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DOI:

[10.1016/j.psychres.2013.08.009](https://doi.org/10.1016/j.psychres.2013.08.009)

Document Version

Early version, also known as pre-print

[Link to publication record in King's Research Portal](#)

Citation for published version (APA):

Monzani, B., Krebs, G., Anson, M., Veale, D., & Mataix-Cols, D. (2013). Holistic versus detailed visual processing in body dysmorphic disorder: Testing the inversion, composite and global precedence effects. *Psychiatry Research. Neuroimaging*, 210(3), 994-999. Advance online publication. <https://doi.org/10.1016/j.psychres.2013.08.009>

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Word count:

- Abstract: 183

- Text: 3,933

- Number of References: 44

- Number of Tables: 2

- Number of Figures: 4

**Holistic versus detailed visual processing in Body Dysmorphic Disorder: testing
the inversion, composite and global precedence effects**

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Conflicts of interest: none.

ABSTRACT

Individuals with Body Dysmorphic Disorder (BDD) are preoccupied with perceived defects in their appearance that are not visible to others. An excessive focus and processing of details has been proposed as a possible mechanism underlying this distorted self-image in BDD. The nature and extent of visuoperceptual abnormalities in BDD however require further investigation; specifically, it remains unclear whether feature-based processing in BDD is a result of a failure of holistic perceptual processes. The present study evaluated whether BDD is associated with an impairment in global processing. Twenty-five individuals with a primary diagnosis of BDD (15 unmedicated, 10 medicated) and 25 matched healthy controls were administered three robust behavioural tasks that test holistic encoding, namely the face inversion, the composite and the navon tasks. Overall, individuals in the BDD and control groups performed similarly in all aspects of holistic processing tested. Our findings suggest that the excessive focus on specific aspects of appearance in BDD may not be explained by impairments in the global encoding of visual information. Implications of these results and suggestions for future research on visual processing in BDD are discussed.

Keywords: Body Dysmorphic Disorder, visual processing, face, global, anxiety, psychopathology.

1. Introduction

Body Dysmorphic Disorder (BDD) is a psychiatric condition marked by an excessive preoccupation with a perceived defect in physical appearance, leading to significant distress and/or functional impairment (American Psychiatric Association, 2000). BDD is relatively common, with prevalence estimates ranging between 1 - 2% in the general population (Rief et al., 2006; Koran et al., 2008; Buhlmann et al., 2010). The symptoms of BDD have been associated with substantial psychiatric comorbidity (Gunstad and Phillips, 2003; Pavan et al., 2008), poor quality of life (Didie et al., 2007) and alarmingly high suicide rates (Phillips et al., 2005a). Although studies have shown BDD to be a familial and moderately heritable disorder (Monzani *et al.*, 2012a), with close etiological links with Obsessive-Compulsive Disorder (OCD) (Bienvenu et al., 2012; Monzani et al., 2012b), at present its precise aetiology remains largely unknown.

Abnormalities in visual processing have been proposed as a putative mechanism underlying the distorted perception of appearance that is a cardinal feature of BDD. Indeed, clinical observations, patient descriptions (Silver and Reavey, 2010) and eye tracking experiments (Grochowski et al., 2012) suggest that individuals with BDD over focus on minor or perceived flaws in their physical appearance (Phillips, 1996; Phillips et al., 2005b; Phillips et al., 2005c). Abnormal brain activation patterns during encoding of global elements of faces and objects (Feusner et al., 2007; Feusner et al., 2010; Feusner et al., 2011) have been taken as additional evidence of an excessive processing of details in BDD compared to controls. Other investigations have attempted to ascertain behavioural evidence of detailed visual processing in BDD using various experimental paradigms. For instance, Stangier et al. (2008) showed an enhanced perception of changes in facial features in a non-clinical sample of female

BDD sufferers, compared to healthy controls and dermatology patients without BDD, possibly suggesting a tendency towards detailed visual processing in BDD. Feusner et al. (2010) and Jefferies et al. (2012) both investigated the face inversion effect (FIE) in BDD. The FIE is defined as a decrement in performance for processing inverted versus upright face images and is considered as a classic ‘signature’ for holistic processing. A reduced FIE was observed, relative to healthy controls, during long stimulus presentations in these studies, possibly suggesting deficits in holistic processing in BDD. Interestingly, the reduced FIE was not evident during short stimulus presentations (500ms) (Feusner et al., 2010). Caution is however needed when interpreting the results of both FIE studies. Methodological issues such as small sample sizes, learning/practice effects from not counterbalancing the order of conditions, and the choice of stimuli (e.g. familiar versus unfamiliar face stimuli) may limit the generalizability of these findings. It is also unclear whether the reduced FIE in BDD is specific to faces or whether it holds to the same extent for objects, which would imply a general propensity to engage in highly detailed processing across all stimuli types (Yin, 1969).

