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

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Abstract

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

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

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

1. Introduction

Body image is described as a multi-dimensional construct that reflects the malleable, conscious representation a person has of their bodily self. This includes subjective emotions and cognitions relating to appearance satisfaction (Cash, 2012; Cash, 2004). As such, body image exists on a spectrum of body image concern (BIC; Callaghan, Lopez, Wong, Northcross, & Anderson, 2011), which can be understood as the amount of concern an individual has about their physical appearance, ranging from healthy or 'positive' to unhealthy (Mundy & Sadusky, 2014). At the extreme negative end of the spectrum, these concerns manifest as body image distortions, which are reported to the point of delusion in some psychiatric conditions (Phillips, Kim, & Hudson, 1995). In particular, perceived flaws in appearance, that are often unnoticeable or considered to be minor by others, are characteristic of mental illnesses such as anorexia nervosa, bulimia nervosa and body dysmorphic disorder (BDD) (American Psychiatric Association, 2013). However, there are subtle symptomatic differences between the conditions, showing that those with anorexia and/or bulimia tend to overemphasise the importance of body weight and shape, focusing on their own 'fat' and/or 'ugly' body parts but directing attention to others' 'beautiful' body parts (Jansen, Nederkoorn, & Mulkens, 2005). In contrast, although bodily concerns may be present, those with BDD are more likely to find themselves preoccupied with facial-, skin- or hair-related appearance concerns (Feusner, Neziroglu, Wilhelm, Mancusi, & Bohon, 2010). As a result, the DSM-5 classifies anorexia and bulimia under ‘feeding and eating disorders,’ whilst BDD is referred to on the obsessive-compulsive spectrum. However, it has been argued that these conditions might be better understood as interrelated body image disorders (Cororve & Gleaves, 2001) due to their shared symptomatology such as body image disturbance, severe psychological distress and reduced psychosocial functioning (Harris & Barraclough, 1997; Mitchison, Crino, & Hay, 2013). Moreover, BDD is often distinctly comorbid with eating disorders (EDs) (Dingemans, van Rood, de Groot, & van Furth, 2012; Jolanta & Tomasz, 2000). These viewpoints were adopted during our investigations, and we thus refer to disorders such as AN, BN and BDDs as disorders characterised by body image disturbance throughout.

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

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

Feusner, Neziroglu, et al., 2010; Suchan, Vocks, & Waldorf, 2015). Given that body image is underpinned by interrelated contributions from perception, cognition, affect and behaviour (Cash, 2012; Cash, 2004) and given the elevated level of dysmorphic appearance concerns seen in EDs and BDD, disturbances to visual perception have been proposed as a possible factor in the maintenance and development of body image disturbance. In particular, it has been suggested that preoccupations with specific body areas or flaws in appearance seen in those with EDs and BDD, might reflect a bias for processing local over global information (Feusner, Neziroglu, et al., 2010; Lang, Lopez, Stahl, Tchanturia, & Treasure, 2014). Specifically, weak central coherence, whereby detail-based, local processing is employed instead of global processing, has been observed across EDs (Lang et al., 2014) as well as in recovered ED participants (Lopez, Tchanturia, Stahl, & Treasure, 2009). This suggests that local processing bias might be a trait characteristic of those who have experienced EDs, perhaps predisposing them to, or helping them to maintain body image disturbance pathologies (Lopez et al., 2009). Weak central coherence is understudied in BDD, although there is evidence to suggest global processing disturbances and local processing bias also exists in this population (Feusner, Neziroglu, et al., 2010; Kerwin, Hovav, Helleman, & Feusner, 2014). Thus, as ED and BDD symptoms are highly comorbid (Mitchison et al., 2013) it is possible that such perceptual disturbances might underpin the high level of attention-to-detail required for the development and maintenance of body image disturbance. Studies investigating face and body processing in populations with high BIC have addressed this directly and report disturbances indicative of a focus on the features of appearance-related stimuli (Beilharz, Atkins, Duncum, & Mundy, 2016; Duncum, Atkins, Beilharz, & Mundy, 2016; Feusner, Moller, et al., 2010; Mundy & Sadusky, 2014; Urgesi et al., 2014; Urgesi et al., 2012). Interestingly, evidence also suggests that face processing mechanisms mature throughout adolescence (particularly early adolescence) into adulthood (e.g. Blakemore, 2008; Blakemore & Mills, 2014; Cohen Kadosh, Johnson, Dick, Cohen Kadosh, & Blakemore, 2013; Mondloch, Le Grand, & Maurer, 2002; Steinberg, 2005; Taylor, Edmonds, McCarthy, & Allison, 2001). The same may be true for body processing mechanisms, fostering the particular vulnerability of some adolescents to developing EDs and BDDs.

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

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

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

Experiment 2 was designed to test more directly whether disturbed configural processing of appearance-related stimuli can precede the onset of illnesses symptomatic of body image disturbance, and/or continue into recovery. To this end, we compared appearance-related configural processing mechanisms between high risk and low risk young women, as well as women who had partially recovered from EDs and BDD. 'High risk' was determined on the basis of BIC and self-objectification in those who had not been diagnosed with EDs/BDD, as self-objectification and body dissatisfaction (Strelan & Hargreaves, 2005) are known traits of disorders such as anorexia, bulimia (Calogero, Davis, & Thompson, 2005) and BDD (Lambrou, Veale, & Wilson, 2011). Furthermore, self-objectification has been identified as a contributing factor to body image disturbance (see Riva, Gaudio, & Dakanalis, 2015 for review).

