction
 21 between them ($F(2, 432) = 37.13, p < .001, \eta_p^2 = .15$). Pairwise comparisons
 22 revealed that participants were more accurate to upright than inverted bodies ($t(217)$
 23 $= 3.14, p = .008$, mean difference = 2.7%) and faces ($t(217) = 10.60, p < .001$, mean
 24 difference = 10.6%), but accuracy did not differ between upright and inverted houses

1 ($t(217) = 2.00, p = .051$, mean difference = 1.2%). The between-subjects effect of
2 Gender was just significant ($F(1, 216) = 3.98, p = .047, \eta_p^2 = .02$) as adolescent
3 women were somewhat more accurate than adolescent men (76.0% vs. 72.1%), but
4 Gender did not interact with either of the within-subjects factors ($F(2, 432) \leq 1.27, p$
5 $\geq .281, \eta_p^2 \leq .00$). The three-way interaction was also non-significant ($F(2, 432) =$
6 $.104, p = .893, \eta_p^2 < .01$), although as before, we conducted planned comparisons.
7 Consequently, Bonferroni-corrected follow-up comparisons revealed that inversion
8 effects were again present for faces ($t(217) \geq 6.18, p \leq .038$) and bodies ($t(217) \geq$
9 $2.00, p \leq .014$) in both genders. In adolescent women, inversion effects were also
10 present for houses ($t(217) = 2.66, p = .011$) whilst this was not the case in the
11 adolescent men ($t(217) = .80, p = .454$). Thus, although the body inversion effect
12 appeared to be somewhat reduced in young women compared to young men, this
13 pattern of results also suggests little difference in face or body inversion effects
14 between the genders.

15

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FIGURE 3 HERE

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18 **2.2.2 Correlational analyses**

19 A Pearson's r correlational analysis was conducted in order to assess the
20 association between self-objectification and BIC, as well as to investigate the
21 relationship between each construct and behavioural performance. In line with
22 previous literature (Beilharz et al., 2016; Mundy & Sadusky, 2014), scores on the
23 SOQ and the BICI, as well as RTs and accuracy to both upright and inverted bodies,

1 faces and houses, were entered into the analysis¹. The false discovery rate (FDR)
2 method of correction for multiple comparisons (Benjamini & Hochberg, 1995) was
3 applied to correlation results ($\alpha = .017$), and results that did not survive correction
4 are not reported. Figures have been colour coded so that male and female
5 participants' data can be identified separately.

6
7 SOQ score was moderately and positively related to BICI score, $r(205) = .41, p <$
8 $.001$, such that the more participants self-objectified the more body concerns they
9 had (see Figure 4) There were no other relationships to report as neither self-
10 objectification nor BIC relates to RTs or accuracy for upright or inverted stimuli.

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FIGURE 4 HERE

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14 2.3 Experiment 1: Interim summary of results

15 As a group, adolescent women gave more relative emphasis to bodily appearance
16 over competence and reported greater levels of BIC than adolescent men. In line
17 with expectations, we also found that self-objectification and BIC were positively
18 related. As expected, inversion effects were observed for faces and bodies in both
19 RTs and accuracy data, meaning participants were less accurate and slower at
20 identifying the correct probe stimulus during inverted trials. Inverting house stimuli
21 also resulted in slower identification of the correct stimulus probe, but did not affect
22 accuracy. These effects were similar for both adolescent men and women, although

¹ Responses to upright and inverted stimuli were entered separately into the analysis so that results would be comparable to previous literature (Beilharz et al., 2016; Mundy & Sadusky, 2014). However, with inversion effects entered into the analysis (difference between upright and inverted stimuli) results do not change.

1 body inversion effects did appear somewhat reduced in female participants.
2 Inversion effects for bodies or faces did not show a systematic relationship with self-
3 objectification or BIC concern in adolescents, perhaps due to relatively low levels of
4 BIC overall and little evidence of extreme self-objectification.

5

6 **3. Experiment 2: Comparing configural processing in high- and low- risk** 7 **young women, and women with EDs/BDD**

8 The aim of Experiment 2 was to assess appearance-related configural processing
9 mechanisms in adolescent women considered to be at either high- or low-risk of
10 developing disorders characterised by body image disturbance, as well as women
11 who had partially recovered from EDs and/or BDD. However, whilst we dichotomised
12 'risk' between groups, it should be noted that risk is still considered as a continuous
13 dimension throughout the study. Thus, the same matching-to-sample task as in
14 Experiment 1 was completed by a sample of women reporting a history of disorders
15 characterised by body image disturbance. Their performance was compared to the
16 performance of a selection of young women taken from Experiment 1, who were
17 considered high- or low- risk according to their scores on the BICI and SOQ. In
18 accordance with DSM-5® (American Psychiatric Association, 2013) participants with
19 a history of Binge Eating Disorder were not recruited as the symptomology focus is
20 heavily based on a relationship with food, rather than body image.

21

1 3.1 Method

2 3.1.1 Participants

3 **Body image disturbance (BID) participants**

4 In addition to the seven adolescent women who reported a history of EDs in
5 Experiment 1, 38 women who had experienced an ED or BDD were recruited via
6 email advertisements sent to University mailing lists. Thus, a total of 45 women,
7 aged 16 – 43 years, who had experienced an ED or BDD were recruited (see Table
8 2 for diagnostic and treatment information).

9
10 Weight-restored anorexic participants were sought and similarly, those with other
11 ED/BDD diagnoses were non-clinical at the time of testing. All participants reported a
12 previous medical diagnosis for their condition and the average age of the sample
13 was 22 years (SD: 6 years). A monetary incentive was offered as time
14 reimbursement.

15

16 **TABLE 2 HERE**

17

18 **High- and low-risk participants**

19 We selected 45 young women from Experiment 1 in order to create a 'high risk'
20 group that matched the BID group on scores of both self-objectification ($t(88) = .579$,
21 $p = .989$) and body concern ($t(88) = 1.745$, $p = .249$); on average, both groups
22 scored within the BICI subclinical range (Littleton et al., 2005). A 'low risk' group was
23 created by selecting 45 young women who scored significantly lower than both the
24 high risk and BID group on both the SOQ ($t(88) \geq 2.730$, $p \leq .022$) and the BICI ($t(88)$

1 ≥ 11.636 , $p < .001$, see Figure 5). Thus, two thirds of the data for this experiment
2 were obtained from Experiment 1. The average age of the high risk group was 17
3 years old (SD 2 years), whilst the average age of the low risk group was 18 years old
4 (SD 2 years).

5

6

FIGURE 5 HERE

7

8 **3.1.2 Ethical declaration**

9 The study was conducted in line with the 2008 Declaration of Helsinki and approved
10 by the local Ethics Committee for the Psychology Department at the University.

11

12 **3.1.3 Apparatus and stimuli**

13 Apparatus and stimuli were exactly the same as in Experiment 1.

14

15 **3.1.4 Procedure**

16 The procedure was exactly the same as in Experiment 1, although BID participants
17 that were not recruited as part of a campus visit were tested individually so as to
18 ensure confidentiality and anonymity.

19

1 3.2 Results

2 3.2.1 Inversion task performance

3 As in Experiment 1, accuracy and mean RTs to correct responses were calculated
4 for each stimulus category and orientation in each participant. Again, trials with a RT
5 higher than 5,000 ms were identified and discarded. Both RT and accuracy data
6 were then subjected to separate 2 x 3 x 3 mixed-subjects ANOVA, with Orientation
7 (upright vs. inverted) and Stimulus (bodies vs. faces vs. houses) as within-subjects
8 factors and Group (low risk vs. high risk vs. BID) as a between-subjects factor. Given
9 that configural face and body processing is reportedly disturbed in populations with
10 high body image disturbance (Feusner, Moller, et al., 2010; Mundy & Sadusky, 2014;
11 Urgesi et al., 2014), we planned follow-up comparisons for the three-way interaction
12 orientation x stimulus x group. All follow-up comparisons of the estimated marginal
13 means were Bonferroni-corrected. Greenhouse-Geisser adjustments to degrees of
14 freedom were applied where necessary. Where applicable, t-tests are reported
15 unsigned.

16

17 RTs

18 The ANOVA on RTs (see Figure 6) revealed a main effect of Orientation ($F(1, 132)$
19 $= 115.11, p < .001, \eta_p^2 = .47$) and of Stimulus ($F(2, 264) = 253.20, p < .001, \eta_p^2 =$
20 $.66$), which was qualified by a significant two-way interaction between them ($F(2,$
21 $264) = 20.71, p < .001, \eta_p^2 = .14$). As in Experiment 1, comparisons of the estimated
22 marginal means revealed that participants were slower to respond to inverted
23 compared to upright faces ($t(134) = 6.26, p < .001$), bodies ($t(134) = 4.01, p < .001$)
24 and houses ($t(134) = 5.27, p < .001$), although as in Experiment 1, inversion effects

1 were most prominent for faces (mean difference = 150 ms), least prominent for
2 houses (mean difference = 43 ms), and bodies fell in between (mean difference =
3 55 ms). A significant Group x Stimulus interaction was also found ($F(4, 264) = 2.97$,
4 $p = .022$, $\eta_p^2 = .04$). Follow-up comparisons revealed that there were no differences
5 between RTs to bodies and faces in the low risk group ($t(44) = .97$, $p = 1.00$) or the
6 BID group ($t(44) = 1.18$, $p = .717$), but that responses to bodies were significantly
7 slower than to faces in the high risk group ($t(44) = 4.04$, $p < .001$). Orientation did not
8 reliably interact with group ($F(2, 132) = 2.48$, $p = .088$, $\eta_p^2 = .04$) and the three-way
9 interaction between Orientation, Stimulus and Group was non-significant ($F(4, 264) =$
10 1.15 , $p = .335$, $\eta_p^2 = .02$). However, we investigated this interaction further for two
11 reasons: Most importantly, separate follow-up comparisons for each group were
12 planned a priori and as argued by Howell (2010), significant interactions in the
13 omnibus ANOVA are unnecessary when specific simple effects are predicted by the
14 study's hypothesis (p.372-373); Secondly, three-way interaction effects are not often
15 found due to reduced power (McClelland & Judd, 1993), which makes it difficult to
16 obtain statistical justification for follow-up comparisons even in studies with large
17 sample sizes such as the present one. Thus, Bonferroni-corrected follow-up
18 comparisons revealed evidence for inversion effects to faces ($t(44) \geq 3.47$, $p \leq .001$)
19 and houses ($t(44) \geq 2.25$, $p \leq .026$) in all groups, as well as to bodies in the low risk
20 group ($t(44) = 2.93$, $p = .004$). In comparison, there was marginal evidence of a
21 body inversion effect in the BID group ($t(44) = 1.97$, $p = .053$), and evidence of a
22 reduced inversion effect in the high risk group ($t(44) = 2.05$, $p = .042$).