Alongside these studies specifically testing detailed versus holistic processing, a number of other investigations assessed different aspects of visual information processing in BDD. Deckersbach and colleagues (2000), for instance, found female BDD participants to exhibit a disproportionate recall of details on the Rey Complex Figure Task; however, no significant impairments, or excessive focus on details, emerged in the copy accuracy condition. The authors interpreted these results as an indication of a nonverbal memory deficit, secondary to impaired strategic processing; yet, abnormalities in detailed processing accounting for these findings cannot be entirely ruled out. In a study investigating the ability to discriminate facial features,

BDD participants were found to be as accurate as OCD patients and healthy controls at recognising faces on the Benton Facial Recognition Test (BFRT) (Buhlmann et al., 2004). Similarly, when assessing the ability to detect subtle differences in symmetry of others' faces, individuals with BDD did not exhibit enhanced visual skills for symmetry compared to OCD patients and healthy controls (Reese et al., 2010). As face recognition and symmetry detection can include elements of both holistic and detailed processing, it is unclear to what extent individuals with BDD relied on detailed processing to attain the same outcomes as controls on these tasks.

Overall, it remains unclear whether the excessive focus on details in appearance and feature-based processing in BDD are a result of a failure of holistic perceptual processes. Further research is needed to evaluate the intactness of global/holistic processing in BDD, that is, the ability to integrate piecemeal information into a coherent whole. Behavioural phenomena, such as the face inversion effect (FIE), the composite face effect (CFE), and the global precedence effect (GPE), have been identified as the “signatures” or strong markers for holistic visual processing. These are well-established, robust, and related tasks capable of identifying deficits in holistic processing in other neuropsychiatric disorders such as prosopagnosia, autism and schizophrenia (Teunisse and de Gelder, 2003; Behrmann et al., 2005; Le Grand et al., 2006; Duchaine et al., 2007; Bookheimer et al., 2008; Butler et al., 2008). The present study aimed to use these paradigms to examine whether the over focus on details in appearance in BDD is attributable to a specific impairment in global processing. Based on the studies suggesting an excessive reliance on, and processing of, details (Feusner et al., 2007; Stangier et al., 2008; Feusner et al., 2009; Feusner et al., 2010; Feusner et al., 2011; Jefferies et al., 2012), we predicted impaired holistic visual processing in BDD. While the inversion face task has been previously tested on a

BDD sample (Feusner et al., 2010; Jefferies et al., 2012), to the best of our knowledge, no previous studies have investigated the composite face effect or the global precedence effect in BDD.

2. Methods

2.1 Participants

Participants consisted of 25 subjects with a primary diagnosis of BDD and 25 healthy controls with no history of Axis I psychiatric disorders. BDD participants were recruited from a specialist BDD clinic at the Maudsley Hospital (London, UK) and a support group for people with BDD. Healthy controls were recruited via the university's volunteer database and circular emails sent to members of staff. The two groups were matched with respect to age, gender and years of education (Table 1). All BDD participants met diagnostic criteria according to the Structured Clinical Interview (SCID) BDD Diagnostic Module (Phillips et al., 1995) and were required to have a score of 24 or higher on the Yale-Brown Obsessive-Compulsive Disorder Scale modified for BDD (BDD-YBOCS) (Phillips et al., 1997). Seventeen of the BDD participants met criteria for an additional Axis 1 diagnosis, namely: major depressive disorder (MDD;N=15), generalized anxiety disorder (GAD;N=3), social anxiety disorder (N=1), and/or dysthymia (N=1). Over 80% (N=22) of the BDD sample reported facial features as their primary concern with appearance. The mean age of BDD onset was 15.8 years (SD = 5.6). Regarding current treatments, 10 of the BDD participants were taking antidepressant medication at the time of the study. The

participants were either not currently receiving psychological treatment or were about to begin a course of CBT for BDD.

----- **Table 1 about here** -----

2.2 Experimental tasks

2.2.1 Inversion task

The face inversion effect (FIE) refers to a drop in performance for recognition of inverted versus upright faces as shown in healthy controls (Yin, 1969). Specifically, inversion disrupts holistic face processing, resulting in feature-based strategies to be employed and a decrease in performance for accuracy of recognition and response latencies. In the presence of deficits in holistic processing, we expect inversion not to affect performance (i.e. we expect a weak FIE).

The stimuli consisted of faces and houses, differing in terms of features (e.g. eyes, mouth, doors, or windows) or spacing between features (e.g. spacing between nose and eyes) (Yovel and Kanwisher, 2004). The face stimuli were created from a grey-scale photograph of a male face (see Yovel and Kanwisher, 2004 for more details on the original paradigm). The task involved four separate conditions (upright face, inverted face, upright house, inverted house), containing a total of 80 randomized part and spacing trials, the order which was counterbalanced. Specifically, pairs of upright or inverted stimuli, consecutively presented for 250 ms each (in line with Yovel and Kanwisher, 2004 pilot study), appeared on the computer

screen, separated by a 1000 ms inter-stimulus interval. The experiment involved indicating as rapidly and accurately as possible whether the two stimuli were the same or different via a key press; each block included 40 randomized trials of identical faces (i.e. same trials) and 40 non-matching trials (i.e. different trials). Viewing distance was 50 cm, with faces subtending $5.1^\circ \times 8^\circ$ of visual angle and houses subtending $8^\circ \times 8^\circ$ of the visual angle. Accuracy rates (percent correct) and mean reaction times were recorded for analyses.