We predicted that the adolescent women in Experiment 1 might report more BIC and self-objectification than the young men, given that western societal norms encourage the objectification of female bodies (Jones, 2001) and that women are more likely to experience body image disturbance than men (Striegel-Moore & Bulik, 2007). Furthermore, whilst we expected that adolescents would show normative configural processing for faces and bodies, indexed by slower RT and reduced accuracy to inverted compared to upright face and body stimuli, we thought these effects might be reduced or altered in adolescent women compared to adolescent men if, indeed, young women were to report greater levels of self-objectification and body concerns (Duncum et al., 2016; Mundy & Sadusky, 2014).

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

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

2.1.2 Ethical declaration

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

2.1.3 Apparatus and stimuli

Questionnaires

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

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

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

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

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

Body, face and house stimuli

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

FIGURE 1 HERE

2.1.4 Procedure

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

FIGURE 2 HERE

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

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

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

2.2 Results

2.2.1 Assessing the differences between young men and women

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

Independent sample t-tests revealed that as a group, adolescent women gave a relative emphasis to appearance over competence, whilst adolescent men gave a relative emphasis to competence over appearance ($t(203) = 4.664$, $p < .001$). Additionally, young women reported a higher level of BIC than young men ($t(216) = 7.828$, $p < .001$, see Table 1). The age of young men and women in the sample did not differ ($t(216) = .329$, $p = .742$).

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

Accuracy

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

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

FIGURE 3 HERE

2.2.2 Correlational analyses

A Pearson's *r* correlational analysis was conducted in order to assess the association between self-objectification and BIC, as well as to investigate the relationship between each construct and behavioural performance. In line with previous literature (Beilharz et al., 2016; Mundy & Sadusky, 2014), scores on the SOQ and the BICI, as well as RTs and accuracy to both upright and inverted bodies, faces and houses, were entered into the analysis[1]. The false discovery rate (FDR) method of correction for multiple comparisons (Benjamini & Hochberg, 1995) was applied to correlation results (α = .017), and results that did not survive correction are not reported. Figures have been colour coded so that male and female participants' data can be identified separately.

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

FIGURE 4 HERE

2.3 Experiment 1: Interim summary of results

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

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

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

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

3.1 Method

3.1.1 Participants

Body image disturbance (BID) participants

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

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

TABLE 2 HERE

High- and low-risk participants

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

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

FIGURE 5 HERE

3.1.2 Ethical declaration

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

3.1.3 Apparatus and stimuli

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

3.1.4 Procedure

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

3.2 Results

3.2.1 Inversion task performance

As in Experiment 1, accuracy and mean RTs to correct responses were calculated for each stimulus category and orientation in each participant. Again, trials with a RT higher than 5,000 ms were identified and discarded. Both RT and accuracy data were then subjected to separate 2 x 3 x 3 mixed-subjects ANOVA, with Orientation (upright vs. inverted) and Stimulus (bodies vs. faces vs. houses) as within-subjects factors and Group (low risk vs. high risk vs. BID) as a between-subjects factor. Given that configural face and body processing is reportedly disturbed in populations with high body image disturbance (Feusner, Moller, et al., 2010; Mundy & Sadusky, 2014; Urgesi et al., 2014), we planned follow-up comparisons for the three-way interaction orientation x stimulus x group. All 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 (see Figure 6) revealed a main effect of Orientation (F(1, 132) = 115.11, p < .001, η_p^2 = .47) and of Stimulus (F(2, 264) = 253.20, p < .001, η_p^2 = .66), which was qualified by a significant two-way interaction between them (F(2, 264) = 20.71, p < .001, η_p^2 = .14). As in Experiment 1, comparisons of the estimated marginal means revealed that participants were slower to respond to inverted compared to upright faces (t(134) = 6.26, p < .001), bodies (t(134) = 4.01, p < .001) and houses (t(134) = 5.27, p < .001), although as in Experiment 1, inversion effects were most prominent for faces (mean difference = 150 ms), least prominent for houses (mean difference = 43 ms), and bodies fell in between (mean difference = 55 ms). A significant Group x Stimulus interaction was also found ($F(4, 264) = 2.97$, $p = .022$, $\eta_p^2 = .04$). Follow-up comparisons revealed that there were no differences between RTs to bodies and faces in the low risk group ($t(44) = .97$, $p = 1.00$) or the BID group ($t(44) = 1.18$, $p = .717$), but that responses to bodies were significantly slower than to faces in the high risk group ($t(44) = 4.04$, $p < .001$). Orientation did not reliably interact with group ($F(2, 132) = 2.48$, $p = .088$, $\eta_p^2 = .04$) and the three-way interaction between Orientation, Stimulus and Group was non-significant ($F(4, 264) = 1.15$, $p = .335$, $\eta_p^2 = .02$). However, we investigated this interaction further for two reasons: Most importantly, separate follow-up comparisons for each group were planned a priori and as argued by Howell (2010), significant interactions in the omnibus ANOVA are unnecessary when specific simple effects are predicted by the study's hypothesis (p.372-373); Secondly, three-way interaction effects are not often found due to reduced power (McClelland & Judd, 1993), which makes it difficult to obtain statistical justification for follow-up comparisons even in studies with large sample sizes such as the present one. Thus, Bonferroni-corrected follow-up comparisons revealed evidence for inversion effects to faces ($t(44) \geq 3.47$, $p \leq .001$) and houses ($t(44) \geq 2.25$, $p \leq .026$) in all groups, as well as to bodies in the low risk group ($t(44) = 2.93$, $p = .004$). In comparison, there was marginal evidence of a body inversion effect in the BID group ($t(44) = 1.97$, $p = .053$), and evidence of a reduced inversion effect in the high risk group ($t(44) = 2.05$, $p = .042$).