23

1 The between-subjects effect of Group was also significant ($F(1, 132) = 8.50, p <$
2 $.001, \eta_p^2 = .11$), as the BID group responded faster than both the low risk group
3 ($t(88) = 3.39, p = .003$) and the high risk group ($t(88) = 3.73, p = .001$), whilst high risk
4 and low risk groups responded similarly ($t(88) = .33, p = 1.00$).

6 Accuracy

7 ANOVA on accuracy data (see Figure 6) revealed a main effect of Orientation ($F(1,$
8 $132) = 96.02, p < .001, \eta_p^2 = .42$) and of Stimulus ($F(2, 264) = 116.18, p < .001, \eta_p^2$
9 $= .47$), which was qualified by a significant two-way interaction between them ($F(2,$
10 $264) = 33.26, p < .001, \eta_p^2 = .20$). As before, follow-up comparisons revealed that
11 participants were more accurate when responding to upright compared to inverted,
12 faces ($t(134) = 10.73, p < .001$), bodies ($t(134) = 3.00, p = .004$) and houses ($t(134)$
13 $= 2.71, p = .005$), although again, inversion effects were most prominent for faces
14 (mean difference = 11.8%), least prominent for houses (mean difference = 1.9%),
15 and bodies fell in between (mean difference = 3.0%). The Group x Stimulus
16 interaction was significant ($F(4, 264) = 3.50, p = .010, \eta_p^2 = .05$), with follow-up
17 comparisons revealing no differences between the groups for face or body stimuli
18 ($t(88) \leq 1.56, p \geq .38$), but that the BID group was more accurate in response to
19 house stimuli than both the low risk group ($t(88) = 2.60, p = .033$) and the high risk
20 group ($t(88) = 3.80, p = .001$). Orientation did not interact with Group ($F(2, 132) =$
21 $.55, p = .580, \eta_p^2 = .01$) and the three-way interaction between Orientation, Stimulus
22 and Group was non-significant ($F(4, 264) = .60, p = .656, \eta_p^2 = .01$). Nevertheless,
23 as before, we investigated this interaction further. Bonferroni-corrected follow-up
24 comparisons revealed that whilst there was evidence for inversion effects in

1 response to faces in all groups ($t(44) \geq 5.35, p < .001$). However, evidence for
2 inversion effects to bodies was seen only in the low risk group ($t(44) = 2.06, p =$
3 $.039$), with marginal effects evident in the high risk group ($t(44) = 1.83, p = .061$) and
4 no effects evident in the BID group ($t(44) = 1.11, p = .258$). Additionally, inversion
5 effects for houses were not evident in the low risk group ($t(44) = .09, p = .923$) but
6 appeared to be present for both high risk ($t(44) = 2.55, p = .017$) and BID ($t(44) =$
7 $2.73, p = .010$) groups.

8
9 The between-subjects effect of Group was also significant ($F(1, 132) = 3.66, p =$
10 $.028, \eta_p^2 = .11$), as the BID group responded more accurately overall compared to
11 the high risk group ($t(88) = 2.67, p = .024$) but not compared to the low risk group
12 ($t(88) = 1.54, p = .352$), whilst high risk and low risk groups responded similarly ($t(88)$
13 $= 1.08, p = .799$).

14

15

FIGURE 6 HERE

16

17 3.2.2 Correlational analyses

18 As in Experiment 1, a Pearson's r correlational analysis was planned in order to
19 assess the relationship between self-objectification and BIC ($\alpha = .017$ after
20 application of FDR correction), as well as to investigate associations between the
21 aforementioned constructs and behavioural performance.

22

1 Findings from Experiment 1 were mirrored here, as SOQ score was moderately and
2 positively related to BICI score, $r(133) = .37, p < .001$ (Figure 7) meaning that the
3 more participants self-objectified the more body concerns they reported. No other
4 relationships can be reported as again, self-objectification and body concern did not
5 relate to RTs or accuracy for upright or inverted stimuli².

6

7

FIGURE 7 HERE

8

9 3.3 Experiment 2: Interim summary of results

10 Inverting body stimuli appeared to be less disruptive to visual processing for the BID
11 group, as they were able to discriminate probe stimuli with the same level of
12 accuracy and within a similar time frame, irrespective of whether bodies were upright
13 or inverted. Similarly, inverting bodies did not affect the accuracy of identifying the
14 correct probe stimulus in the high risk group, although it did increase RT. In
15 comparison, the low risk group displayed typical inversion effects for bodies in both
16 RTs and accuracy. Inversion effects in both RTs and accuracy were seen in all
17 groups for faces and houses. In addition, the BID group were quicker to respond
18 overall and were also more accurate in their responses to houses than both other
19 groups. Participants in the high risk group were slower to respond to bodies than
20 both other stimuli. Furthermore, as in Experiment 1, BICI score was positively related
21 to SOQ score.

² As in Experiment 1, responses to upright and inverted stimuli were entered separately into the analysis. Again, with inversion effects entered into the analysis (difference between upright and inverted stimuli) results do not change.

1 **4. Discussion**

2 Two studies were conducted in order to investigate whether appearance-related
3 configural processing deficits may precede the potential onset of illnesses
4 characterised by body image disturbance, and/or continue into recovery. In
5 Experiment 1, configural processing mechanisms were investigated in young men
6 and women, as adolescence has been identified as a particularly vulnerable time for
7 the development of EDs (Striegel-Moore & Bulik, 2007) and BDD (Bjornsson et al.,
8 2013), and may thus also be an at-risk stage of development for body image
9 disturbances. Moreover, the single most predicative risk factor for the development
10 of body image disturbance is thought to be gender (Striegel-Moore & Bulik, 2007).
11 As a result, we predicted that adolescent women would report higher levels of BIC
12 and a greater extent of self-objectification, which might be associated with altered
13 appearance-related configural processing (Duncum et al., 2016; Mundy & Sadusky,
14 2014). In Experiment 2, we directly compared high risk young women (risk defined
15 by high BIC and self-objectification), low risk young women and women who were
16 partially recovered from EDs and/or BDD. We predicted that appearance-related
17 configural processing might be similar in the high risk and BID group, and that it
18 would differ to the low risk group (Feusner, Moller, et al., 2010; Mundy & Sadusky,
19 2014; Urgesi et al., 2014).

20

21 In Experiment 1, we found higher levels of BIC and greater self-objectification in
22 adolescent women compared to adolescent men, supporting our hypothesis.
23 However, although questionnaire measures were positively related, they were not
24 associated with behavioural performance. Moreover, comparable effects of body and

1 face inversion were found between the genders. This suggests that, as a group, both
2 adolescent men and women show typical inversion effects for both appearance-
3 related and object stimuli. Furthermore, this suggests that although there is evidence
4 for a slow maturation of configural face processing mechanisms throughout
5 adolescence into adulthood (e.g. Blakemore & Mills, 2014; Mondloch et al., 2002;
6 Steinberg, 2005; Taylor et al., 2001), configural processing of appearance-related
7 stimuli appears to be evident by 17 years of age.

8

9 In Experiment 2, we found that the BID group showed no inversion effects for body
10 stimuli in accuracy, and only marginal body inversion effects in RTs, as performance
11 was comparable for upright and inverted body discrimination. This group were also
12 significantly quicker to respond overall and were more accurate when discriminating
13 houses than both the low risk and high risk groups of young women. Configural body
14 processing also appeared to be somewhat disrupted in the high risk group, as there
15 were no inversion effects in the accuracy of discriminating bodies and reduced
16 inversion effects in RTs. Moreover, participants in the high risk group were generally
17 slower to respond to bodies than both other groups. This suggests that atypical
18 configural body representation is not only present in women with anorexia (Urgesi et
19 al., 2014) and (subclinical) dysmorphic concern (Mundy & Sadusky, 2014), but that it
20 might extend both to women recovering from disorders marked by body image
21 disturbance and to adolescent women with high levels of self-objectification and
22 dysmorphic concern. Typical inversion effects were seen for faces and houses in all
23 groups and those in the low risk group also displayed typical BIEs in both RT and
24 accuracy. As in Experiment 1, BIC and self-objectification did not systematically
25 relate to behavioural performance but were positively related to each other. This

1 relationship is perhaps unsurprising, as body dissatisfaction and self-objectification
2 have both been reported as traits in both EDs (Calogero et al., 2005) and BDD
3 (Lambrou et al., 2011). However, relatively little emphasis is given to the interaction
4 between these two constructs, which may be of interest for diagnosis and treatment.
5 Future research should hence consider BIC in the context of self-objectification in
6 order to further work towards an understanding of ED and BDD aetiology. We will
7 now proceed to discuss specific findings from each study in turn.

8

9 **4.1 Appearance-related configural processing in adolescence**

10 As expected, adolescent women showed higher BIC and greater emphasis on bodily
11 appearance compared to bodily competence than young men, which is in line with
12 findings from previous research (e.g. Abbott & Barber, 2010; Furnham, Badmin, &
13 Sneade, 2002; Muth & Cash, 1997). It has been proposed that this difference may
14 occur, at least in part, as a result of the cultural definitions assigned to what a male
15 and female body *should* be; typically, male bodies are thought of as active and
16 agentic, whereas the function of the female body is to be attractive and sexually
17 pleasing (see Knauss, Paxton, & Alsaker, 2008; Smolak, 2004 for reviews) . In our
18 study, not only did young women report higher levels of BIC but they also self-
19 objectified to a greater extent than young men. As we also found that BIC and self-
20 objectification were linearly related, our results therefore support the idea that body
21 dissatisfaction in women might be motivated by the belief that the primary function of
22 a female body is to look good. Additionally, reports show that these culturally defined
23 bodily understandings are propagated by the media, family and peers from a young
24 age (see Knauss et al.; Smolak, 2004 for review) , which in turn affects adolescent

1 women more than adolescent men (Hargreaves & Tiggemann, 2004). Our results
2 suggest that such social messages may have impacted adolescent women's body
3 image differently from men's by the age of 17, whilst at least one study has shown
4 that girls as young as 6 years old self-objectify to a similar extent to adult women
5 (Jongenelis, Byrne, & Pettigrew, 2014). However, it should be noted that in our study
6 there was essentially no evidence for particularly strong self-objectification in young
7 women despite the differences between the genders. Specifically, adolescent
8 women scored an average of 1.51 on the SOQ (with a range of -25 to 25), whilst a
9 score of 25 indicates the most extreme level of self-objectification and a score of -25
10 indicates the opposite extreme. Furthermore, there was a clear spread of scores on
11 both the BICI and SOQ (see Figure 1), with some young women falling within the
12 range of lower scores. Thus, further research should address how and why some
13 young women seem to be protected from such culturally defined body
14 understandings as self-objectification, whilst others appear to be more susceptible to
15 their influence.