2.2.2 Composite task

The composite face effect refers to a difficulty in matching top face halves when aligned/ fused with different bottom halves, as opposed to when they are misaligned, presumably due to holistic mechanisms instantly forming a new facial configuration (Young et al., 1987). In individuals with a propensity towards detailed visual processing, less interference from alignment is expected. The task (Le Grand *et al.*, 2004) consisted of two counterbalanced blocks: an aligned condition, whereby the top and bottom segments of faces are aligned (subtending $11.2^\circ \times 15.9^\circ$ of visual angle from a distance of 50 cm) and a misaligned condition, in which the top face half is misaligned from the bottom segments ($16.7^\circ \times 15.9^\circ$ from a distance of 50 cm). Face stimuli were gray-scale digitized images of adult male and female Caucasian faces. Each block contained 48 trials, of which 24 comprised identical top halves (i.e. “same trials”) while 24 were non-matching stimuli (i.e. “different trials”); the bottom halves of the faces were always different. The procedure involved presenting pairs of faces sequentially for 200 ms, separated by a 300 ms inter-stimulus interval. Participants indicated via key press if the top halves of the two faces were the same or if they were

different, as quickly and as accurately as possible. Accuracy rates and reaction time were recorded for statistical analyses.

2.2.3 Navon task

The navon task (Navon, 1977) is a well-suited experiment to examine the global precedence effect (GPE), defined as a preference and superiority for processing global aspects of a scene at the expenses of the local details. The paradigm (Duchaine et al., 2007) consisted of four hierarchical letters of two types: *consistent* letters, in which the global and local letters share identity (e.g. a large H made of smaller Hs) or *inconsistent* letters, in which the letters at the two levels have different identities (e.g. a large S made of small Hs). According to the GPE, the global/large and consistent letters are identified faster than the local/small and inconsistent letters.

The local and global conditions were administered in separate blocks of 96 trials each. The consistent and inconsistent letters were randomized within each block, for a total of 192 trials. Before each block, participants were instructed to attend to either the global or local letters. Each trial was initiated with a central fixation cross of 500 ms duration, subsequently replaced by one of the four possible stimuli, which remained on the screen until a response was made via key press.

2.2.4 Apparatus

The experimental tasks were presented on an Apple MacBook laptop with a 36.4 x 24.9 cm screen, using Matlab 2007b and Psychtoolbox 3.0. The apparatus recorded participants' responses and reactions times in milliseconds.

2.3 Measures

All participants were screened for Axis I disorders, using the Mini International Neuropsychiatric Inventory (MINI) (Sheehan et al., 1998). BDD diagnoses were confirmed using the SCID BDD Diagnostic Module (Phillips et al., 1995). Participants in the BDD group also completed the Yale-Brown Obsessive-Compulsive Disorder Scale modified for BDD (BDD-YBOCS), a validated, reliable, and semi-structure measure of BDD symptoms severity. Each item is scored on a 0-4 scale, with total score ranging from 0 to 48 (Phillips et al., 1997). Clinical diagnoses and assessments were carried out by the first author, a PHD student with expertise in BDD trained in the administration of diagnostic interviews, or by licensed clinical psychologists at the specialist BDD clinic (Maudsley Hospital), with years of experience with this patient group.

All participants in the study also completed self-report questionnaires, including a demographic questionnaire on age, gender and level of education, and the Hospital Anxiety and Depression Scale (HADS; Zigmond and Snaith, 1983). The HADS is a widely used 14-item measure of anxiety and depressive symptoms, with strong empirical support for its psychometric properties (Bjelland et al., 2002).

2.4 Procedure

Written informed consent was obtained from all participants at the start of the experiment. Visual acuity, with correction if necessary, was assessed using the Snellen Eye Chart. Participants were screened for BDD and Axis I disorders and asked to complete clinician-rated and self-reported questionnaires thereafter. Finally, subjects completed the three experimental tasks in the same order, namely the inversion task, followed by the composite task, and finally the navon task. A training

block was administered at the start of each experiment to assure the subjects understood the instructions and task. Study participation took place in a quiet testing room at the Institute of Psychiatry (London, UK) and lasted approximately 1.5 hours.

3. Results

3.1 Inversion task

Analyses were based on the size of the inversion effect for faces and for houses, calculated as the difference in accuracy rates and response times between upright and inverted stimuli for each participant. For both accuracy rates and response times, we performed a 2x2 Analysis of Variance (ANOVA) with Group (BDD, controls) as the between-subject factor and Stimulus (house, face) as the within-subject factor.

No Group effects [$F(1, 48) = 0.32, p = 0.57$] nor Group * Stimulus interactions [$F(1, 48) = 0.01, p = 0.97$] emerged for accuracy. BDD participants and controls exhibited an inversion effect specific for faces, and not applicable to houses/objects (Effect of stimulus: $F(1, 48) = 35.7, p < 0.001$) (Figure 1a). Similar results were found for reaction times, with orientation affecting response times during face processing [Effect of stimulus: $F(1, 48) = 11.01, p = 0.002$] more so than for houses, but again, no main effects of Group nor Group * Stimulus interactions [Effect of Group: $F(1, 48) = 0.01, p = 0.9$; Group * Stimulus interactions: $F(1, 48) = 0.002, p = 0.96$] (Figure 1b). In sum, both BDD and control groups exhibited a robust FIE in terms of accuracy rates and response times.