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

Accuracy

ANOVA on accuracy data (see Figure 6) revealed a main effect of Orientation (*F*(1, 132) = 96.02, $p < .001$, η_p^2 = .42) and of Stimulus (*F*(2, 264) = 116.18, $p < .001$, η_p^2 = .47), which was qualified by a significant two-way interaction between them (*F*(2, 264) = 33.26, $p < .001$, η_p^2 = .20). As before, follow-up comparisons revealed that participants were more accurate when responding to upright compared to inverted, faces (*t*(134) = 10.73, $p <$. 001), bodies (*t*(134) = 3.00, p = .004) and houses (*t*(134) = 2.71, p = .005), although again, inversion effects were most prominent for faces (mean difference = 11.8%), least prominent for houses (mean difference = 1.9%), and bodies fell in between (mean difference = 3.0%). The Group x Stimulus interaction was significant (*F*(4, 264) = 3.50, p = .010, η_p^2 = .05), with follow-up comparisons revealing no differences between the groups for face or body stimuli (*t*(88) ≤ 1.56, p ≥ .38), but that the BID group was more accurate in response to house stimuli than both the low risk group (*t*(88) = 2.60, p = .033) and the high risk group (*t*(88) = 3.80, p = .001). Orientation did not interact with Group (*F*(2, 132) = .55, p = .580, η_p^2 = .01) and the three-way interaction between Orientation, Stimulus and Group was non-significant (*F*(4, 264) = .60, p = .656, η_p^2 = .01). Nevertheless, as before, we investigated this interaction further. Bonferroni-corrected follow-up comparisons revealed that whilst there was evidence for inversion effects in response to faces in all groups (t(44) ≥ 5.35, p < .001). However,evidence for inversion effects to bodies was seen only in the low risk group (t(44) = 2.06, p = .039), with marginal effects evident in the high risk group (t(44) = 1.83, p = .061) and no effects evident in the BID group (t(44) = 1.11, p = .258). Additionally, inversion effects for houses were not evident in the low risk group (t(44) = .09, p = .923) but appeared to be present for both high risk (t(44) = 2.55, p = .017) and BID (t(44) = 2.73, p = .010) groups.

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

FIGURE 6 HERE

3.2.2 Correlational analyses

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

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

FIGURE 7 HERE

3.3 Experiment 2: Interim summary of results

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

4. Discussion

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

In Experiment 1, we found higher levels of BIC and greater self-objectification in adolescent women compared to adolescent men, supporting our hypothesis. However, although questionnaire measures were positively related, they were not associated with behavioural performance. Moreover, comparable effects of body and face inversion were found between the genders. This suggests that, as a group, both adolescent men and women show typical inversion effects for both appearance-related and object stimuli. Furthermore, this suggests that although there is evidence for a slow maturation of configural face processing mechanisms throughout adolescence into adulthood (e.g. Blakemore & Mills, 2014; Mondloch et al., 2002; Steinberg, 2005; Taylor et al., 2001), configural processing of appearance-related stimuli appears to be evident by 17 years of age.

In Experiment 2, we found that the BID group showed no inversion effects for body stimuli in accuracy, and only marginal body inversion effects in RTs, as performance was comparable for upright and inverted body discrimination. This group were also significantly quicker to respond overall and were more accurate when discriminating houses than both the low risk and high risk groups of young women. Configural body processing also appeared to be somewhat disrupted in the high risk group, as there were no inversion effects in the accuracy of discriminating bodies and reduced inversion effects in RTs. Moreover, participants in the high risk group were generally slower to respond to bodies than both other groups. This suggests that atypical configural body representation is not only present in women with anorexia (Urgesi et al., 2014) and (subclinical) dysmorphic concern (Mundy & Sadusky, 2014), but that it might extend both to women recovering from disorders marked by body image disturbance and to adolescent women with high levels of self-objectification and dysmorphic concern. Typical inversion effects were seen for faces and houses in all groups and those in the low risk group also displayed typical BIEs in both RT and accuracy. As in Experiment 1, BIC and self-objectification did not systematically relate to behavioural performance but were positively related to each other. This relationship is perhaps unsurprising, as body dissatisfaction and self-objectification have both been reported as traits in both EDs (Calogero et al., 2005) and BDD (Lambrou et al., 2011). However, relatively little emphasis is given to the interaction between these two constructs, which may be of interest for diagnosis and treatment. Future research should hence consider BIC in the context of self-objectification in order to further work towards an understanding of ED and BDD aetiology. We will now proceed to discuss specific findings from each study in turn.