16

17 Despite the difference in questionnaire scores found between groups, evidence for
18 appearance-related configural processing mechanisms was comparable between
19 genders. This differs from previous research, which found altered configural
20 processing in those with higher levels of BIC (e.g. Duncum et al., 2016; Mundy &
21 Sadusky, 2014). It is possible that these differences did not occur in our sample
22 because overall levels of BIC were within the normal range (see Littleton et al., 2005
23 for clinical cut-off point). This suggests that there may be a threshold of BIC that is to
24 be reached before altered configural processing is evident, which supports Beilharz
25 et al. (2016) who argue for a graded local processing bias in line with increases in

1 BIC. With that in mind, our findings suggest that appearance-related configural
2 processing mechanisms present typically during adolescence. They also suggest
3 that, as such, it is unlikely that configural processing deficits or local processing
4 biases are underlying factors contributing towards the elevated risk for individuals in
5 this age group in the most general of terms. However, our findings may help to
6 explain why young women are at greater risk of developing disorders characterised
7 by body image disturbance (Striegel-Moore & Bulik, 2007). This is because we found
8 that adolescent women were more self-objectifying than men of the same age, whilst
9 also reporting higher levels of BIC. Future research would therefore benefit from
10 addressing when this difference develops and why it does so, in order for early
11 interventions to be instigated that would reduce BIC and encourage all adolescents
12 to focus relatively more on their abilities and relatively less on their appearance.

13

14 **4.2 Configural body processing is altered in high risk young women and** 15 **women recovering from disorders characterised by body image** 16 **disturbance**

17 Configural body processing appeared to be somewhat disrupted in the BID group, as
18 inversion effects were not apparent in accuracy and were only marginally evident in
19 RT. Unlike other studies (e.g. Beilharz et al., 2016; Feusner, Moller, et al., 2010;
20 Mundy & Sadusky, 2014), the present study did find evidence for typical configural
21 face processing in this population. It is possible that this difference occurred because
22 a large proportion of the BID group had suffered from EDs, rather than BDD, as
23 evidence suggests that configural body processing is disturbed in women with
24 anorexia (Urgesi et al., 2014; Urgesi et al., 2012), whilst configural face processing is

1 intact in anorexia (Urgesi et al., 2014) but disturbed in those with BDD (e.g. Feusner,
2 Moller, et al., 2010). If this is the case, it suggests that appearance-related configural
3 processing deficits in those with subclinical BIC, as in Mundy and Sadusky (2014) for
4 example, might become disorder-specific as an illness progresses. Understanding
5 this is particularly important for determining the aetiology of such illnesses, which is
6 relevant for early interventions and treatment. As a result, future research should
7 seek to assess appearance-related configural processing mechanisms in those
8 specifically 'at risk' of EDs or BDD and compare them to distinct ED/BDD groups.
9 Nonetheless, our findings show a level of disruption to body-related visual
10 processing in women who are recovering from disorders characterised by body
11 image disturbance and self-objectification. This is in line with research that
12 evidences a selective deficit in configural body processing that is perhaps
13 characteristic of women with anorexia (Urgesi et al., 2014; Urgesi et al., 2012).
14 Furthermore, it has been suggested that the feature-based analysis of the human
15 body, which predominates when configural representation is disrupted, may
16 underpin, and perhaps help to maintain, fixations with perceived deficits, 'fat' body
17 parts and 'flaws' in appearance that are typically seen in anorexia and BDD (Mundy
18 & Sadusky, 2014; Urgesi et al., 2014). For the first time, we present evidence to
19 suggest that this might generalise across eating and body dysmorphic disorders. As
20 research investigating visual processing in EDs other than anorexia is scarce, this
21 finding is of particular importance because it suggests that disturbed appearance-
22 related configural processing should be investigated as an underlying mechanism for
23 body image disturbance more generally. Further findings to support this, would
24 therefore have implications for both treatment for, and recovery from, disorders
25 characterised by body image disturbance.

1

2 In addition, we have also shown for the first time, that despite moving into recovery
3 and reporting subclinical levels of BIC on average (see Littleton et al., 2005), women
4 who have experienced an ED or BDD might visually analyse the body in a piecemeal
5 way. Hence, atypical visual analysis of the human form might be an ongoing
6 symptom of disorders characterised by body image disturbance, which could be of
7 particular interest with regards to treatment and relapse-prevention. For example, if
8 local processing bias contributes to the underlying mechanisms of body image
9 disturbance pathology, then sufferers may benefit from a form of training that
10 promotes configural processing (as has been done for fingerprints, Busey &
11 Vanderkolk, 2005; Greebles, Gauthier & Tarr, 1997; and houses, Husk, Bennett, &
12 Sekuler, 2007). As a result, it is possible that focus would shift from perceived flaws
13 or minor defects in appearance due to the body being perceived as a whole. The BID
14 group were also quicker and more accurate at discriminating houses than both other
15 groups. Given that non-corporeal stimuli are supposedly processed in a feature-
16 based manner, the superior performance of the BID group in responses to houses
17 could be taken as evidence of local-processing bias. This is further supported as we
18 found that the BID group were generally faster to respond than both other groups
19 (Beilharz et al., 2016), although this must be taken with some caution as it is also
20 possible that faster and partially more accurate responses in this group were due to
21 somewhat greater maturity. Nevertheless, this finding is of interest given that
22 Groves, Kennett, and Gillmeister (2017) report rapid neural encoding of visual stimuli
23 in those with an ED compared to controls. It seems therefore that the differences in
24 RT observed in this study might mirror the reported electroencephalographic effects.
25 Furthermore, as Groves et al. (2017) suggest that such rapid encoding of visual

1 stimuli might be a potential marker for ED symptomatology, future research should
2 seek to address whether quicker RTs to visual stimuli truly are the behavioural
3 manifestation of this. As a result, it might then be possible to suggest objective
4 markers of ED symptomatology in both brain and behaviour.

5

6 Another novel and important finding to emerge from this study is that configural body
7 processing was also similarly disrupted in the high risk group. As in previous
8 research (Duncum et al., 2016; Urgesi et al., 2014), this disruption was only seen for
9 accuracy data, not for RTs. Likewise, Beilharz et al. (2016) found a correlation
10 between BIC and accuracy rates to inverted stimuli, but not RTs. At present, there is
11 little understanding about why accuracy rather than RT might be affected in high BIC
12 populations (see Duncum et al., 2016), especially as other studies have found RT
13 differences between low BIC, high BIC and BDD (Mundy & Sadusky, 2014). Given
14 that our BID group displayed only marginal evidence of configural body processing in
15 RTs, it could be that participants in studies that report RT differences (e.g. Mundy &
16 Sadusky, 2014) are clinical but undiagnosed (a point also argued by Duncum et al.,
17 2016). With that in mind, it seems that configural processing deficits manifest in
18 accuracy either before, or more so, than they do in RTs. Future studies may
19 therefore benefit from addressing why this might be the case.

20

21 Nonetheless, contrary to other studies of non-clinical participants with elevated levels
22 of BIC (e.g. Mundy & Sadusky, 2014), we found evidence of typical configural face
23 processing in the high risk group. It is possible that the difference occurred because
24 we also accounted for elevated levels of self-objectification. It has been shown

1 specifically, that self-objectification appears to be linked to body image disturbance
2 in anorexia (see Riva et al., 2015 for review). Perhaps then, elevated levels of self-
3 objectification coupled with high BIC is indicative of those at risk of developing EDs
4 characterised by body image disturbance, rather than BDD. This is supported by the
5 observation that the BID group was largely populated by women who had
6 experienced EDs, and they too showed evidence for disturbances in the visual
7 processing of only body stimuli. Future research should aim to address this by
8 comparing the extent of self-objectification in EDs and BDD, whilst considering how
9 this relates to body image disturbance. In doing do, it may help to distinctly identify
10 those at risk of EDs and those at risk of BDD.

11

12 Participants in the high risk group were also slower to respond to bodies than other
13 stimuli. Although not directly tested, this finding could reflect an attentional bias for
14 disorder-relevant stimuli, as for example, Gotlib, Krasnoperova, Yue, and Joormann
15 (2004) found that depressed participants spent more time attending to sad faces.
16 Moreover, Horndasch et al. (2012) found that young women with EDs showed an
17 attentional bias towards unclothed body parts, proposing that this was a behavioural
18 manifestation of the tendency to over-evaluate the importance of body weight and
19 shape. They go on to suggest that shifting attentional processes away from body
20 shape may therefore help to alleviate some BIC when idealised media images are
21 viewed. It could be argued then, that longer RTs to bodies compared to other stimuli
22 in our high risk group, might reflect a tendency to over evaluate the importance of
23 body weight and shape in subclinical populations. This is supported by research that
24 shows those who rate their body as unattractive have been found to focus on their
25 own 'unattractive' body parts whilst focusing on others' 'attractive' body parts (Roefs

1 et al., 2008), mirroring what has been observed in the ED population (Jansen et al.,
2 2005). Such attentional bias for bodies may therefore initiate and help to maintain
3 BIC [in the same way that vigilance has been proposed to initiate and maintain
4 anxiety, see 88] through heightened attention to bodies, and in particular, one's own
5 'unattractive' body parts. Moreover, given that the BID group were generally faster
6 and more accurate to respond than both other groups, such vigilant piecemeal
7 processing over a number of years could result in a general level of expertise that
8 means those in recovery from EDs/BDD perform particularly well on tasks of visual
9 discrimination.

10

11 This idea of vigilance towards other bodies in those with high BIC and self-
12 objectification is supported by neuroimaging evidence. For example, Vocks et al.
13 (2010) found enhanced limbic activity in anorexic participants compared to controls,
14 as they viewed other women's bodies. They specifically suggest that this may reflect
15 a stronger emotional response and more vigilance to other women's bodies. The
16 suggestion to shift attentional processes away from body shape (Horndasch et al.,
17 2012) may therefore be of particular interest for early interventions in young women
18 who show elevated levels of BIC and self-objectification. As the BID group did not
19 show this effect, this would suggest that such vigilance to other women's bodies
20 might dissipate with recovery.