Further analyses were conducted to compare group performance during processing of faces differing in part-based versus spacing information (Figure 2);

again, no significant main effect of group [accuracy: $F(1, 48) = 0.05$, $p = 0.81$; reaction times: $F(1,48) = 0.65$, $p = 0.42$] was evident, indicating comparable ability between BDD and control individuals to identify changes to faces and houses that differed in parts or spacing.

----- **Figure 1 and 2 about here** -----

3.2 Composite task

The size of the composite effect was calculated as the difference in accuracy rates and response times between aligned and misaligned trials. With respect to accuracy, a 2 x 2 ANOVA, with the between subject factor of Group (BDD, controls) and the within-subject factor of Alignment (Aligned, Misaligned) revealed a significant main effect of Alignment [$F(1, 48) = 27.01$, $p < 0.01$]; both groups demonstrated enhanced performance for misaligned, relatively to aligned, faces. However, no effects of Group [$F(1, 48) = 0.50$, $p = 0.48$] or Group * Alignment interactions were significant [$F(1, 48) = 0.17$, $p = 0.68$] (Figure 3). The analyses were repeated for reaction times and, similarly, both groups appeared to be faster when processing misaligned versus aligned faces [effect of alignment: $F(1,48) = 28.7$, $p < 0.01$], but no significant group differences were found [main effect of group $F(1,48) = 0.39$, $p = 0.53$]. In line with intact holistic processing, BDD participants demonstrated a composite effect of similar magnitude to controls; both were equally facilitated during face recognition by misalignment.

----- **Figure 3 about here** -----

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3.3 Navon task

The navon task was used to examine global visual processing using non-symptom-related stimuli. Analyses were performed on response times (RT) for correct responses only. An ANOVA with Level (Global, Local) and Consistency (Consistent, Inconsistent) as within-subject factors and Group (Controls, BDD) as a between-subject factor was carried out. Consistently with the GPE, both groups showed a superiority and preference for global (large) letters at the expenses of the local (small) letters, as evidence by faster response times [main effect of level: $F(1, 48) = 252.16, p < 0.001$]. Both groups showed a similar pattern of response to the hierarchical letters with response times not differing significantly between groups [no main effect of group; $F(1, 48) = 0.03, p = 0.84$]. No interaction of Group * Level was found [$F(1, 48) = 0.34, p = 0.55$] (Figure 4).

----- **Figure 4 about here** -----

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3.4 Medication effects

Because 10 patients were on antidepressant medication at the time of the testing, we ran a 3-way ANOVA to compare the performances of medicated BDD patients, unmedicated BDD patients and healthy controls. The results revealed no statistically significant differences on any of the tasks (all p-values > 0.1) (Table 2).

----- Table 2 about here -----

3.5 Correlation analyses

We next examined whether performance on any of the tasks was correlated with BDD symptom severity and/or with anxiety and depression scores, as assessed using the BDD-YBOCS and HADS, respectively (Phillips et al., 1997). Using Spearman coefficient of correlations, we found no statistically significant associations (all p -values >0.1).

4. Discussion

The present study aimed to evaluate the integrity of visual processing in BDD by testing three of the classic hallmarks of holistic processing: the face inversion effect, the composite face effect, and the global precedence effect. To our knowledge, the current study is the first to test the composite face and global precedence effects in BDD. While two previous investigations have examined the FIE in BDD (Feusner *et al.*, 2010), the current study further evaluated whether the FIE is restricted to faces versus objects, and whether BDD patients and controls process parts and spacing information differently. Contrary to previous findings and to a holistic bias hypothesis in BDD, our findings provide converging evidence of intact global processing. Indeed, individuals in the BDD and control groups performed similarly in all aspects of holistic processing tested.

Our findings are inconsistent with previous studies that have indicated an excessive reliance on, and processing of, details in BDD (Feusner et al., 2007; Stangier et al., 2008; Feusner et al., 2009; Feusner et al., 2010; Feusner et al., 2011; Jefferies et al., 2012). Although methodological differences limit comparisons across studies on visual processing in BDD, there may be several possible reasons why we did not observe impairments in holistic processing in our patient sample.

In a previous study on the FIE by Feusner et al. (2010), no differences between BDD and controls emerged during short stimuli presentations (500 ms). When using longer (5000 ms) stimulus presentations in their study, however, BDD patients exhibited a reduced inversion effect (Feusner et al., 2010). Similarly, using unlimited exposure to images of famous people in the upright and inverted orientation, a second study (Jefferies et al., 2012) found evidence of a superior ability of BDD patients to recognize inverted faces compared to controls. These findings further converge with data from neuroimaging studies in BDD, which have also revealed abnormal brain activations during visual encoding of global elements of faces and houses presented on a screen for 3 or 4 seconds (Feusner et al., 2007; Feusner et al., 2010; Feusner et al., 2011). Taken together, it may be argued that whilst individuals with BDD present intact holistic abilities as evident during short stimulus presentations, longer exposure to stimuli may allow patients enough time to engage in a detailed processing style. Future work would benefit from further assessment of the impact of stimuli duration on performance during visual scanning in BDD.