4.1 Appearance-related configural processing in adolescence

As expected, adolescent women showed higher BIC and greater emphasis on bodily appearance compared to bodily competence than young men, which is in line with findings from previous research (e.g. Abbott & Barber, 2010; Furnham, Badmin, & Sneade, 2002; Muth & Cash, 1997). It has been proposed that this difference may occur, at least in part, as a result of the cultural definitions assigned to what a male and female body *should* be; typically, male bodies are thought of as active and agentic, whereas the function of the female body is to be attractive and sexually pleasing (see Knauss, Paxton, & Alsaker, 2008; Smolak, 2004 for reviews) . In our study, not only did young women report higher levels of BIC but they also self-objectified to a greater extent than young men. As we also found that BIC and self-objectification were linearly related, our results therefore support the idea that body dissatisfaction in women might be motivated by the belief that the primary function of a female body is to look good. Additionally, reports show that these culturally defined bodily understandings are propagated by the media, family and peers from a young age (see Knauss et al.; Smolak, 2004 for review) , which in turn affects adolescent women more than adolescent men (Hargreaves & Tiggemann, 2004). Our results suggest that such social messages may have impacted adolescent women's body image differently from men's by the age of 17, whilst at least one study has shown that girls as young as 6 years old self-objectify to a similar extent to adult women (Jongenelis, Byrne, & Pettigrew, 2014). However, it should be noted that in our study there was essentially no evidence for particularly strong self-objectification in young women despite the differences between the genders. Specifically, adolescent women scored an average of 1.51 on the SOQ (with a range of -25 to 25), whilst a score of 25 indicates the most extreme level of self-objectification and a score of -25 indicates the opposite extreme. Furthermore, there was a clear spread of scores on both the BICI and SOQ (see Figure 1), with some young women falling within the range of lower scores. Thus, further research should address how and why some young women seem to be protected from such culturally defined body understandings as self-objectification, whilst others appear to be more susceptible to their influence.

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

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

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

Configural body processing appeared to be somewhat disrupted in the BID group, as inversion effects were not apparent in accuracy and were only marginally evident in RT. Unlike other studies (e.g. Beilharz et al., 2016; Feusner, Moller, et al., 2010; Mundy & Sadusky, 2014), the present study did find evidence for typical configural face processing in this population. It is possible that this difference occurred because a large proportion of the BID group had suffered from EDs, rather than BDD, as evidence suggests that configural body processing is disturbed in women with anorexia (Urgesi et al., 2014; Urgesi et al., 2012), whilst configural face processing is intact in anorexia (Urgesi et al., 2014) but disturbed in those with BDD (e.g. Feusner, Moller, et al., 2010). If this is the case, it suggests that appearance-related configural processing deficits in those with subclinical BIC, as in Mundy and Sadusky (2014) for example, might become disorder-specific as an illness progresses. Understanding this is particularly important for determining the aetiology of such illnesses, which is relevant for early interventions and treatment. As a result, future research should seek to assess appearance-related configural processing mechanisms in those specifically ‘at risk’ of EDs or BDD and compare them to distinct ED/BDD groups. Nonetheless, our findings show a level of disruption to body-related visual processing in women who are recovering from disorders characterised by body image disturbance and self-objectification. This is in line with research that evidences a selective deficit in configural body processing that is perhaps characteristic of women with anorexia (Urgesi et al., 2014; Urgesi et al., 2012). Furthermore, it has been suggested that the feature-based analysis of the human body, which predominates when configural representation is disrupted, may underpin, and perhaps help to maintain, fixations with perceived deficits, ‘fat’ body parts and ‘flaws’ in appearance that are typically seen in anorexia and BDD (Mundy & Sadusky, 2014; Urgesi et al., 2014). For the first time, we present evidence to suggest that this might generalise across eating and body dysmorphic disorders. As research investigating visual processing in EDs other than anorexia is scarce, this finding is of particular importance because it suggests that disturbed appearance-related configural processing should be investigated as an underlying mechanism for body image disturbance more generally. Further findings to support this, would therefore have implications for both treatment for, and recovery from, disorders characterised by body image disturbance.

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

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

Nonetheless, contrary to other studies of non-clinical participants with elevated levels of BIC (e.g. Mundy & Sadusky, 2014), we found evidence of typical configural face processing in the high risk group. It is possible that the difference occurred because we also accounted for elevated levels of self-objectification. It has been shown specifically, that self-objectification appears to be linked to body image disturbance in anorexia (see Riva et al., 2015 for review). Perhaps then, elevated levels of self-objectification coupled with high BIC is indicative of those at risk of developing EDs characterised by body image disturbance, rather than BDD. This is supported by the observation that the BID group was largely populated by women who had experienced EDs, and they too showed evidence for disturbances in the visual processing of only body stimuli. Future research should aim to address this by comparing the extent of self-objectification in EDs and BDD, whilst considering how this relates to body image disturbance. In doing do, it may help to distinctly identify those at risk of EDs and those at risk of BDD.