21

22 On the other hand, it has been proposed that longer RTs do not necessarily reflect
23 an attentional bias, but difficulty with disengaging from a stimulus (e.g. Amir, Elias,
24 Klumpp, & Przeworski, 2003; Bindemann, Burton, Hooge, Jenkins, & de Haan, 2005;

1 Fox, Russo, Bowles, & Dutton, 2001; Koster, Crombez, Verschuere, & De Houwer,
2 2004; Koster, De Raedt, Goeleven, Franck, & Crombez, 2005). In particular, it has
3 been proposed that threat stimuli affect attentional dwell time, such that attention is
4 held and participants struggle to locate target stimuli (Fox et al., 2001). Given that
5 longer response latencies were only evident when high risk participants were
6 discriminating body stimuli, this indicates that bodies might have been perceived as
7 a threat. This interpretation is supported by Amir et al. (2003), who found that those
8 with social phobia struggled to disengage attention from socially threatening stimuli
9 (e.g. a social threat word, such as humiliated), which was reflected in longer RTs.
10 Moreover, studies have found that those with EDs rate body stimuli more highly with
11 regards to arousal (Mai et al., 2015) and aversion (Uher et al., 2005).

12 It is possible that the observation of other bodies promotes a threat response due to
13 social comparison. For example, Corning, Krumm, and Smitham (2006) found that
14 own-body evaluations were more negative in women with ED symptoms during
15 same-sex body comparisons, whilst women without ED symptoms were unaffected.
16 Furthermore, eye-tracking studies have shown bulimic individuals report more body
17 dissatisfaction after comparing their bodies to those of others (Blechert, Nickert,
18 Caffier, & Tuschen-Caffier, 2009). BIC in bulimia has also been linked to social-self
19 concerns (Striegel-Moore, Silberstein, & Rodin, 1993), whilst self-other corporeal
20 comparisons reportedly provoke body-focused anxiety even in asymptomatic
21 populations (Halliwell & Dittmar, 2004). Consequently, similar to the anxiety induced
22 by social threat words in Amir et al. (2003), bodies may induce anxiety in
23 adolescents with elevated levels of BIC and self-objectification. Longer RTs to
24 bodies in the high risk population may therefore be a behavioural manifestation of
25 threat response. Again, as BID participants did not show such an effect, this would

1 suggest that other women's bodies are not threatening during recovery from a
2 disorder characterised by body image disturbance and self-objectification.

3

4 In future, studies should seek to directly address whether these results in subclinical
5 populations reflect an attentional bias towards body stimuli, or difficulty disengaging
6 from body stimuli. This is particularly important in order to understand the underlying
7 mechanisms of the effect, such that early interventions may appropriately address
8 either an overevaluation of body weight and shape, or the perception of a body as a
9 threat. Nonetheless, as there were no differences between response times to bodies
10 and other stimuli in the BID group, this suggests that the underlying mechanism for
11 the effect is likely to be reduced once sufferers begin to recover. Bodies therefore,
12 either no longer pose a threat perhaps because comparison behaviours have
13 reduced, or bodies no longer disproportionately capture attention perhaps because
14 body weight and shape is no longer unduly emphasised. Given that RT to bodies
15 was found to increase alongside BIC in Beilharz et al. (2016), the attentional
16 processes involved with body observation may particularly characterise those who
17 are 'at risk' of developing EDs or BDD, rather than those who have suffered from
18 such an illness. The response speed profile to bodies may thus be a useful tool for
19 charting recovery and perhaps even predicting relapse.

20

21 Beilharz et al. (2016) proposed that local processing bias might be an objective
22 marker of BIC as accuracy rates for face and body stimuli were positively associated
23 with BIC. We found no such relationships, which appears to put into question
24 Beilharz et al.'s proposal. However, the difference between our findings could be due

1 to the use of different questionnaire measures of dysmorphic concern. Beilharz et al.
2 (2016) measured BIC with the Dysmorphic Concern Questionnaire (DCQ; Mancuso,
3 Knoesen, & Castle, 2010), whilst we used the BICI (Littleton et al., 2005). By
4 comparison, the DCQ is a diagnostic tool used in order to screen for BDD, whilst the
5 BICI claims to address BIC in both EDs and BDD (e.g. Ghadakzadeh et al., 2011;
6 Littleton et al., 2005). It is possible then, that local processing bias might be a marker
7 for BIC in BDD but not in EDs. Further to this, Beilharz et al. (2016) did not apply any
8 correction for multiple comparisons to their correlational results and as relationships
9 between behavioural measures and questionnaire scores were not highly significant,
10 perhaps interpretations are drawn beyond the power of the data. As a result, more
11 work seeking to assess the relationship between BIC and behavioural measures of
12 local processing bias needs to be completed before an objective marker of general
13 BIC can be confirmed.

14

15 **5 Limitations**

16 When interpreting the results of the studies presented, several limitations should be
17 considered.

18

19 In Experiment 1, the sample comprised 75% female participants. Extrapolating the
20 general findings to a population of adolescent males should therefore be done
21 somewhat cautiously. As a result, it is important for future research to continue to
22 investigate the possibility of gender differences in adolescent visual face and body
23 processing, but with equal sample sizes where possible.

1 In Experiment 2, the high- and low- risk adolescent groups were not matched to the
2 BID group in terms of mean age (17 and 18 vs. 22 years). The ideal scenario would
3 have been to present data from an age-matched group of recovered teens,
4 alongside our high- and low-risk groups. However, by its very nature, this was an
5 unlikely possibility, as it is exceptionally rare to find recovered teens given that
6 adolescence is the typical age of onset for disorders characterised by body image
7 disturbance. Age then, was somewhat inherent to the questions we were addressing,
8 given that recovery comes with age. In line with that, whilst we could have
9 investigated comparisons between age-matched high- and low-risk older participants
10 and the BID group, this would have addressed a question quite separate to those
11 that were of interest in these studies. This is further illustrated as 'risk' was defined
12 according to levels of self-objectification and body concern within individuals of a
13 vulnerable age for the onset of these disorders.

14

15 As we are not aware of any literature to suggest dramatic changes in the baseline
16 visual processing of bodies and faces between late adolescence and young
17 adulthood (existing studies e.g., Blakemore (2008), Blakemore and Mills (2014) and
18 Cohen Kadosh et al. (2013), suggest differences between earlier adolescence and
19 adults, some of which might be related to puberty rather than age, and which are
20 more specifically concerning affective face processing), we do not think the (small)
21 mismatch in age is of huge concern. Furthermore, although age, and pubertal stage,
22 are important considerations for future research, configural processing of
23 appearance-related stimuli was evident and intact in the adolescent sample
24 presented in Experiment 1. As both low- and high- risk adolescents were selected
25 from Experiment 1, this would suggest that any changes to appearance-related

1 visual processing from adolescence to adulthood are unlikely to account for our
2 findings.

3 It should also be noted that Body Mass Index (BMI) information was not obtained.
4 This was because taking such measurements may be triggering to those with eating
5 disorders, and because the research questions presented in these studies were not
6 concerned specifically with BMI. Previous investigations suggest that those in
7 recovery from eating disorders do not necessarily differ from controls in terms of BMI
8 (e.g. Groves et al., 2017). Given that, we do not think differences in BMI would
9 explain our results. However, it is possible that taking actual body size into account
10 could inform the wider understanding of how, if at all, altered appearance-related
11 visual processing manifests in disorders characterised by body image disturbance,
12 as well as in those at risk. It would therefore be of interest to obtain participants'
13 body measurements in future studies of a similar nature in settings where this can be
14 done in a safe way.

15

16 **6 Conclusions**

17 Configural processing for both bodies and faces in adolescent men and women was
18 intact and unrelated to self-reported levels of BIC and self-objectification. As a result,
19 it is unlikely that atypical visual processing mechanisms contribute to the increased
20 vulnerability toward developing EDs and BDD that young people experience as a
21 group. However, BIC and self-objectification were found to be higher in young
22 women compared to young men, which may help to explain why being female
23 increases the risk of developing an ED or BDD (Striegel-Moore & Bulik, 2007). This

1 seems to be especially true, as some of these young women showed increased
2 vulnerability to BIC and self-objectification.

3

4 Adolescent women in the high risk group showed altered configural body processing,
5 as their discrimination accuracy was no higher for upright than inverted bodies.

6 Further to this, they took longer when discriminating body stimuli, suggestive of
7 attentional differences that may reflect either a threat response to bodies, or an

8 overevaluation of body weight and shape. It is important for future research to

9 address the underlying mechanisms associated with attentional differences to body
10 stimuli in at-risk and clinical populations.

11

12 For the first time, we also report evidence for potential deficits in configural body
13 processing in women recovering from disorders characterised by body image

14 disturbance and self-objectification, as typical BIEs (lower and less accurate

15 responses to inverted body stimuli compared to upright) were not observed in the

16 BID group. Given that these women were generally quicker to respond, and were

17 also more accurate when discriminating houses, perhaps a local processing bias

18 underpins this altered processing, although it also suggests that such a perceptual

19 bias is not completely specific to illness-relevant stimuli (i.e., bodies) in this

20 population.

21

22 Therefore, not only does it seem that feature-based body processing might be an

23 ongoing maladaptation evident in women recovering from disorders characterised by

1 BID and self-objectification, but that this altered processing style may also be evident
2 in non-clinical individuals with high BIC and self-objectification, who are thus
3 potentially at risk of developing illnesses characterised by BID (Calogero et al., 2005;
4 Lambrou et al., 2011; Strelan & Hargreaves, 2005). As such, these findings are of
5 direct relevance to research that investigates strategies for identifying at-risk
6 individuals and/or for monitoring and predicting successful recovery in those already
7 affected.

8

9 While this study documented evidence for potential differences at the group level,
10 behavioural performance (inversion effects) did not systematically relate with BIC or
11 self-objectification, however. It is not possible at this time therefore, to conclude that
12 altered visual perception of the human body is directly related to high levels of BIC or
13 self-objectification.