Inconsistencies with previous findings may also be partly attributed to variation in stimuli and sample characteristics across studies on visual processing in BDD. A major difference between our study and Jeffries et al.'s FIE experimental paradigm (2012) was the degree of familiarity with the face stimuli. Their study presented

images of famous people in the upright and inverted orientation. Patients with BDD frequently compare their own features to those of celebrities and this could have resulted in better recognition of inverted faces of famous people relative to controls, possibly reflected in their reduced FIE. Using unfamiliar face images in our study allowed us to test the more classic FIE and control for the effect of familiarity on face recognition; it is however possible that individuals with BDD apply different encoding strategies to familiar and unfamiliar faces. Differences in results with previous studies may also arise from task-related issues, such as morphing, averaging, and cropping techniques. As opposed to Feusner et al.'s (2010) FIE paradigm, face stimuli in the current study were not morphed or cropped, which may affect the level of task difficulty and ultimately influence the results. Finally, Stangier et al. (2008) found that BDD patients were more accurate at detecting subtle changes in facial features. In our study, BDD and controls were equally efficient at recognizing faces that differed in parts and/or spacing between parts. The reasons for these discrepant findings are not clear, though differences in sample characteristics are worth noting however. Whereas our sample included male and female participants with severe BDD, Stangier' sample included only female BDD sufferers with mild-to-moderate BDD and a low rate of comorbidity.

Finally, testing conditions varied significantly between our study and previous investigations. Feusner et al. (2010) used simultaneous presentation of face pairs. With long and simultaneous presentations, participants have ample opportunity for feature-based scanning, which is less feasible during short and sequential matching tasks. In our navon task, participants were instructed to attend to specific information (global or local elements) at the start of each block. Previous studies on autism, however, have observed discrepancies in findings when using this approach compared

to a divided attention version of the Navon task, in which participants were given a choice of which level to attend for the identification of a target (Plaisted et al., 1999; Koldewyn et al., 2012). These task-related issues raise an interesting question as to whether visual abnormalities in BDD could stem from a *preference* to process local information when given the choice by testing conditions, as opposed to a deficit in global or detailed processing. Further research is needed to test this hypothesis and examine whether the excessive focus on details in BDD is associated with a difference in preference or choice, in the absence of an actual impairment.

A number of limitations should be considered when interpreting the findings from this study. The modest sample size also impeded exclusion of BDD participants with comorbid mood or anxiety disorders from our analyses. However, since most individuals with BDD meet criteria for an additional axis I diagnosis (Phillips et al., 2005c), it can be argued that this is an ecologically valid sample. Some of the patients were on medication. While we found no statistically significant differences on task performance between medicated and unmedicated patients and controls, these analyses may have been underpowered; moreover, the effects sizes for the FIE task were in the medium to large range. Taken together, therefore, we cannot fully rule out the possibility that medication had an impact on our findings. Future research should attempt to recruit unmedicated patients, although this is not always feasible given the high-risk nature of this patient group.

With these caveats in mind, and to conclude, the current study provides evidence of intact holistic processes during visual encoding in BDD. Our results therefore do not support the hypothesis that the excessive focus on aspects of physical appearance associated with BDD is due to a deficit in holistic processing.

Acknowledgements

We are most grateful to Dr Yovel, Dr Maurer, and Dr Duchaine for providing the experimental tasks and to Dr Ana Costa for her help with recruitment.

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Table 1. Demographic characteristics (mean and standard deviations) of the BDD and control groups.

	Controls (N=25)	BDD (N=25)	p value*
Age	30.4 (9.4)	29.4 (7.5)	0.68
Gender	16 F, 9 M	14 F, 11 M	0.56
Education	16.9 (1.6)	15.9 (1.9)	0.05
BDD-YBOCS	-	32.7 (3.9)	-
HADS	3.4 (2.8)	20.4 (8.5)	<0.01