Participants in the high risk group were also slower to respond to bodies than other stimuli. Although not directly tested, this finding could reflect an attentional bias for disorder-relevant stimuli, as for example, Gotlib, Krasnoperova, Yue, and Joormann (2004) found that depressed participants spent more time attending to sad faces. Moreover, Horndasch et al. (2012) found that young women with EDs showed an attentional bias towards unclothed body parts, proposing that this was a behavioural manifestation of the tendency to over-evaluate the importance of body weight and shape. They go on to suggest that shifting attentional processes away from body shape may therefore help to alleviate some BIC when idealised media images are viewed. It could be argued then, that longer RTs to bodies compared to other stimuli in our high risk group, might reflect a tendency to over evaluate the importance of body weight and shape in subclinical populations. This is supported by research that shows those who rate their body as unattractive have been found to focus on their own ‘unattractive’ body parts whilst focusing on others’ ‘attractive’ body parts (Roefs et al., 2008), mirroring what has been observed in the ED population (Jansen et al., 2005). Such attentional bias for bodies may therefore initiate and help to maintain BIC [in the same way that vigilance has been proposed to initiate and maintain anxiety, see 88] through heightened attention to bodies, and in particular, one's own 'unattractive' body parts. Moreover, given that the BID group were generally faster and more accurate to respond than both other groups, such vigilant piecemeal processing over a number of years could result in a general level of expertise that means those in recovery from EDs/BDD perform particularly well on tasks of visual discrimination.

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

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

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

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

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

Beilharz et al. (2016) proposed that local processing bias might be an objective marker of BIC as accuracy rates for face and body stimuli were positively associated with BIC. We found no such relationships, which appears to put into question Beilharz et al.'s proposal. However, the difference between our findings could be due to the use of different questionnaire measures of dysmorphic concern. Beilharz et al. (2016) measured BIC with the Dysmorphic Concern Questionnaire (DCQ; Mancuso, Knoesen, & Castle, 2010), whilst we used the BICI (Littleton et al., 2005). By comparison, the DCQ is a diagnostic tool used in order to screen for BDD, whilst the BICI claims to address BIC in both EDs and BDD (e.g. Ghadakzadeh et al., 2011; Littleton et al., 2005). It is possible then, that local processing bias might be a marker for BIC in BDD but not in EDs. Further to this, Beilharz et al. (2016) did not apply any correction for multiple comparisons to their correlational results and as relationships between behavioural measures and questionnaire scores were not highly significant, perhaps interpretations are drawn beyond the power of the data. As a result, more work seeking to assess the relationship between BIC and behavioural measures of local processing bias needs to be completed before an objective marker of general BIC can be confirmed.

5 Limitations

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

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

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

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

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

6 Conclusions

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

Adolescent women in the high risk group showed altered configural body processing, as their discrimination accuracy was no higher for upright than inverted bodies. Further to this, they took longer when discriminating body stimuli, suggestive of attentional differences that may reflect either a threat response to bodies, or an overevaluation of body weight and shape. It is important for future research to address the underlying mechanisms associated with attentional differences to body stimuli in at-risk and clinical populations.

For the first time, we also report evidence for potential deficits in configural body processing in women recovering from disorders characterised by body image disturbance and self-objectification, as typical BIEs (lower and less accurate responses to inverted body stimuli compared to upright) were not observed in the BID group. Given that these women were generally quicker to respond, and were also more accurate when discriminating houses, perhaps a local processing bias underpins this altered processing, although it also suggests that such a perceptual bias is not completely specific to illness-relevant stimuli (i.e., bodies) in this population.

Therefore, not only does it seem that feature-based body processing might be an ongoing maladaptation evident in women recovering from disorders characterised by

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

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

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8. Tables and Figures

Presented as they appear within the text.

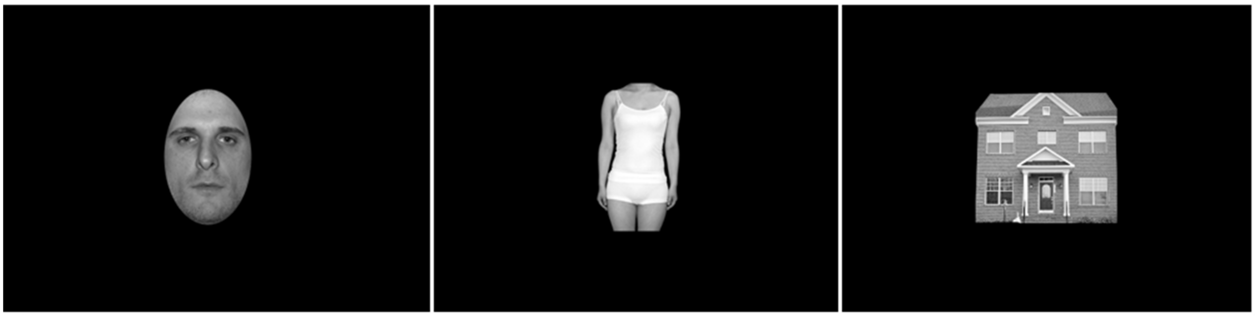

Figure 1. Example stimuli controlled for overall image brightness and presented greyscale on a black background. On the left, a neutral male face; in the middle, a female body; and on the right, a house.