14

15 **7. References**

- 16 Abbott, Bree D, & Barber, Bonnie L. (2010). Embodied image: Gender differences in
17 functional and aesthetic body image among Australian adolescents. *Body*
18 *Image*, 7(1), 22-31.
- 19 American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of*
20 *Mental Disorders (DSM-5®)*. Arlington: American Psychiatric Publishing.
- 21 Amir, N., Elias, J., Klumpp, H., & Przeworski, A. (2003). Attentional bias to threat in
22 social phobia: Facilitated processing of threat or difficulty disengaging

- 1 attention from threat? *Behaviour Research and Therapy*, 41(11), 1325-1335.
 2 doi: 10.1016/s0005-7967(03)00039-1
- 3 Arcelus, J., Mitchell, A. J., Wales, J., & Nielsen, S. (2011). Mortality rates in patients
 4 with anorexia nervosa and other eating disorders: A meta-analysis of 36
 5 studies. *Archives of General Psychiatry*, 68(7), 724-731. doi:
 6 10.1001/archgenpsychiatry.2011.74
- 7 Beilharz, Francesca L., Atkins, Kelly J., Duncum, Anna J. F., & Mundy, Matthew E.
 8 (2016). Altering visual perception abnormalities: A marker for body image
 9 concern. *PLoS ONE*, 11(3), e0151933. doi: 10.1371/journal.pone.0151933
- 10 Benjamini, Yoav, & Hochberg, Yosef. (1995). Controlling the false discovery rate: a
 11 practical and powerful approach to multiple testing. *Journal of the Royal*
 12 *Statistical Society. Series B (Methodological)*, 289-300.
- 13 Bindemann, Markus, Burton, A. Mike, Hooge, Ignace T. C., Jenkins, Rob, & de Haan,
 14 Edward H. F. (2005). Faces retain attention. *Psychonomic Bulletin & Review*,
 15 12(6), 1048-1053. doi: 10.3758/BF03206442
- 16 Bjornsson, Andri S., Didie, Elizabeth R., Grant, Jon E., Menard, William, Stalker,
 17 Emily, & Phillips, Katharine A. (2013). Age at onset and clinical correlates in
 18 body dysmorphic disorder. *Comprehensive Psychiatry*, 54(7), 893-903. doi:
 19 10.1016/j.comppsy.2013.03.019
- 20 Blakemore, Sarah-Jayne. (2008). The social brain in adolescence. *Nature Reviews*
 21 *Neuroscience*, 9(4), 267-277. doi: 10.1038/nrn2353
- 22 Blakemore, Sarah-Jayne, & Mills, Kathryn L. (2014). Is adolescence a sensitive
 23 period for sociocultural processing? *Annual Review of Psychology*, 65(1),
 24 187-207. doi: 10.1146/annurev-psych-010213-115202

- 1 Blechert, J, Nickert, T, Caffier, D, & Tuschen-Caffier, B. (2009). Social comparison
2 and its relation to body dissatisfaction in bulimia nervosa: evidence from eye
3 movements. *Psychosomatic Medicine*, 71(8), 907-912. doi:
4 10.1097/PSY.0b013e3181b4434d
- 5 Buchanan, Ben G, Rossell, Susan L, & Castle, David J. (2011). Body dysmorphic
6 disorder: a review of nosology, cognition and neurobiology. *Neuropsychiatry*,
7 1(1), 71-80.
- 8 Busey, Thomas A., & Vanderkolk, John R. (2005). Behavioral and
9 electrophysiological evidence for configural processing in fingerprint experts.
10 *Vision Research*, 45(4), 431-448.
- 11 Callaghan, Glenn M., Lopez, Albertina, Wong, Lily, Northcross, Jasalynne, &
12 Anderson, Kristina R. (2011). Predicting consideration of cosmetic surgery in
13 a college population: A continuum of body image disturbance and the
14 importance of coping strategies. *Body Image*, 8(3), 267-274.
- 15 Calogero, Rachel M. (2012). Objectification theory, self-objectification, and body
16 image. *Encyclopedia of body image and human appearance*, 2, 574-580.
- 17 Calogero, Rachel M., Davis, William N., & Thompson, J. Kevin. (2005). The role of
18 self-objectification in the experience of women with eating disorders. *Sex*
19 *Roles*, 52(1-2), 43-50. doi: 10.1007/s11199-005-1192-9
- 20 Cash, Thomas F. (2012). *Encyclopedia of body image and human appearance*:
21 Academic Press.
- 22 Cash, Thomas F. (2004). Body image: past, present, and future. *Body Image*, 1(1),
23 1-5.
- 24 Cohen Kadosh, Kathrin, Johnson, Mark H., Dick, Frederic, Cohen Kadosh, Roi, &
25 Blakemore, Sarah-Jayne. (2013). Effects of Age, Task Performance, and

- 1 Structural Brain Development on Face Processing. *Cerebral Cortex*, 23(7),
2 1630-1642. doi: 10.1093/cercor/bhs150
- 3 Corning, Alexandra F., Krumm, Angela J., & Smitham, Lora A. (2006). Differential
4 social comparison processes in women with and without eating disorder
5 symptoms. *Journal of Counseling Psychology*, 53(3), 338-349. doi:
6 10.1037/0022-0167.53.3.338
- 7 Cororve, Michelle B., & Gleaves, David H. (2001). Body dysmorphic disorder: a
8 review of conceptualizations, assessment, and treatment strategies. *Clinical*
9 *Psychology Review*, 21(6), 949-970. doi: 10.1016/S0272-7358(00)00075-1
- 10 Dingemans, Alexandra E., van Rood, Yanda R., de Groot, Ineke, & van Furth, Eric F.
11 (2012). Body dysmorphic disorder in patients with an eating disorder:
12 Prevalence and characteristics. *The International Journal of Eating Disorders*,
13 45(4), 562-569. doi: 10.1002/eat.20972
- 14 Duncum, A. J. F., Atkins, K. J., Beilharz, F. L., & Mundy, M. E. (2016). Abnormalities
15 in the visual processing of viewing complex visual stimuli amongst individuals
16 with body image concern. *Advances in Cognitive Psychology*, 12(1), 39-49.
17 doi: 10.5709/acp-0185-0
- 18 Feusner, Jamie D., Moller, Hayley, Altstein, Lily, Sugar, Catherine, Bookheimer,
19 Susan, Yoon, Joanne, & Hembacher, Emily. (2010). Inverted face processing
20 in body dysmorphic disorder. *Journal of Psychiatric Research*, 44(15), 1088-
21 1094.
- 22 Feusner, Jamie D., Neziroglu, Fugen, Wilhelm, Sabine, Mancusi, Lauren, & Bohon,
23 Cara. (2010). What Causes BDD: Research findings and a proposed model.
24 *Psychiatric Annals*, 40(7), 349-355.

- 1 Fox, Elaine, Russo, Riccardo, Bowles, Robert, & Dutton, Kevin. (2001). Do
2 threatening stimuli draw or hold visual attention in subclinical anxiety? *Journal*
3 *of Experimental Psychology: General*, 130(4), 681-700. doi: 10.1037/0096-
4 3445.130.4.681
- 5 Fredrickson, Barbara L, Roberts, Tomi-Ann, Noll, Stephanie M, Quinn, Diane M, &
6 Twenge, Jean M. (1998). That swimsuit becomes you: Sex differences in self-
7 objectification, restrained eating, and math performance. *Journal of*
8 *Personality and Social Psychology*, 75(1), 269.
- 9 Fredrickson, Barbara L, & Roberts, Tomi-Ann. (1997). Objectification theory.
10 *Psychology of Women Quarterly*, 21(2), 173-206.
- 11 Furnham, Adrian, Badmin, Nicola, & Sneade, Ian. (2002). Body image
12 dissatisfaction: Gender differences in eating attitudes, self-esteem, and
13 reasons for exercise. *The Journal of Psychology*, 136(6), 581-596. doi:
14 10.1080/00223980209604820
- 15 Gauthier, Isabel, & Tarr, Michael J. (1997). Becoming a "Greeble"expert: Exploring
16 mechanisms for face recognition. *Vision Research*, 37(12), 1673-1682.
- 17 Ghadakzadeh, Saber, Ghazipour, Ali, Khajeddin, Niloufar, Karimian, Negar, &
18 Borhani, Mehrdad. (2011). Body Image Concern Inventory (BICI) for
19 identifying patients with BDD seeking rhinoplasty: Using a Persian (Farsi)
20 version. *Aesthetic Plastic Surgery*, 35(6), 989-994. doi: 10.1007/s00266-011-
21 9718-8
- 22 Gotlib, Ian H., Krasnoperova, Elena, Yue, Dana Neubauer, & Joormann, Jutta.
23 (2004). Attentional biases for negative interpersonal stimuli in clinical
24 depression. *Journal of Abnormal Psychology*, 113(1), 127-135. doi:
25 10.1037/0021-843X.113.1.121

- 1 Grant, Jon E., & Phillips, Katharine A. (2004). Is anorexia nervosa a subtype of body
2 dysmorphic disorder? Probably not, but read on *Harvard Review of*
3 *Psychiatry*, 12(2), 123-126. doi: 10.1080/10673220490447236
- 4 Groves, Katie, Kennett, Steffan, & Gillmeister, Helge. (2017). Evidence for ERP
5 biomarkers of eating disorder symptoms in women. *Biological Psychology*.
6 doi: 10.1016/j.biopsycho.2016.12.016
- 7 Halliwell, Emma, & Dittmar, Helga. (2004). Does size matter? The impact of model's
8 body size on women's body-focused anxiety and advertising effectiveness.
9 *Journal of Social and Clinical Psychology*, 23(1), 104.
- 10 Hargreaves, Duane A., & Tiggemann, Marika. (2004). Idealized media images and
11 adolescent body image: "Comparing" boys and girls. *Body Image*, 1(4), 351-
12 361.
- 13 Harris, E C, & Barraclough, B. (1997). Suicide as an outcome for mental disorders. A
14 meta-analysis. *The British Journal of Psychiatry*, 170(3), 205-228. doi:
15 10.1192/bjp.170.3.205
- 16 Hartmann, A. S., Thomas, J. J., Greenberg, J. L., Elliott, C. M., Matheny, N. L., &
17 Wilhelm, S. (2015). Anorexia nervosa and body dysmorphic disorder: A
18 comparison of body image concerns and explicit and implicit attractiveness
19 beliefs. *Body Image*, 14, 77-84.
- 20 Hartmann, Andrea S., Greenberg, Jennifer L., & Wilhelm, Sabine. (2013). The
21 relationship between anorexia nervosa and body dysmorphic disorder. *Clinical*
22 *Psychology Review*, 33(5), 675-685.
- 23 Horndasch, Stefanie, Kratz, Oliver, Holczinger, Anna, Heinrich, Hartmut, Hönig,
24 Florian, Nöth, Elmar, & Moll, Gunther H. (2012). "Looks do matter"—visual

- 1 attentional biases in adolescent girls with eating disorders viewing body
2 images. *Psychiatry Research*, 198(2), 321-323.
- 3 Howell, DC. (2010). *Statistical Methods for Psychology* (8th ed.). Belmont, CA:
4 Cengage Wadsworth.
- 5 Husk, Jesse S., Bennett, Patrick J., & Sekuler, Allison B. (2007). Inverting houses
6 and textures: Investigating the characteristics of learned inversion effects.
7 *Vision Research*, 47(27), 3350-3359.
- 8 Jansen, Anita, Nederkoorn, Chantal, & Mulkens, Sandra. (2005). Selective visual
9 attention for ugly and beautiful body parts in eating disorders. *Behaviour*
10 *Research and Therapy*, 43(2), 183-196.
- 11 Jolanta, J Rabe-Jablonska, & Tomasz, M Sobow. (2000). The links between body
12 dysmorphic disorder and eating disorders. *European Psychiatry*, 15(5), 302-
13 305.
- 14 Jones, Diane Carlson. (2001). Social comparison and body image: Attractiveness
15 comparisons to models and peers among adolescent girls and boys. *Sex*
16 *Roles*, 45(9-10), 645-664.
- 17 Jongenelis, M. I., Byrne, S. M., & Pettigrew, S. (2014). Self-objectification, body
18 image disturbance, and eating disorder symptoms in young Australian
19 children. *Body Image*, 11(3), 290-302. doi: 10.1016/j.bodyim.2014.04.002
- 20 Jorgensen, Lisa, Castle, David, Roberts, Clare, & Groth-Marnat, Gary. (2001). A
21 clinical validation of the Dysmorphic Concern Questionnaire. *Australian and*
22 *New Zealand Journal of Psychiatry*, 35(1), 124-128.
- 23 Kerwin, Lauren, Hovav, Sarit, Helleman, Gerhard, & Feusner, Jamie D. (2014).
24 Impairment in local and global processing and set-shifting in body dysmorphic