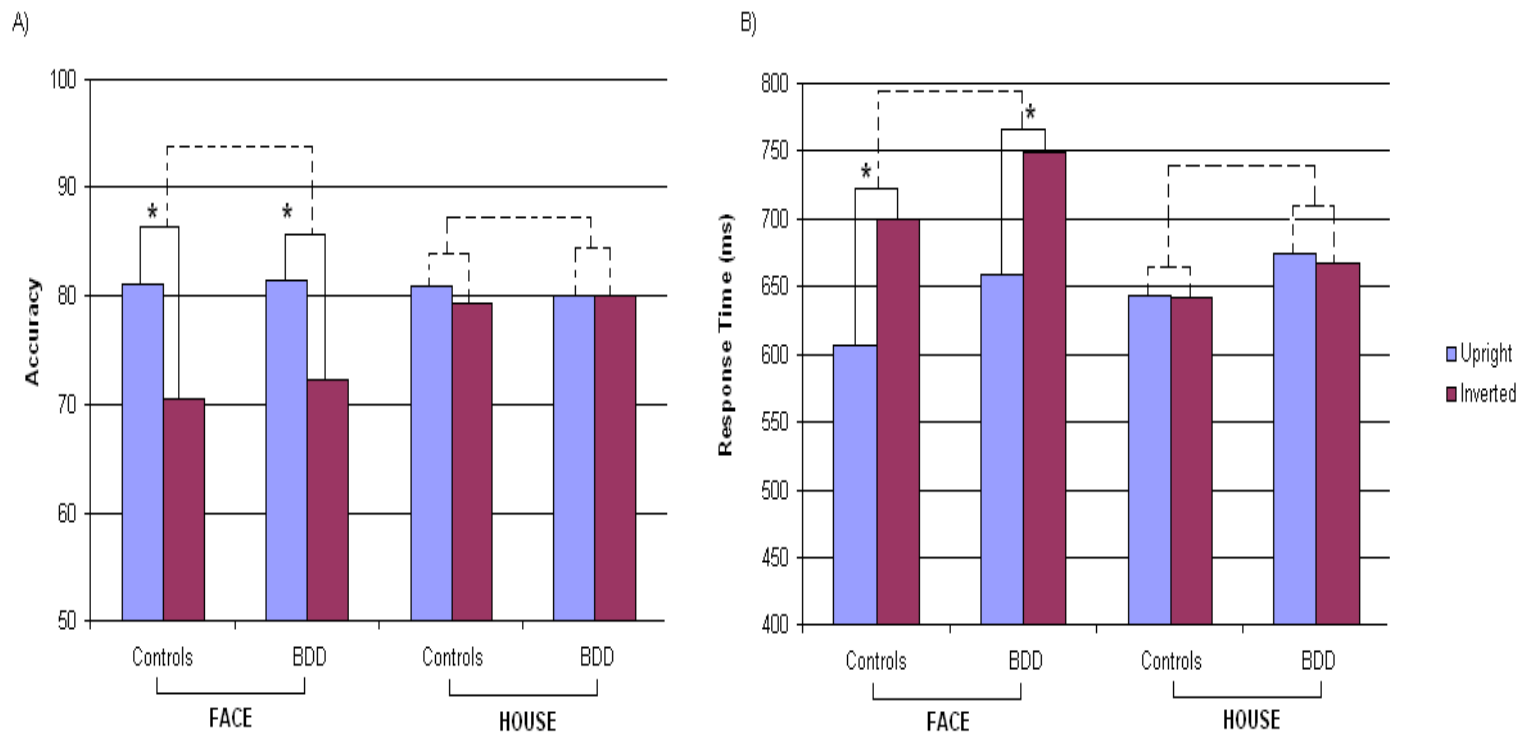
Abbreviations: BDD, Body dysmorphic disorder; BDD-YBOCS, BDD version of the Yale-Brown Obsessive-Compulsive Disorder Scale; HADS, Hospital Anxiety and Depression Scale. * Based on t-test and χ^2 test analyses.

Table 2. Three-way ANOVA results of test performance for medicated and unmedicated BDD patients and healthy controls.

	<i>F</i>	<i>p value</i>	η_p^2
<i>Face Inversion Task</i>			
<i>Accuracy</i>	2.44	0.1	0.09
<i>Reaction Times</i>	2.11	0.13	0.08
<i>Composite Face Task</i>			
<i>Accuracy</i>	0.25	0.77	0.011
<i>Reaction Times</i>	0.24	0.78	0.010
<i>Navon Task</i>			
<i>Reaction Times</i>	0.02	0.97	0.001