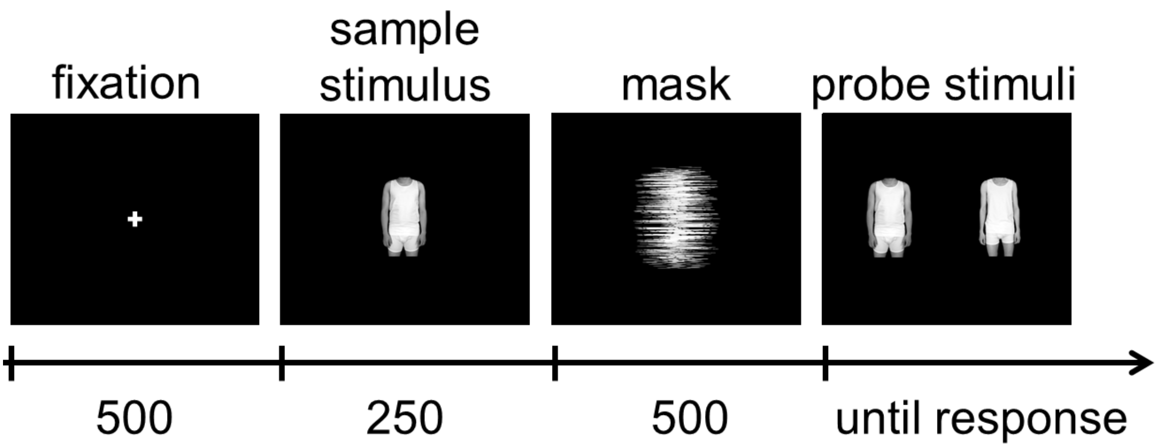

Figure 2. Stimulus sequence and timeline (in ms) of one upright body trial. Sequence and timing was the same for all upright and inverted body, face and house trials.

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.

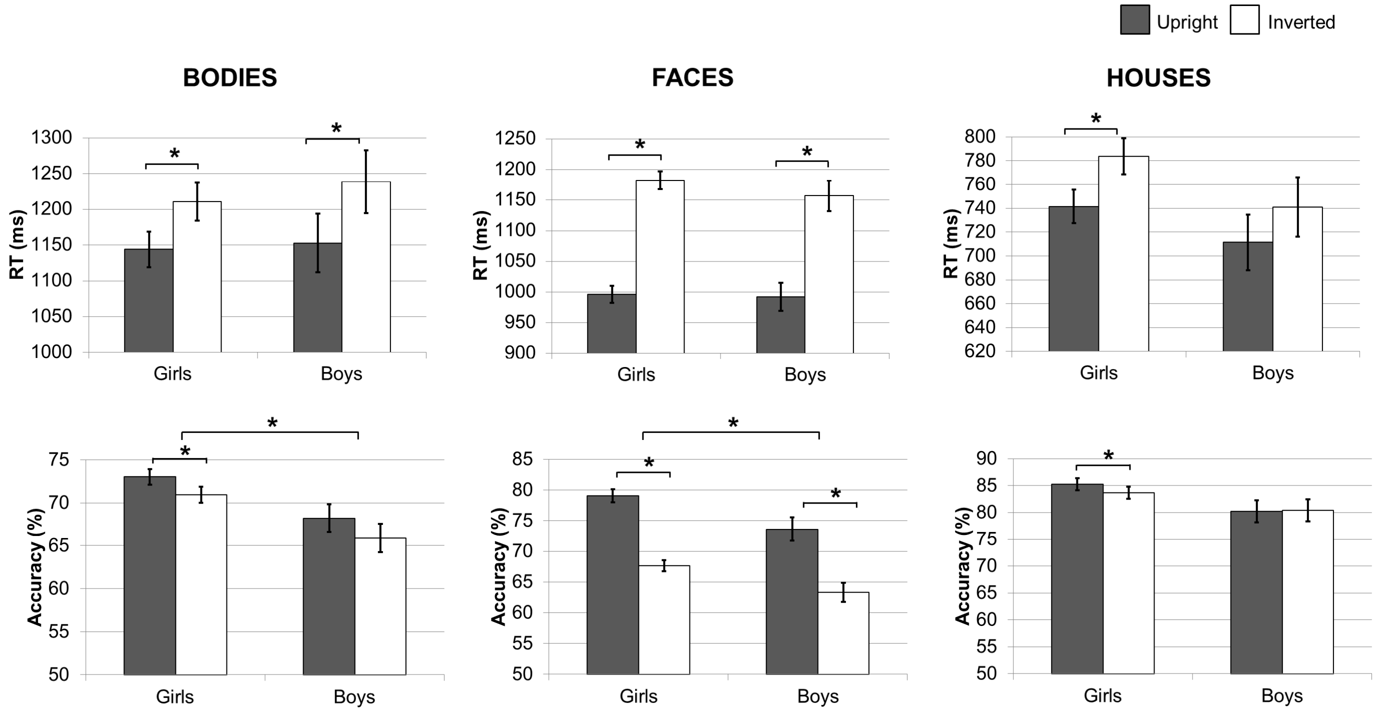

Figure 3. Top panel shows RT (ms), bottom panel shows accuracy (%), reported for young men and women. RT and accuracy to bodies can be seen in the left panel, faces in the middle panel and houses in the right panel. Responses to upright stimuli are depicted in grey and responses to inverted stimuli are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