- 1 disorder. *Journal of Psychiatric Research*, 57, 41-50. doi:
2 10.1016/j.jpsychires.2014.06.003
- 3 Knauss, Christine, Paxton, Susan, & Alsaker, Françoise. (2008). Body
4 Dissatisfaction in Adolescent Boys and Girls: Objectified Body
5 Consciousness, Internalization of the Media Body Ideal and Perceived
6 Pressure from Media. *Sex Roles*, 59(9-10), 633-643. doi: 10.1007/s11199-
7 008-9474-7
- 8 Koster, E. H., Crombez, G., Verschuere, B., & De Houwer, J. (2004). Selective
9 attention to threat in the dot probe paradigm: Differentiating vigilance and
10 difficulty to disengage. *Behaviour Research and Therapy*, 42(10), 1183-1192.
11 doi: 10.1016/j.brat.2003.08.001
- 12 Koster, E. H., De Raedt, R., Goeleven, E., Franck, E., & Crombez, G. (2005). Mood-
13 congruent attentional bias in dysphoria: maintained attention to and impaired
14 disengagement from negative information. *Emotion*, 5(4), 446-455. doi:
15 10.1037/1528-3542.5.4.446
- 16 Lambrou, Christina, Veale, David, & Wilson, Glenn. (2011). The role of aesthetic
17 sensitivity in body dysmorphic disorder. *Journal of Abnormal Psychology*,
18 120(2), 443-453. doi: 10.1037/a0022300
- 19 Lang, Katie, Lopez, Carolina, Stahl, Daniel, Tchanturia, Kate, & Treasure, Janet.
20 (2014). Central coherence in eating disorders: An updated systematic review
21 and meta-analysis. *The World Journal of Biological Psychiatry*, 15(8), 586-
22 598. doi: 10.3109/15622975.2014.909606
- 23 Littleton, Heather, & Breitkopf, Carmen Radecki. (2008). The Body Image Concern
24 Inventory: Validation in a multiethnic sample and initial development of a

- 1 Spanish language version. *Body Image*, 5(4), 381-388. doi:
2 10.1016/j.bodyim.2008.06.004
- 3 Littleton, Heather L., Axsom, Danny, & Pury, Cynthia L. S. (2005). Development of
4 the body image concern inventory. *Behaviour Research and Therapy*, 43(2),
5 229-241.
- 6 Lopez, Carolina, Tchanturia, Kate, Stahl, Daniel, & Treasure, Janet. (2009). Weak
7 central coherence in eating disorders: A step towards looking for an
8 endophenotype of eating disorders. *Journal of Clinical and Experimental*
9 *Neuropsychology*, 31(1), 117-125. doi: 10.1080/13803390802036092
- 10 Mai, S., Gramann, K., Herbert, B. M., Friederich, H. C., Warschburger, P., &
11 Pollatos, O. (2015). Electrophysiological evidence for an attentional bias in
12 processing body stimuli in bulimia nervosa. *Biological Psychology*, 108, 105-
13 114. doi: 10.1016/j.biopsycho.2015.03.013
- 14 Mancuso, Serafino G, Knoesen, Natalie P, & Castle, David J. (2010). The
15 Dysmorphic Concern Questionnaire: A screening measure for body
16 dysmorphic disorder. *Australian and New Zealand Journal of Psychiatry*,
17 44(6), 535-542.
- 18 Maurer, Daphne, Le Grand, Richard, & Mondloch, Catherine J. (2002). The many
19 faces of configural processing. *Trends in Cognitive Sciences*, 6(6), 255-260.
- 20 Mazzeo, Suzanne E. (1999). Modification of an existing measure of body image
21 preoccupation and its relationship to disordered eating in female college
22 students. *Journal of Counseling Psychology*, 46(1), 42-50. doi: 10.1037/0022-
23 0167.46.1.42
- 24 McClelland, Gary H, & Judd, Charles M. (1993). Statistical difficulties of detecting
25 interactions and moderator effects. *Psychological Bulletin*, 114(2), 376-390.

- 1 Miner-Rubino, Kathi, Twenge, Jean M., & Fredrickson, Barbara L. (2002). Trait Self-
2 Objectification in Women: Affective and Personality Correlates. *Journal of*
3 *Research in Personality*, 36(2), 147-172.
- 4 Minnebusch, D A., & Daum, I. (2009). Neuropsychological mechanisms of visual
5 face and body perception. *Neuroscience & Biobehavioral Reviews*, 33(7),
6 1133-1144. doi: 10.1016/j.neubiorev.2009.05.008
- 7 Minnebusch, D A., Keune, P M., Suchan, B., & Daum, I. (2010). Gradual inversion
8 affects the processing of human body shapes. *NeuroImage*, 49(3), 2746-
9 2755. doi: 10.1016/j.neuroimage.2009.10.046
- 10 Minnebusch, D A., Suchan, Boris., & Daum, Irene. (2009). Losing your head:
11 Behavioral and electrophysiological effects of body inversion. *Journal of*
12 *Cognitive Neuroscience*, 21(5), 865-874. doi: 10.1162/jocn.2009.21074
- 13 Mitchison, D., Crino, R., & Hay, P. (2013). The presence, predictive utility, and
14 clinical significance of body dysmorphic symptoms in women with eating
15 disorders. *Journal of Eating Disorders*, 1, 20. doi: 10.1186/2050-2974-1-20
- 16 Mondloch, Catherine J, Le Grand, Richard, & Maurer, Daphne. (2002). Configural
17 face processing develops more slowly than featural face processing.
18 *Perception*, 31(5), 553-566.
- 19 Mundy, E, Matthew, & Sadusky, Andrea. (2014). Abnormalities in visual processing
20 amongst students with body image concerns. *Advances in Cognitive*
21 *Psychology*, 10(2), 39-48. doi: 10.5709/acp-0155-4
- 22 Muth, Jennifer L., & Cash, Thomas F. (1997). Body-image attitudes: What difference
23 does gender make? *Journal of Applied Social Psychology*, 27(16), 1438-1452.
24 doi: 10.1111/j.1559-1816.1997.tb01607.x

- 1 Noll, Stephanie M, & Fredrickson, Barbara L. (1998). A mediational model linking
2 self-objectification, body shame, and disordered eating. *Psychology of*
3 *Women Quarterly*, 22(4), 623-636.
- 4 Papadopoulos, Fotios C, Ekblom, Anders, Brandt, Lena, & Ekselius, Lisa. (2009).
5 Excess mortality, causes of death and prognostic factors in anorexia nervosa.
6 *The British Journal of Psychiatry*, 194(1), 10-17. doi:
7 10.1192/bjp.bp.108.054742
- 8 Phillips, Katharine A, Coles, Meredith E, Menard, William, Yen, Shirley, Fay,
9 Christina, & Weisberg, Risa B. (2005). Suicidal ideation and suicide attempts
10 in body dysmorphic disorder. *The Journal of Clinical Psychiatry*, 66(6), 717-
11 725.
- 12 Phillips, Katharine A, Kim, Jennie M, & Hudson, James I. (1995). Body image
13 disturbance in body dysmorphic disorder and eating disorders. Obsessions or
14 delusions? *The Psychiatric Clinics of North America*, 18(2), 317-334.
- 15 Reed, Catherine L, Stone, Valerie E, Grubb, Jefferson D, & McGoldrick, John E.
16 (2006). Turning configural processing upside down: Part and whole body
17 postures. *Journal of Experimental Psychology: Human Perception and*
18 *Performance*, 32(1), 73-87.
- 19 Reed, Catherine L., Stone, Valerie E., Bozova, Senia, & Tanaka, James. (2003). The
20 body-inversion effect. *Psychological Science*, 14(4), 302-308.
- 21 Riva, Giuseppe, Gaudio, Santino, & Dakanalis, Antonios. (2015). The
22 neuropsychology of self-objectification. *European Psychologist*, 34-43.
- 23 Robbins, Rachel A., & Coltheart, Max. (2012). The effects of inversion and familiarity
24 on face versus body cues to person recognition. *Journal of Experimental*

- 1 *Psychology: Human Perception and Performance*, 38(5), 1098-1104. doi:
2 10.1037/a0028584
- 3 Roefs, Anne, Jansen, Anita, Moresi, Sofie, Willems, Paul, van Grootel, Sara, & van
4 der Borgh, Anouk. (2008). Looking good. BMI, attractiveness bias and visual
5 attention. *Appetite*, 51(3), 552-555.
- 6 Rosen, James C., & Ramirez, Elena. (1998). A comparison of eating disorders and
7 body dysmorphic disorder on body image and psychological adjustment.
8 *Journal of Psychosomatic Research*, 44(3-4), 441-449.
- 9 Ruffolo, Jessica S., Phillips, Katharine A., Menard, William, Fay, Christina, &
10 Weisberg, Risa B. (2006). Comorbidity of body dysmorphic disorder and
11 eating disorders: Severity of psychopathology and body image disturbance.
12 *The International Journal of Eating Disorders*, 39(1), 11-19.
- 13 Smolak, Linda. (2004). Body image in children and adolescents: where do we go
14 from here? *Body Image*, 1(1), 15-28.
- 15 Steinberg, Laurence. (2005). Cognitive and affective development in adolescence.
16 *Trends in Cognitive Sciences*, 9(2), 69-74.
- 17 Strelan, Peter, & Hargreaves, Duane. (2005). Women who objectify other women:
18 The vicious circle of objectification? *Sex Roles*, 52(9), 707-712. doi:
19 10.1007/s11199-005-3737-3
- 20 Striegel-Moore, Ruth H, & Bulik, Cynthia M. (2007). Risk factors for eating disorders.
21 *American Psychologist*, 62(3), 181.
- 22 Striegel-Moore, Ruth H, Dohm, Faith A, Kraemer, Helena C, Taylor, C Barr, Daniels,
23 Stephen, Crawford, Patricia B, & Schreiber, George B. (2003). Eating
24 disorders in white and black women. *American Journal of Psychiatry*, 160(7),
25 1326-1331.