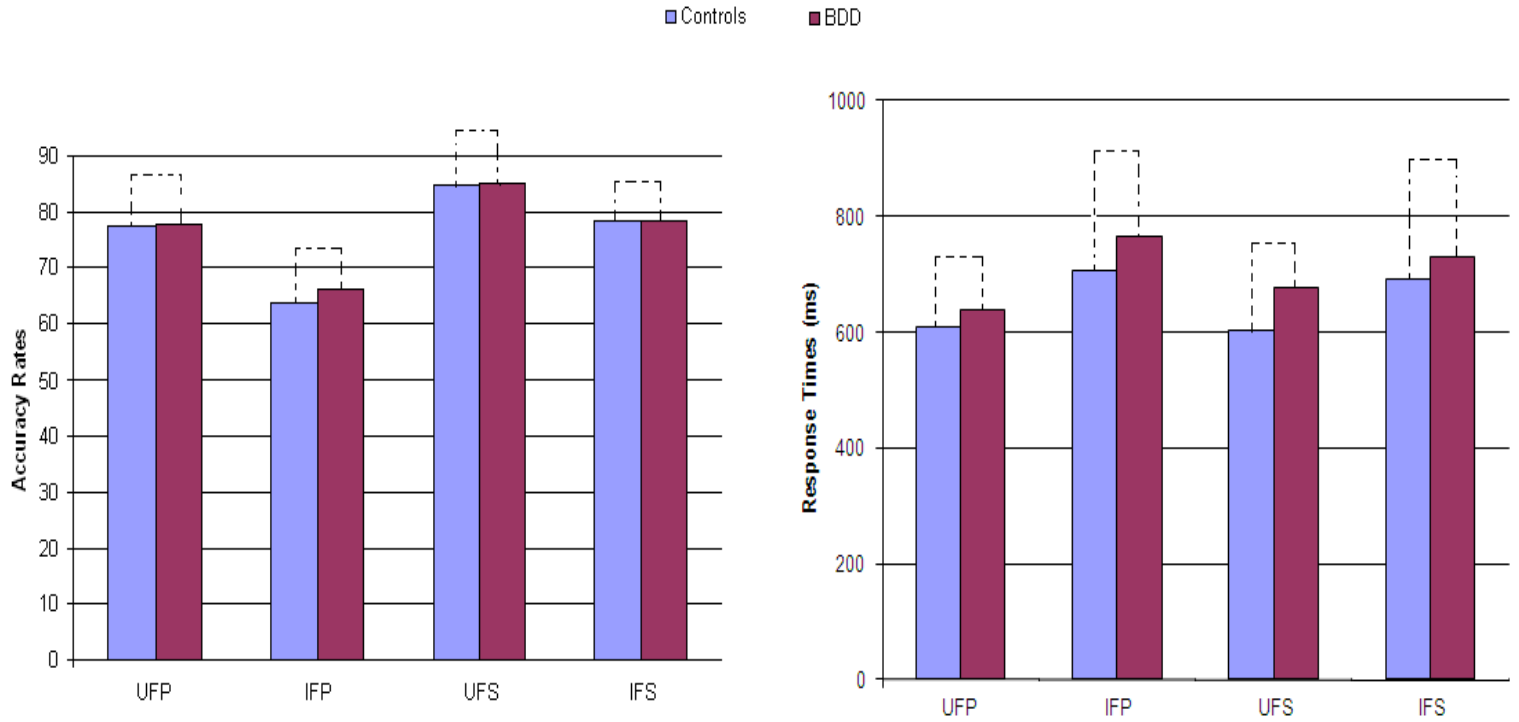
Abbreviations: η_p^2 , Partial Eta Squared

Figure 1. Performance on upright and inverted faces and house stimuli in BDD patients versus healthy controls.



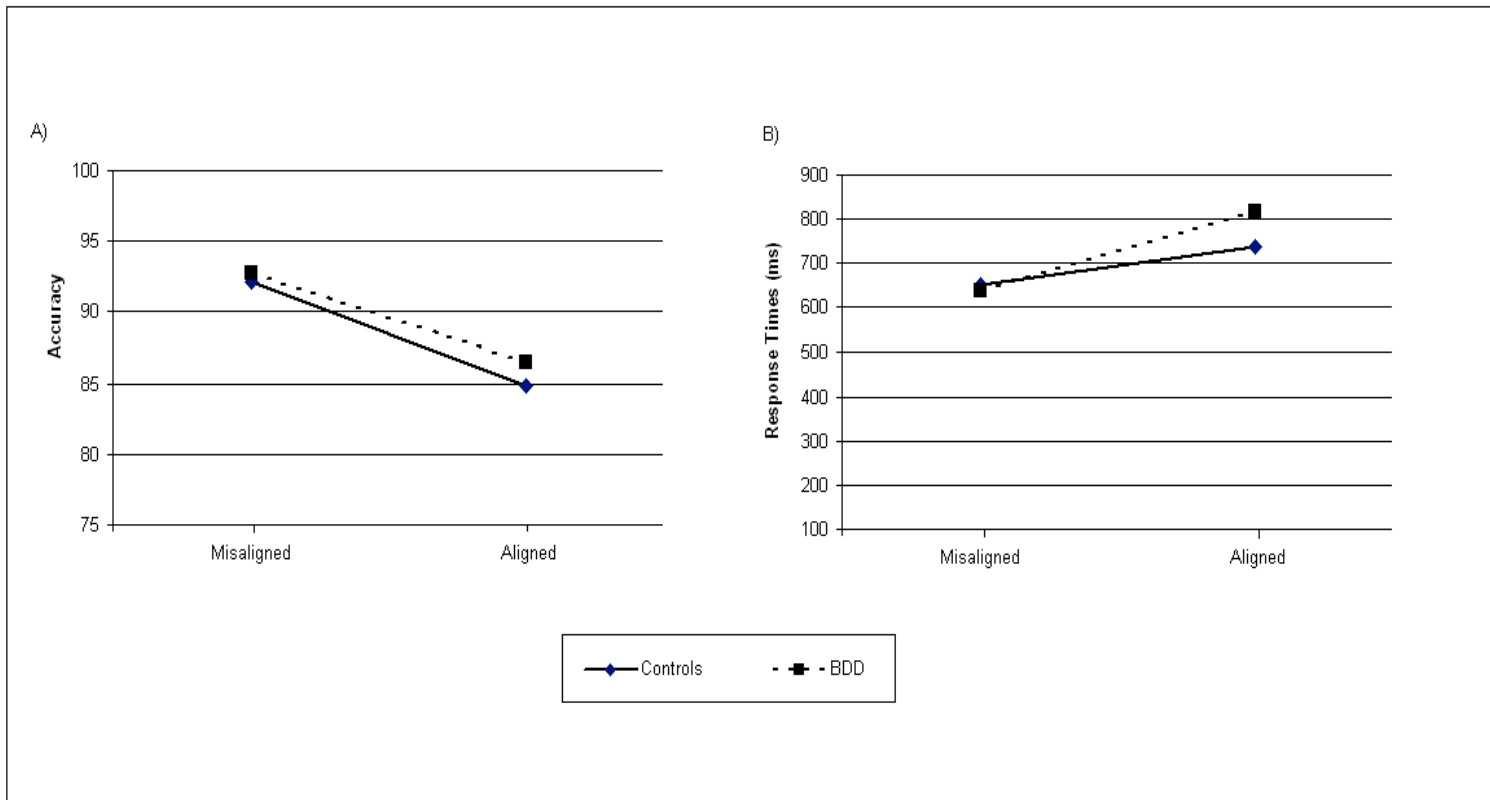
Percent accuracy rates (A) and response times (B) for upright and inverted face and house stimuli. Continuous lines and asterisks denote statistically significant comparisons ($p < 0.05$); dotted lines represent non significant comparisons.