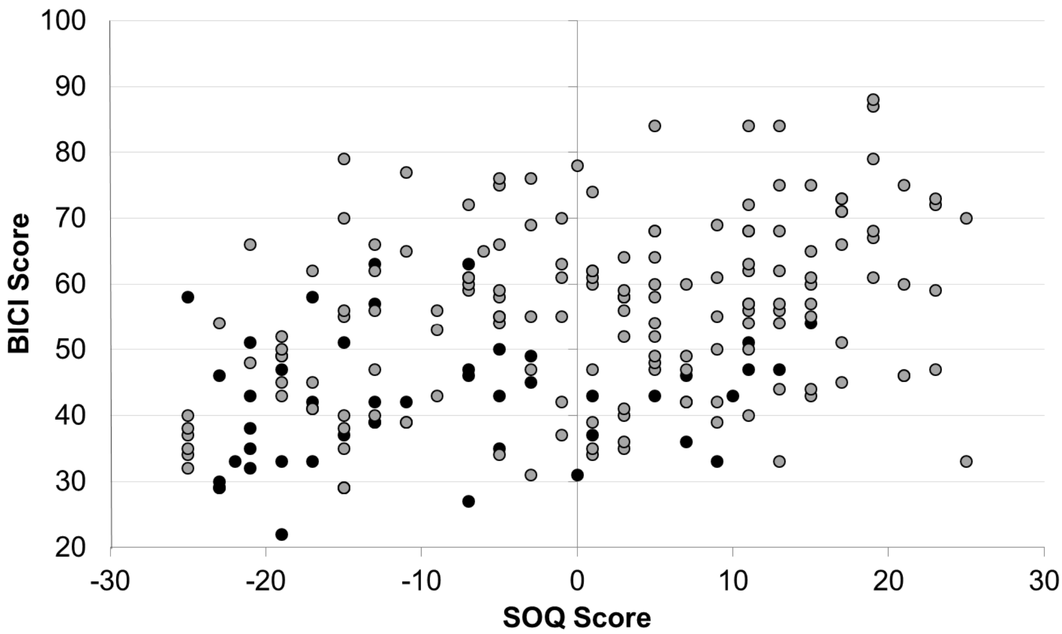

Figure 4. Moderate positive relationship between SOQ score and BICI score, *r*(205) = .41, p < .001, with young men's data in black, and young women's data in grey.

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.

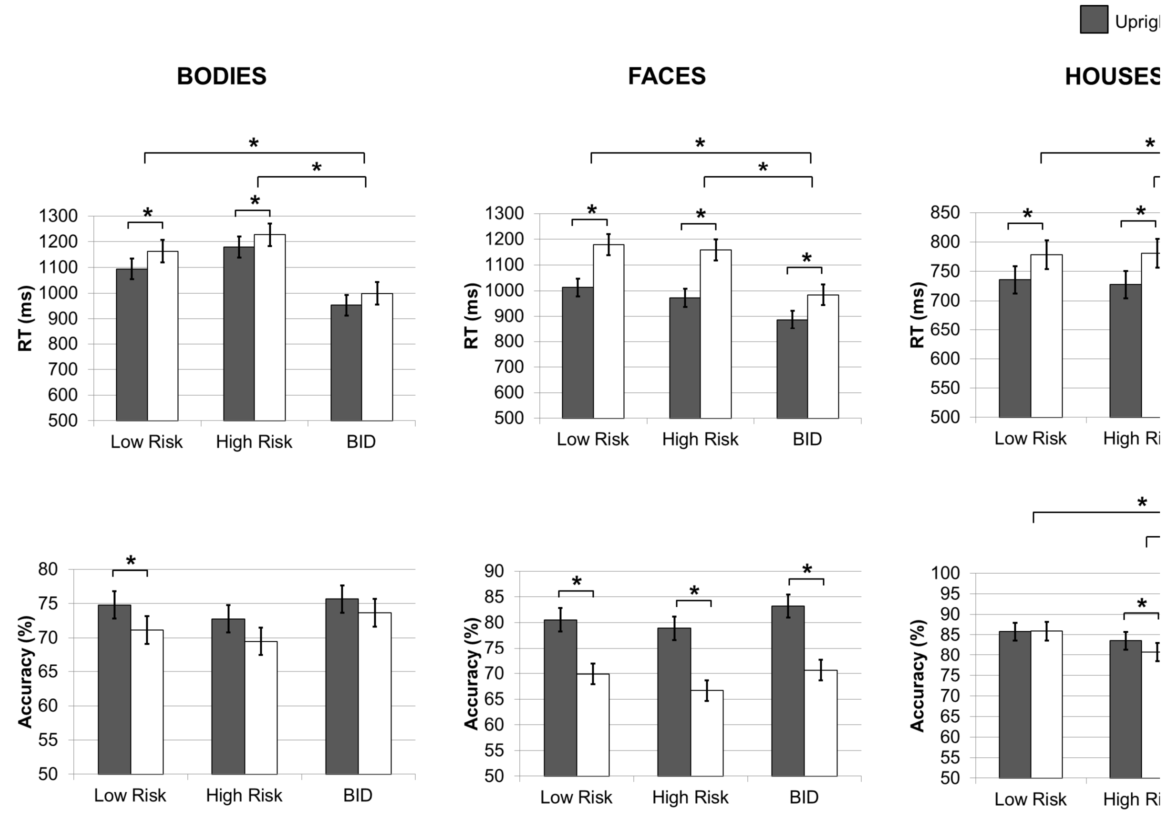

Figure 6. Top panel shows RT (ms), bottom panel shows accuracy (%), reported for low risk, high risk and BID groups. RT and accuracy to bodies are shown in the left panel, faces in the middle panel and houses in the right panel. Upright stimuli are depicted in grey and inverted stimuli are depicted in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