- 1 Striegel-Moore, Ruth H., Silberstein, Lisa R., & Rodin, Judith. (1993). The social self
2 in bulimia nervosa: Public self-consciousness, social anxiety, and perceived
3 fraudulence. *Journal of Abnormal Psychology, 102*(2), 297-303. doi:
4 10.1037/0021-843X.102.2.297
- 5 Suchan, Boris, Vocks, Silja, & Waldorf, Manuel. (2015). Alterations in activity,
6 volume, and connectivity of body-processing brain areas in anorexia nervosa.
7 *European Psychologist*. doi: doi:10.1027/1016-9040/a000213
- 8 Sullivan, Patrick F. (1995). Mortality in anorexia nervosa. *American Journal of*
9 *Psychiatry, 152*(7), 1073-1074.
- 10 Taylor, Margot J, Edmonds, Gillian E, McCarthy, Gregory, & Allison, Truett. (2001).
11 Eyes first! Eye processing develops before face processing in children.
12 *NeuroReport, 12*(8), 1671-1676.
- 13 Tottenham, Nim, Tanaka, James W., Leon, Andrew C., McCarry, Thomas, Nurse,
14 Marcella, Hare, Todd A., . . . Nelson, Charles. (2009). The NimStim set of
15 facial expressions: Judgments from untrained research participants.
16 *Psychiatry Research, 168*(3), 242-249. doi: 10.1016/j.psychres.2008.05.006
- 17 Uher, R., Murphy, T., Friederich, H. C., Dalgleish, T., Brammer, M. J., Giampietro,
18 V., . . . Treasure, J. (2005). Functional neuroanatomy of body shape
19 perception in healthy and eating-disordered women. *Biological Psychiatry,*
20 *58*(12), 990-997. doi: 10.1016/j.biopsych.2005.06.001
- 21 Urgesi, Cosimo, Fornasari, Livia, Canalaz, Francesca, Perini, Laura, Cremaschi,
22 Silvana, Faleschini, Laura, . . . Brambilla, Paolo. (2014). Impaired configural
23 body processing in anorexia nervosa: evidence from the body inversion effect.
24 *British Journal of Psychology, 105*(4), 486-508. doi: 10.1111/bjop.12057

- 1 Urgesi, Cosimo, Fornasari, Livia, Perini, Laura, Canalaz, Francesca, Cremaschi,
2 Silvana, Faleschini, Laura, . . . Brambilla, Paolo. (2012). Visual body
3 perception in anorexia nervosa. *International Journal of Eating Disorders*,
4 45(4), 501-511. doi: 10.1002/eat.20982
- 5 Vocks, Silja, Busch, Martin, Grönemeyer, Dietrich, Schulte, Dietmar, Herpertz,
6 Stephan, & Suchan, Boris. (2010). Neural correlates of viewing photographs
7 of one's own body and another woman's body in anorexia and bulimia
8 nervosa: An fMRI study. *Journal of Psychiatry & Neuroscience*, 35(3), 163-
9 176. doi: 10.1503/jpn.090048
- 10 Yin, Robert K. (1969). Looking at upside-down faces. *Journal of Experimental*
11 *Psychology*, 81(1), 141-145. doi: 10.1037/h0027474
- 12 Yovel, Galit, Pelc, Tatiana, & Lubetzky, Ida. (2010). It's all in your head: Why is the
13 body inversion effect abolished for headless bodies? *Journal of Experimental*
14 *Psychology: Human Perception and Performance*, 36(3), 759-767. doi:
15 10.1037/a0017451
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1 **8. Tables and Figures**

2 Presented as they appear within the text.

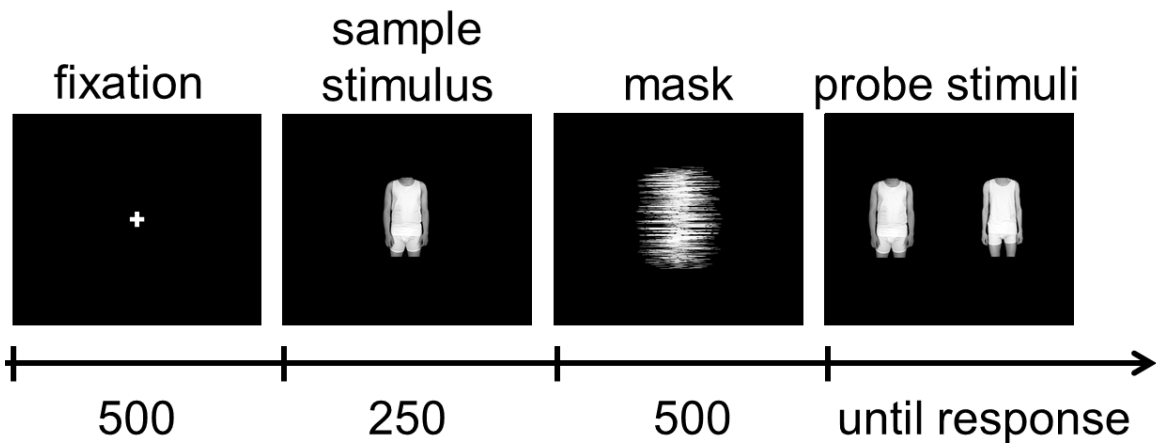
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Figure 1. Example stimuli controlled for overall image brightness and presented greyscale on a black background. On the left, a neutral male face; in the middle, a female body; and on the right, a house.

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Figure 2. Stimulus sequence and timeline (in ms) of one upright body trial. Sequence and timing was the same for all upright and inverted body, face and house trials.

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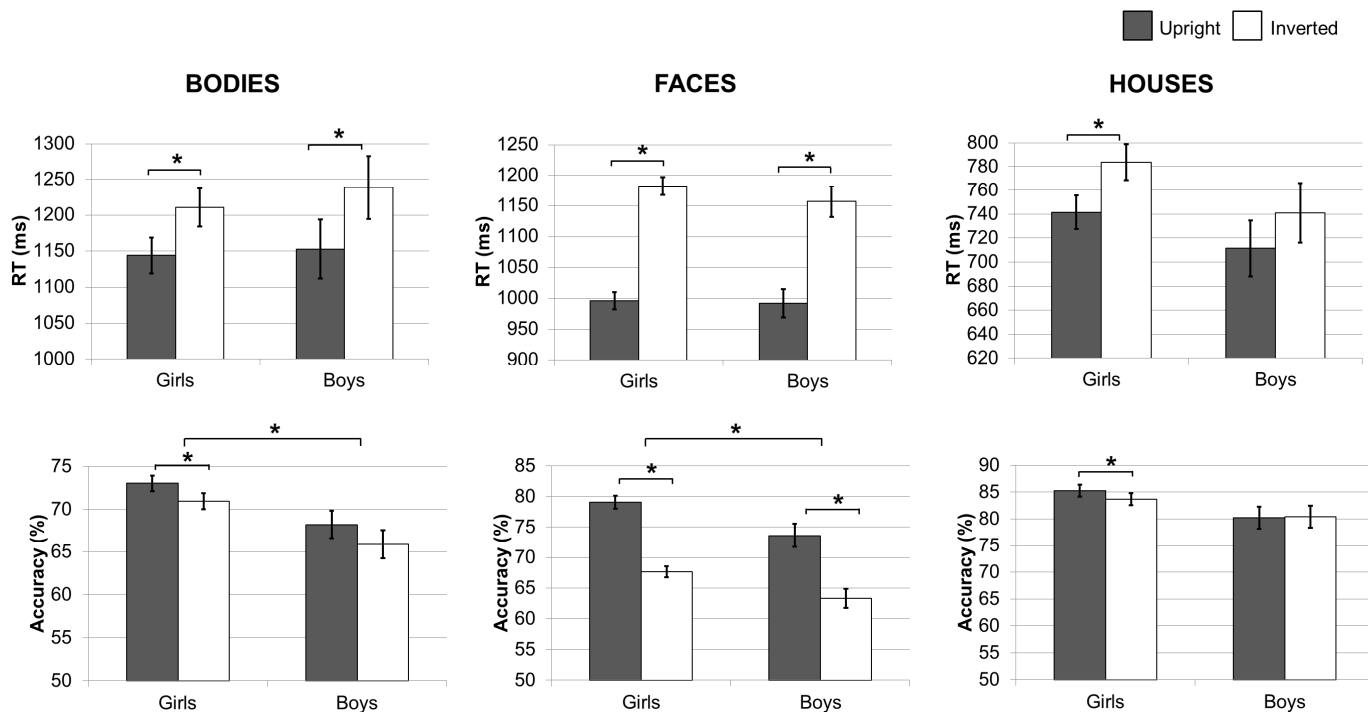
Table 1

Average age and questionnaire scores of young men ($n = 58$) and young women ($n = 160$) in the sample. Four young men and seven young women did not complete the SOQ correctly so their data were discarded for that measure.

	Age (years)	BICI Score	Self-Objectification Score
Young women	17.36 (1.63)	56.35 (13.53)	1.51 (13.15)
Young men	17.26 (2.59)	43.03 (10.07)	-8.13 (12.36)

Note: Standard deviation in parentheses.

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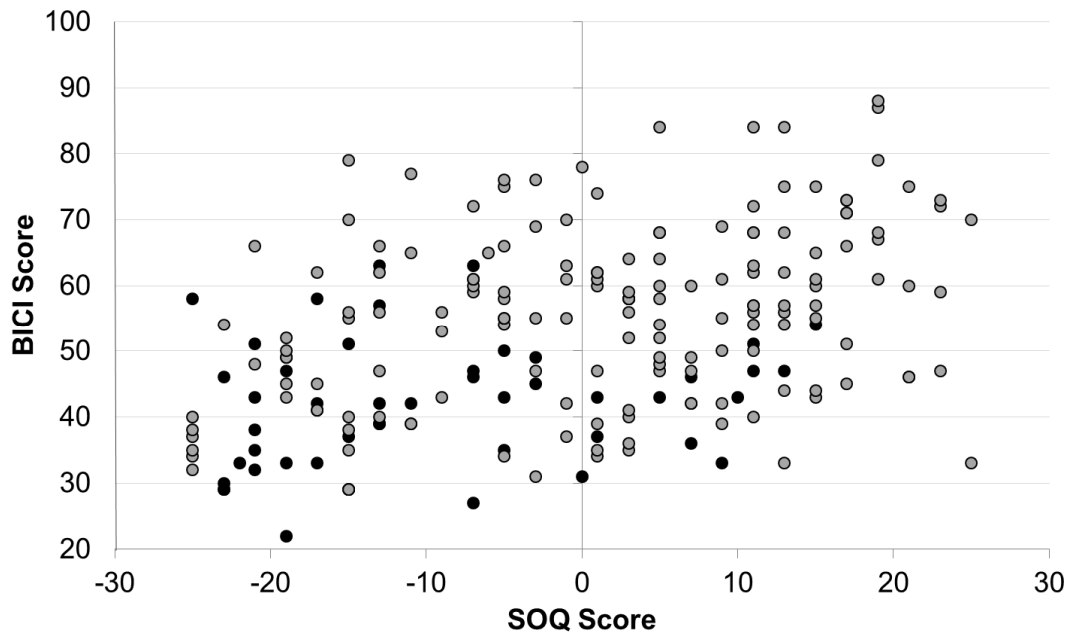


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Figure 3. Top panel shows RT (ms), bottom panel shows accuracy (%), reported for young men and women. RT and accuracy to bodies can be seen in the left panel, faces in the middle panel and houses in the right panel. Responses to upright stimuli are depicted in grey and responses to inverted stimuli are depicted in white. Error bars depict standard error of the means and asterisks indicate significant pairwise comparisons.