Figure 2. Face inversion effect (upright – inverted) for part and spacing visual information in BDD patients vs healthy controls.



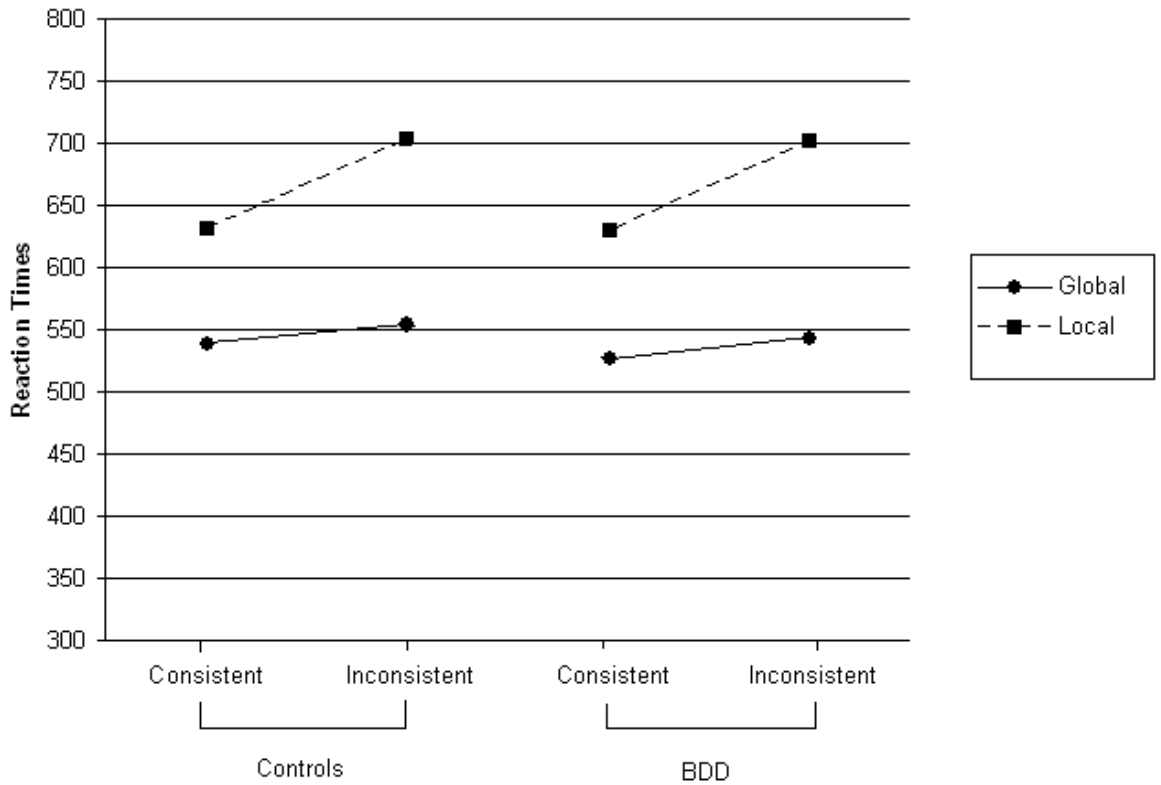
UFP, upright face parts; IFP, inverted face parts; UFS, upright face spacing; IFS, inverted face spacing. Dotted lines represent non significant comparisons.

Figure 3. Results of the composite face effect task.



Percent accuracy rates (A) and response times (B) for aligned and misaligned faces.

Figure 4. Results of the global precedence effect task.



Reaction times for BDD and controls on the navon paradigm for global (large) and local (small) stimuli.