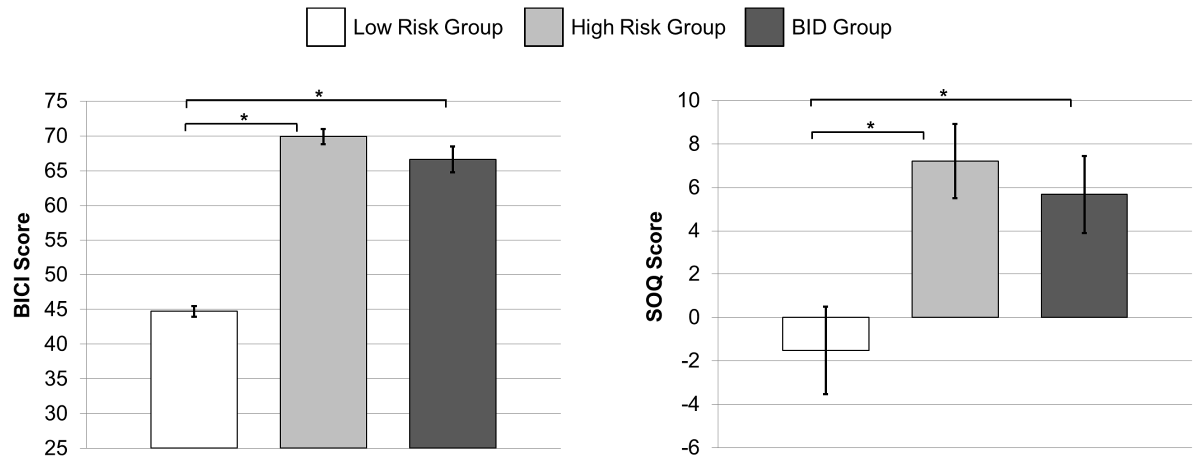

Figure 5. Left panel shows BICI scores and right panel shows SOQ scores. The low risk group is depicted in white, the high risk group in light grey and the BID group in dark grey.

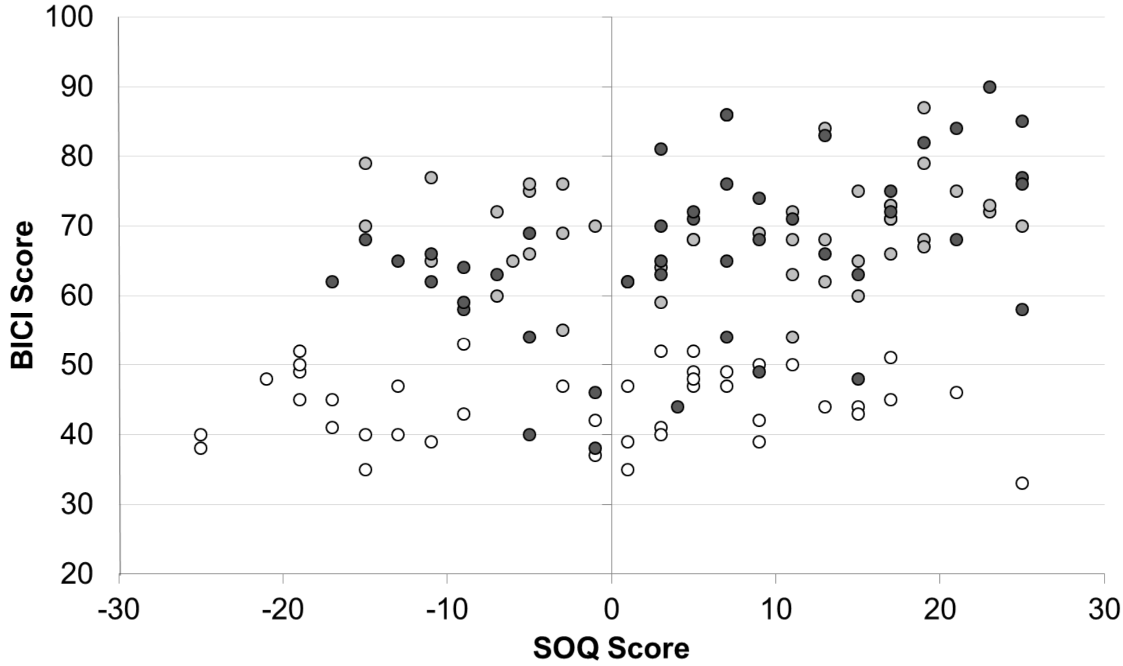

Figure 7. Moderate positive relationship between SOQ score and BICI score, *r*(133) = .37, p < .001, with data from the low risk group depicted in white, data from the high risk group depicted in light grey, and data from the BID group depicted in dark grey.