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Figure 4. Moderate positive relationship between SOQ score and BICI score, $r(205) = .41$, $p < .001$, with young men's data in black, and young women's data in grey.

2

Table 2

Body image disturbance (BID) group diagnostic and treatment information.

	Total	Recovered	Partially recovered	Unrecovered	Medicated	Counselled
AN	22	8	14	0	1	0
BN	9	4	3	2	0	0
BDD	3	0	1	2	0	0
AN & BN	5	1	4	0	1	1
AN & BDD	3	0	3	0	1	0
BN & BDD	1	-	1	-	0	0
AN & EDNOS	1	1	-	-	0	0
BDD & EDNOS	1	1	-	-	0	0

Note. Anorexia Nervosa (AN), Bulimia Nervosa (BN), Body Dysmorphic Disorder (BDD), Eating Disorder Not Otherwise Specified (EDNOS). Treatment referred to was current at time of testing. One anorexic participant was medicated with oestrogen as an aid to induce the menstrual cycle, one participant with co-morbid anorexia and bulimia was medicated to increase potassium levels and aid depression whilst one

participant with co-morbid anorexia and BDD was also medicated to aid depression.

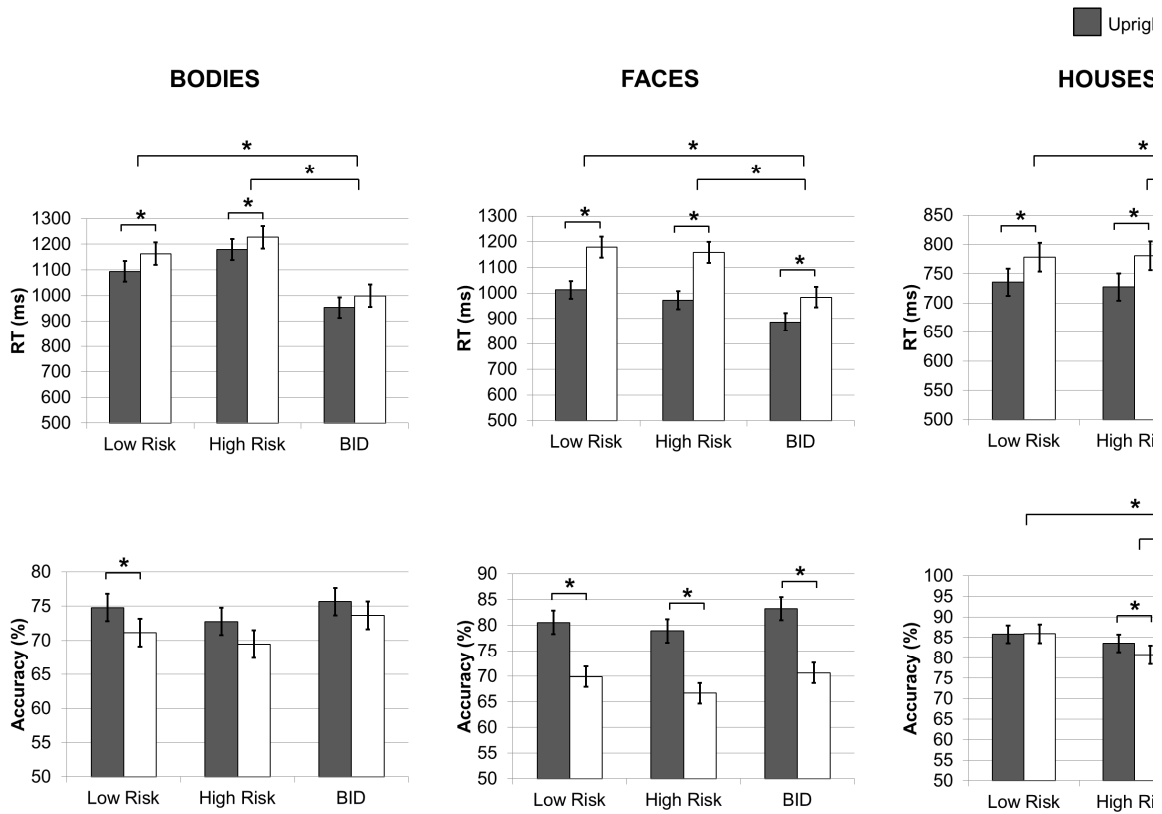


Figure 6. Top panel shows RT (ms), bottom panel shows accuracy (%), reported for low risk, high risk and BID groups. RT and accuracy to bodies are shown in the left panel, faces in the middle panel and houses in the right panel. Upright stimuli are depicted in grey and inverted stimuli are depicted in white. Error bars depict standard error and asterisks indicate significant pairwise comparisons.

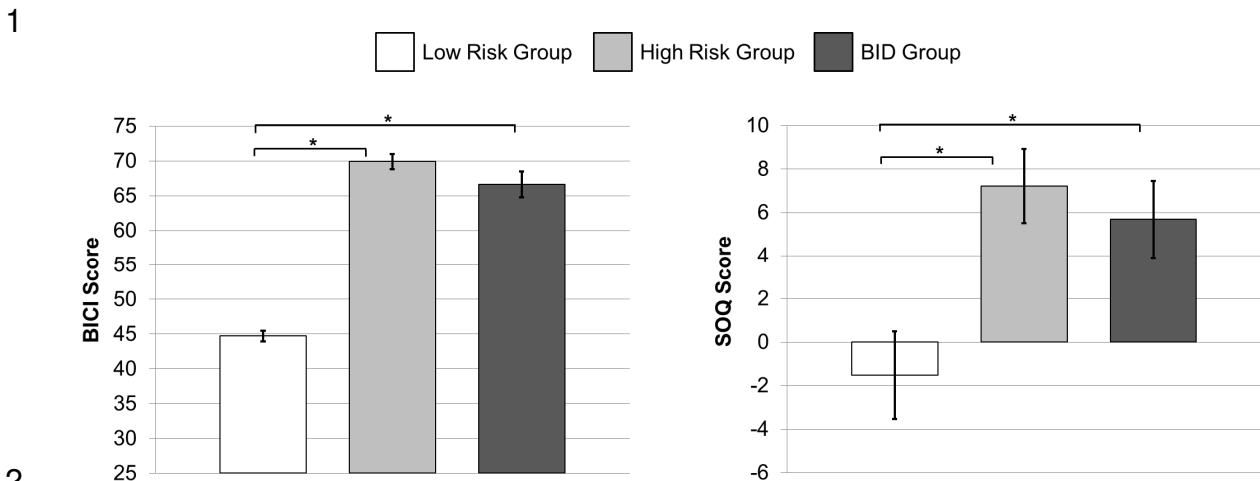


Figure 5. Left panel shows BICI scores and right panel shows SOQ scores. The low risk group is depicted in white, the high risk group in light grey and the BID group in dark grey.

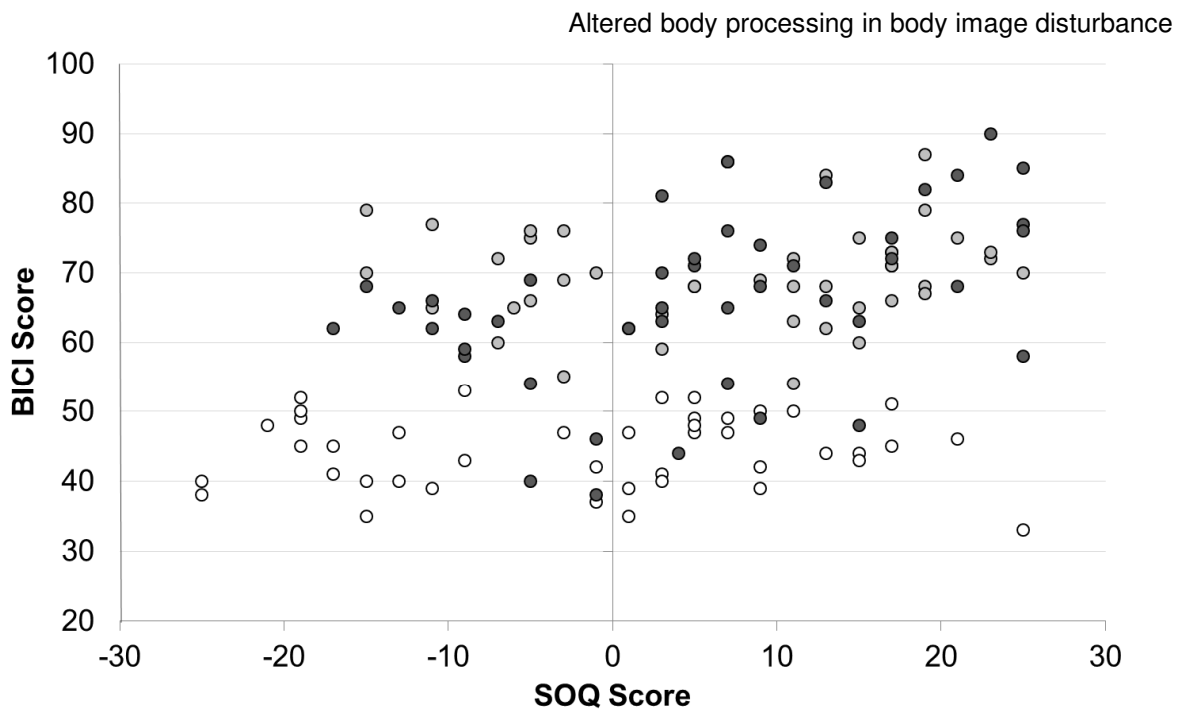


Figure 7. Moderate positive relationship between SOQ score and BICI score, $r(133) = .37$, $p < .001$, with data from the low risk group depicted in white, data from the high risk group depicted in light grey, and data from the BID group depicted in dark grey.

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